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The intersection of learning difficulties and behavior problems – a scoping review of intervention research

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Learning difficulties (LDif) and behavioral problems (BP) frequently co-occur. Affected students typically require interventions targeting learning-, social-, as well as emotional and behavioral-domains. The goal of this scoping review is therefore to provide an overview of the research on interventions that target these critical areas for students with or at-risk of disabilities. In total, 48 relevant studies were identified and analyzed regarding addressed competencies, target groups, the setting of the interventions as well as underlying causal assumptions. The review identified a variety of interventions and approaches designed to address LDif and BP, which makes it impossible to draw conclusions on a single best approach. Co-occurring LDif and BP reflect a plurality of difficulties that are incompatible with a 'one size fits all' approach. The vast majority of studies assumed that the relationship between LDif and BP are reciprocal/unidirectional. Few studies focused common variables that potentially affect both LDif and BP. In addition, the majority of studies addressed child-level variables. Future research should be conducted to focus on variables at the environmental or institutional level that might impact both LDif and BP.

KEYWORDS

learning difficulties, behavioral problems, intervention, literature review, school – aged children

1. Introduction

In educational contexts, learning difficulties can be observed frequently and across different settings. While most students struggle in institutionalized learning only for a limited time and in isolated areas during their school life, some students experience persistent and pervasive failure. Such failure is often labeled using different terminologies such as learning disabilities, specific learning disorders or special educational needs (e.g., Grigorenko et al., 2020; Mähler, 2020; Krämer et al., 2021). In light of the plurality of categories, it is not surprising that there 'is no universally agreed definition of learning difficulties' (MacKay, 2009, p. 10). 'Learning difficulties' might thus be regarded as an umbrella term for variations of different learning deficits (Lenhard et al., 2013) that differ in severity and chronicity. Hereby (specific) learning disabilities (LD) can be regarded as the most severe forms of low achievement (Kavale and Forness, 2000), which manifest in varying forms and are of pervasive nature. Students with LD usually exhibit major difficulties in at least one of different basic areas of learning (reading, writing, math and/or language) (Kavale and Forness, 2000). In this paper, we use the term learning difficulties to describe the overarching category of learning deficits that encompasses specific operationalizations. When research findings are based on a specific operationalization

of learning deficits, however, this will be named accordingly in the theoretical explanations. This leads to a use of different terminology (learning difficulties, learning disorders, learning disabilities).

Traditionally, learning disabilities were described as underachievement that relied on ability-achievement discrepancies in the identification (e.g., Kavale and Forness, 2000; Grigorenko et al., 2020). The current ICD-11 criteria are yet other criteria that still are used to define specific learning disorders as an achievement that 'is markedly below what would be expected for chronological age and general level of intellectual functioning' to assign the label of developmental learning disorders (World Health Organization, 2023). The Convention on the Rights of Persons with Disabilities (UN General Assembly, 2006) however defines disabilities as a result of the interaction between individuals with impairments and various barriers in their daily environment emphasizing a social model of disability. Hence, learning disabilities might be regarded as a consequence of a mismatch between students' profiles (e.g., working memory deficits, lack of metacognitive control) and societal barriers (e.g., the quality of the instruction, structure of teaching materials). Therefore, it is not surprising that other recent conceptualizations are increasingly moving away from emphasizing achievement discrepancy criteria and highlight inadequate responses to school-based interventions as 'an alternative inclusion criterion' (Grigorenko et al., 2020, p. 39).

As mentioned above, despite the variations of learning difficulties, they occur frequently in schools and often result in both academic and behavioral problems. Students with learning difficulties depict the largest group among students with special educational needs (SEN). In Germany, approximately one third of all students with SEN is identified as having learning difficulties (KMK, 2020). Consistently, Grigorenko et al. (2020) state that learning disabilities are the largest category of SEN in the United States. From a clinical perspective, Moll et al. (2014) point out that specific learning disorders are among the most common mental disorders in children and adolescents. At the same time, different and inconsistent diagnostic criteria are applied, which leads to differences in the estimated prevalence across studies (MacKay, 2009). Hence, broader or unspecific diagnostic inclusion criteria might result in higher prevalence estimates. Regardless of the exact prevalence rate, teachers are faced with the challenge of meeting the needs of students with learning difficulties on a daily basis. This becomes even more important as more and more schools move to inclusive school models, causing an increase in the number of students with special educational needs in these schools. In this regard, the importance of teachers' self-efficacy concerning the implementation of inclusive teaching has been stressed (De Neve et al., 2015; Kiel et al., 2020). Designing appropriate educational support for students with such specific needs might further require special knowledge such as insights into potential causal explanations of learning difficulties as well as information on effective interventions.

1.1. The Interplay of learning difficulties and emotional/behavioral problems

The development of learning difficulties can be explained from different theoretical perspectives. Neuro-biological approaches, which emphasize cognitive determinants in explaining academic achievement (Lenhard et al., 2013), belong to the most prominent explanations of LD (Büttner and Hasselhorn, 2011). Here, neuro-cognitive determinants exemplary comprise working memory (e.g., Maehler and Schuchardt, 2011), attentional processes (e.g., Gadeyne et al., 2004; Commodari, 2012; Rabiner et al., 2016) or metacognition (e.g., Ohtani and Hisasaka, 2018). However, socio-emotional variables might additionally explain the development and manifestation of learning difficulties. In line with this, associations of academic achievement and variables such as (academic) self-concept (e.g., Chapman, 1988), motivation (e.g., Sideridis, 2009) as well as emotions (e.g., Pekrun et al., 2017; Sainio et al., 2019) are described.

In light of these findings, it is not surprising that additional socio-emotional or behavioral problems are described for students who struggle in academic learning. These can be of internalizing or externalizing nature (Willcutt and Pennington, 2000; Visser et al., 2020). With regard to internalizing behaviors, Visser et al. (2020) highlighted that 20% of the students with specific learning disorders fulfilled criteria of anxiety disorders, almost 30% showed depressive symptoms. Willcutt and Pennington (2000) report high levels of anxiety and depression in children and adolescents with reading difficulties. A meta-analysis by Nelson and Harwood (2011) revealed higher anxiety scores for children with learning difficulties in comparison to their peers. In addition, struggling learners report lower levels of school well-being (Ingesson, 2007; Benassi et al., 2022).

Several studies highlight that externalizing behaviors seem to co-occur with learning difficulties as well. Some time ago, Kavale and Forness (1996) suggested that up to 75% of the students with learning difficulties show problems in their social behavior. More recently, Visser et al. (2020) report increased rates of conduct disorder and ADHD in children with specific learning disorders. Similarly, Willcutt and Pennington (2000) found that students with reading difficulties are more likely to meet the criteria of ADHD as well as oppositional and conduct disorders. Multiple studies report negative associations between behavioral problems and academic achievement *per se* (e.g., Nelson et al., 2004; Algozzine et al., 2011; Ennis et al., 2018). Breslau et al. (2009) found that internalizing and externalizing problems at the age of 6 negatively predicted academic achievement at the age of 17. Similar results are reported by Malinauskiene et al. (2011), who showed that delinquent behavior as well as somatic symptoms were accompanied by lower academic achievement. The relation between behavioral problems and learning difficulties seems to be particularly strong for externalizing behaviors as well as attention problems, which have negative effects on academic success (Barriga et al., 2002; Nelson et al., 2004; Masten et al., 2005; Breslau et al., 2009; McLeod et al., 2012). The specific relevance of attention processes is further stressed by studies that examine academic outcomes of children with attentional difficulties (e.g., ADHD). Rabiner et al. (2016) found that inattention in grade 1 leads to lower academic achievement in grade 5. Furthermore, a study by Mayes et al. (2000) indicated that more than two thirds of the students with ADHD showed learning difficulties. Similarly, Dietz and Montague (2006) showed high levels of comorbidity between ADHD, emotional and behavioral disorders and LD. Horbach et al. (2020) discuss that ADHD moderates the relationship between specific learning disorders in reading/spelling and behavioral difficulties. When explaining the link between learning difficulties and attentional problems, several recent studies addressed a range of variables. E.g., Child et al. (2019) examine potential correlates of reading, math and attentional skills. They identify working memory and phonological awareness to play an overlapping role. Peterson et al. (2017) extend these results by further highlighting

processing speed to be associated to the overlap of reading, math and attention. At the same time, specific executive functions were related to each domain. Regarding the vast body of research on the association of ADHD and learning difficulties, it is not surprising that a range of intervention studies consequently focused co-occurring ADHD and learning difficulties (DuPaul et al., 2012; Fabiano et al., 2021).

1.2. Models of comorbidity and appropriate interventions

In practice, co-occurring learning difficulties and behavioral problems (such as ADHD) might pose a particular challenge for teachers and students (Rock et al., 1997). Questions on how to address co-occurring problems ask for necessary insights into causal patterns of the comorbidity of both phenomena. Among other, the interplay of learning and behavioral difficulties might be explained in light of different theoretical models of comorbidities (e.g., Neale and Kendler, 1995; Pennington, 2006). Here, different scenarios of comorbidity of multifactorial phenomena are distinguished, which might serve as a framework for clustering co-occurring learning difficulties and behavioral problems. Such explanations can be traced back to the works of Pennington (2006), who argues (in the case of reading disorder and ADHD) that "each individual disorder would each have its own profile of risk factors (both etiologic and cognitive), with some of these risk factors being shared by another disorder, resulting in comorbidity" (p. 404). Such multiple deficit models focus on overlapping explanatory variables that might be addressed to influence both domains. The causal link between learning difficulties and behavioral problems can thereby be explained by a range of variables. For example, students' working memory capacity as well as executive functions could have an impact on their academic achievement as well as on their classroom behavior. Potentially influencing variables might be located on the neuro-biological level (e.g., self-regulation skills, executive functions, attention), as well as environmental level (e.g., socio-economic background, parenting style, instructional quality). In contrast, single-deficit models depict alternative explanations. Here, models of multiformity (or symptom phenocopy hypothesis) by Neale and Kendler (1995) describe that an increased risk for difficulties in one area leads to difficulties in a second area. For example, learning difficulties could lead to an increased risk of inattentive or hyperactive behavior in the classroom or inattentive behavior could increase the risk of having learning difficulties. Based on these assumptions, variables associated with either behavior problems or learning difficulties can be addressed in a first step to indirectly influence the second area of interest. At the same time, the validity of single deficit models for explaining heterotypic comorbidities (e.g., learning and behavioral difficulties) has been questioned (Moll et al., 2020). Nonetheless, single-deficit models are still being applied in current research.

Differentiating models of comorbidity in practice might be difficult, however, deciding on the causal model of reference and key variables to address seems to be crucial for the development of effective and appropriate interventions. Insights into effective existing interventions trying to target aspects of both learning and behavior might support practitioners' decisions on the most appropriate approach. The importance of such interventions is additionally stressed by the fact that students with co-occurring problems might be more severely impaired than students with just one problem area (Mayes et al., 2000; McLeod et al., 2012) and benefit less from the interventions applied (Rock et al., 1997; Rabiner et al., 2004; Herzog and Casale, 2022).

1.3. Research aim

The high frequency of co-occurring learning difficulties and behavior problems stresses the importance of specific interventions for this group of students. However, up until today an overview of effective interventions is lacking. At the same time, insights in promising approaches might support researchers and practitioners in choosing and developing the most appropriate instruction for affected students. Thus, the aim of this systematic scoping review is to give an overview of evaluated interventions that address both learning difficulties and behavioral problems within their research design.

The objective of this review is to:

(1) describe the interventions applied in research studies,

(2) summarize the outcomes and competencies addressed by the interventions reviewed,

(3) determine the descriptive characteristics of students included,

(4) describe the nature and the setting of the interventions,

(5) describe the underlying causal assumptions.

2. Methods

2.1. Search procedure

To answer the aforementioned research questions, relevant articles were identified in a first step. Therefore, the databases PubPsych and PsycINFO were searched using the following search-syntax:

- To address learning and behavior problems:
  - AB:(learn* OR math* OR read* OR litera* OR arithmet* OR num* OR achievement OR scholastic OR writ* OR spelling OR dyslex* OR dyscalculia OR acalculia OR agraphia)
  - AB:(behav*r OR emotion* OR social* OR internal* OR externaliz* OR attention OR ADH* OR depress* OR anxiety OR fear OR psych*) **AND** AB:(problem* OR difficult* OR poor)
- To identify intervention studies:
  - AB:(intervention OR promot* OR improve* OR enhance* OR stimulat* OR train* OR treatment OR therapy OR program OR tutor* OR support OR best practice)
- To address comorbidity:
  - AB:(comorbid* OR co-occur* OR combin*)
- To identify a school-aged sample:
  - AB:(child* OR adoles* OR school* OR)
- To exclude studies on intellectual disabilities and autism:
  - NOT AB:(intellectual disabilit* OR autis*)

Additional to the descriptors above, German synonyms were used in the search syntax. All key areas were combined by the Boolean operator AND. The descriptors were used to browse the abstracts of records. The exclusion criteria was included after an initial search yielded in the identification of multiple records focusing autism or persons with intellectual disabilities. In order to exclude these studies early in the identification process, the initial search syntax was adapted.

2.1.1. Inclusion and exclusion criteria

Studies needed to fulfill the following criteria to be included in the review:

- The study is an intervention study. Medication studies without any further interventions were excluded. Regarding the research design, all kinds of designs (e.g., randomized controlled trials, multiple baseline designs, single case studies) were included.
- Both learning and behavioral dimensions were included as dependent variables in the study design.
- The sample was of school age (5–17 years).
- Participants had at least problems in one of the target areas (learning or behavior) prior to the intervention.
- The study was published in a peer-reviewed journal in English, German or Dutch language.
- The publication date was less than 25 years ago.

We decided to include studies, in which participants only had problems in one of the target areas (learning difficulties or behavioral problems), in cases where both learning and behavioral dimensions were included as dependent variables. This approach might result in different categories of studies: a) studies that explicitly assume comorbid learning difficulties and behavioral problems prior to the intervention; b) studies that implicitly assume comorbid learning difficulties and behavioral problems prior to the intervention; c) studies that do not assume comorbidity but examine transfer effects across domains. To decide which category a study belongs to, the rationale within the studies was examined. An example of studies in category b) would be a study in which the included sample has difficulties in only one domain, but the authors argue theoretically that students with problems in that domain typically also have difficulties in the other domain, or when they describe a risk factor that could underlie both target domains without explicitly testing for co-occurring difficulties in their sample.

2.2. Study selection

The initial search yielded in 4059 articles (02/18/21). Following the PRISMA-guidelines (Moher et al., 2009), duplicates were removed first. Afterwards, articles that were not published in any of the aforementioned languages were excluded. The remaining 3,140 articles were included in a title screening, which led to the exclusion of the majority of studies. At the same time, all sources that could not be identified as empirical articles describing an intervention study (e.g., dissertations, book chapters) were excluded. 346 studies were included in the abstract screening. Due to the long-lasting screening process, the literature search was repeated for a second time (04/29/22). At the same time, references of the included articles were searched for relevant studies. This resulted in 97 full-texts that were assessed for eligibility. A total of N = 48 full-texts were included in the review at hand (see Figure 1). Included references are marked with an asterisk in the reference list. During the screening process all studies were assessed by the first author and a second person (student assistant) separately. In case of disagreements, they were resolved by discussing the critical articles until a consensus was reached.

2.3. Data extraction

The platform 'Covidence' (Veritas Health Innovation, 2022) was used for study selection and data extraction. 'Covidence' allows to create a digital data extraction template, which can then be used to extract all relevant information from the included articles. Apart from the relevant information to answer the research questions, general information about the studies such as author(s), title, publication date and country, in which the study took place, were extracted. The relevant data to answer the research questions include information on:

- *Research questions and research design*: It was coded whether a qualitative or quantitative approach was applied, which type of research design (e.g., experimental or single case) was used, whether a control group was present and if so, what kind of control group (e.g., waiting control). In addition, design specifics, such as the number of measuring points were extracted. The dependent variables, which targeted learning and behavior difficulties, as well as specific research questions were coded.
- *Description of the sample:* The derived information about the sample include sample size, gender distribution, age range, mean age and/or class level, school level as well as the learning difficulties and/or behavior problems that were described prior to the intervention.
- *Intervention*: To get an overview of the different interventions, several information were gathered. These include duration of the intervention (e.g., timespan, number of sessions, length of each session), implementation specifics (e.g., group size, setting) as well as addressed competencies.
- *Causal assumptions:* The information comprised assumptions of comorbidity described in the studies. To extract this information, the rationale throughout the theoretical background of the studies was analyzed.
- *Main findings of the study:* The main findings of the study regarding the target areas were summarized.

Data extraction was conducted by the first author. To pilot the data extraction template, 10 studies were randomly selected and additionally coded by the same student assistant that helped during the initial screening. The initial agreement between both raters was approx. 65%. Disagreements were consequently discussed, and the extraction template was adapted accordingly. To minimize the number of inaccuracies, as many single choice options as possible were used in the final template. Free text fields mostly asked for very short and clear information such as sample size, gender ratio or name of the implemented training program (if applicable). Potential limitations of

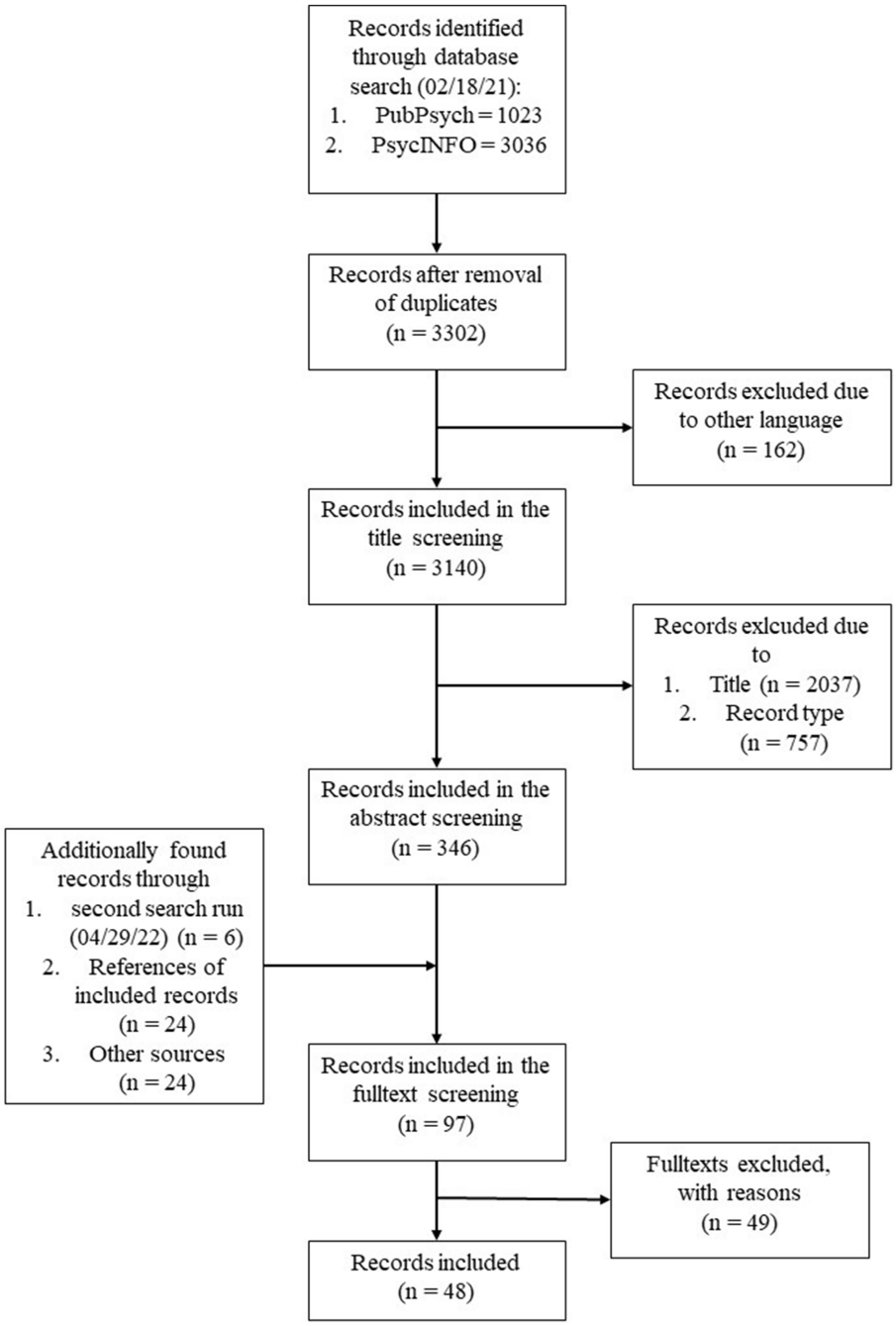

FIGURE 1
Study selection process.

this approach are discussed in the respective section at the end of the discussion.

3. Results

An overview of the extracted information can be found in Tables 1, 2. In order to facilitate the presentation of the results, Table 1 provides information on the design of the included studies, whereas Table 2 contains information on the characteristics of the intervention and the main results of the included studies.

Each table was divided regarding the form of comorbidity that was assumed in the study. Approximately 25% of the included studies explicitly assumed a comorbidity of learning difficulties (LDif) and behavioral problems (BP) prior to the intervention. A total of 14.58% of the studies were classified as implicitly assuming comorbidity prior to the intervention [e.g., Casale et al. (2017) as well as Keller and Brunstein (2022) who assume that students with attention problems are in need of a writing intervention - and thus might be affected by learning difficulties]. A total of 20.83% of the included studies were rated as not having prior theoretical assumptions on the comorbidity of BP and LDif, but including at least partly participants that showed

TABLE 1 Extracted information on design characteristics of the included studies.

Reference	Measuring points	Control	Dependent variable			Sample
			Learning	Behavior	Related competence	
Explicit comorbidity						
Randomized controlled trials						
Elias et al. (2003)	2 (pre, post)	Language workshop	School achievement	Conduct problems *(e)*, hyperactivity *(e)*		*N* = 39 (100% male); 8–11 years; learning and behavior problems
Gray et al. (2012)	2 (pre, post)	Math training	Academic achievement (reading, spelling, math)	Hyperactivity *(e)*, inattention	Working memory capacity	*N* = 60 (86.7% male); 12–17 years; LD and ADHD; semiresidential school
Sibley et al. (2016)	3 (pre-post-follow-up)	Treatment as usual	Grade point average	ADHD symptoms *(e)*, disruptive behavior *(e)*	Organizational skills	*N* = 128 (64.9% male); 11–15 years; ADHD and academic impairment
Tamm et al. (2017)	3 (pre-post-follow-up)	Comparison of 3 conditions: reading treatment (student training); ADHD treatment (medication + parent training) OR combination of both	Word and pseudoword reading	ADHD symptoms *(e)*		*N* = 216 (61.1% male); *M* = 8.84 years; ADHD and reading difficulties
Tannock et al. (2018)	2 (pre-post)	Comparison of 6 conditions: One of 3 different academic programs in combination with either medication OR placebo	Single word reading, phonological analysis skills, word decoding skills, reading comprehension, arithmetic computation	ADHD symptoms *(e)*, oppositional behavior *(e)*		*N* = 65 (75.38%); 7–11 years; ADHD and reading disorder
Pre-Post (with control group)						
Everatt et al. (2011)	Unclear	Treatment as usual	Spelling of English words		Off-task behavior	*N* =?; 7–15 years; ADHD symptoms and learning disabilities; school for children with learning disabilities
Keller and Brunstein (2022)	3 (pre-interim-post)	Writing training alone OR waiting control	Story writing skills	Selective Attention, inhibition, attention control		*N* = 38 (89.5% male); *M* = 11.91 years; attention and behavior problems; deficits in writing skills
Pre-Post (without control group)						
Koenigs et al. (2019)	3 (pre-pre-post)	Test results 10 weeks before the intervention served as control	Reading and spelling skills	ADHD symptoms *(e)*		*N* = 21 (71% male); 7–10 years; inattention, reading and/or spelling difficulties
Multiple Baseline						
Mautone et al. (2005)	<19	–	Math performance		On- and off-task behavior	*N* = 3 (100% male); 8–9 years; ADHD and math difficulties

(Continued)

TABLE 1 (Continued)

Reference	Measuring points	Control	Dependent variable			Sample
			Learning	Behavior	Related competence	
Ota and DuPaul (2002)	16	–	Math performance		Active and passive engagement, off-task behavior	*N* = 3 (100% male); 4th – 6th grade; ADHD and attending school for learning disabilities
Single case						
Lee et al. (1999)	> 30	Single case experimental design (A-B-A)	Correctly solved math tasks	Problem behavior *(e)*	Off-task behavior	*N* = 2 (100% male); 9 years; emotional/ behavioral disorder and math difficulties
Schieltz et al. (2020)	> 54	Single case design (ABC)	Academic performance (reading fluency & math computation)	Problem behavior *(individual for each boy; mainly e)*		*N* = 2 (100% male); 7;9 years & 8;5 years; behavior and learning problems
Implicit comorbidity						
Randomized controlled trials						
Hechtman et al. (2004)	6	Attention control (plus medication) OR medication alone	Academic performance (math, reading, spelling, comprehension)	Symptoms of depression *(i)*	Homework behavior	*N* = 103 (93%); 7–9 years; ADHD
Rabiner et al. (2010)	3 (pre-post-follow-up)	Waiting control	Academic achievement (reading and math), academic performance (e.g., task accuracy, academic success; teacher rating)	Attention, symptoms of hyperactive–impulsive *(e)*, anxious *(i)*, and oppositional behavior *(e)*, social problems		N = 77 (69% male); 1st graders; attention problems
Pre-Post (with control group)						
Paananen et al. (2018)	3 (pre-post-follow-up)	Waiting control	Reading, mathematics	Attention	Executive functions	*N* = 90 (82.2% male); 7–12 years; attention and/ or executive function problems that impact learning
Roberts et al. (2015)	4 (reading), 3 (attention)	Treatment as usual	Reading ability	Attention		*N* = 419 (54% male); 5th graders; reading difficulties
Pre-Post (without control)						
Kopelman-Rubin et al. (2012)	2	–	Academic grades	Externalizing & internalizing behavior		*N* = 40 (70% male); 11–15 years; learning disorders, most with comorbid disorders
Multiple baseline						
Casale et al. (2017)	< 22	–	Writing performance		Academically engaged behavior	*N* = 3 (100% male); 13 years; ADHD, different areas of SEN (1x learning, 2x emotional and social development)

(Continued)

TABLE 1 (Continued)

Reference	Measuring points	Control	Dependent variable			Sample
			Learning	Behavior	Related competence	
Wehby et al. (2003)	< 22	–	Reading achievement (e.g., nonsense word, reading of sight words, letter sounds)	Problem behavior (e.g., making fun of others, physical aggression) *(e)*	On-task behavior	*N* = 8 (100% male); 7–10 years, emotional and behavioral disorders
Indirect comorbidity (not theoretically assumed but information on comorbidity rate in sample description)						
Randomized controlled trials						
Evans et al. (2011)	6	Community care	Academic impairment, grade point average	Symptoms of ADHD *(e)*, oppositional defiant disorder *(e)* and conduct disorder *(e)*	Classroom performance	*N* = 49 (71% male); 10–13 years; ADHD and academic or social impairment
Fabiano et al. (2010)	2 (pre-post)	Treatment as usual	Academic achievement (reading, math), academic progress, academic productivity, academic success	Rule violation, symptoms of ADHD *(e)*, oppositional defiant disorder *(e)*, and conduct disorder *(e)*		*N* = 63 (86% male); 6–12 years; SEN students; ADHD, 19% with learning disability
Langberg et al. (2006)	2 (pre-post)	District run after school program	Grades, academic progress	ADHD symptoms *(e)*, problem behavior *(e)*	Organizational skills	*N* = 48 (66.7% male); 6th and 7th graders; learning (and behavior) difficulties
Power et al. (2012)	4 (pre-interim-post-follow-up)	Coping with ADHD through Relationships and Education (CARE)	Academic performance	Symptoms of ADHD *(e)* and oppositional defiant disorder *(e)*	Homework problems	*N* = 199 (68% male); 2nd – 6th grade; ADHD; 26% with learning disability
Schultz et al. (2017)	6 (9 for grades)	Community care	Grades	ADHD symptoms *(e)*	Organizational skills, homework problems	*N* = 216 (72.2% male); 6th – 8th grade; ADHD and academic or social impairment
Pre-Post (with control group)						
Freilich and Shechtman (2010)	3 (pre, post, follow-up)	Academic assistance only	Achievements in language, history, and math	Behavioral problems *(i & e)*		*N* = 93 (70% male); 7–15 years; learning disability, 26% with ADHD
Friedman et al. (2019)	2 (pre-post)	*Group 1:* ADHD *Group 2:* ADHD AND specific learning disorder	Study skills	Inattention	Homework problems, organizational skills	*N* = 74 (51.4% male); 7–11 years; ADHD, 47.3% with specific learning disorder
Pre-Post (without control group)						
Antshel et al. (2012)	2 (pre-post)	–	Academic progress, grade point average, learning problems	ADHD symptoms *(e)*, externalizing and internalizing behavior		*N* = 68 (66.2% male); 14–18 years; ADHD; *n* = 5 with learning disability
Single case						
Dursun et al. (2021)	2 (pre-post)	–	Learning problems	Symptoms of ADHD *(e)*, anxiety *(e)*, psychosomatic *(i)* and conduct problems *(e)*		*N* = 3 (67% male); 14–17 years; ADHD; 67% with learning problems

(Continued)

TABLE 1 (Continued)

Reference	Measuring points	Control	Dependent variable			Sample
			Learning	Behavior	Related competence	
Walter and Döpfner (2006)	2 (pre-post) + weekly ratings	Test results 4 weeks before the intervention served as control	Learning behavior, achievement problems	Problem behavior *(i & e)*, depressive symptoms *(i)*		*N* = 10 (80% male); 13–16 years; academic underachievement, mostly with comorbid disorders
No direct or indirect assumption of comorbidity						
Randomized controlled trial						
Boyer et al. (2015)	3 (pre-post-follow-up)	Comparison of planning skills intervention OR discussion of individual problems		ADHD symptoms *(e)*, symptoms of depression *(i)*, anxiety *(i)*, oppositional defiant disorder *(e)*, conduct disorder *(e)*, internalizing and externalizing problems	Planning skills, executive functions	*N* = 159 (73.5% male); 12–17 years; ADHD
Chacko et al. (2014)	2 (pre-post)	Placebo (low-level working memory training)	Academic achievement (reading, spelling, math)	ADHD symptoms *(e)*	Working memory capacity	*N* = 85 (78% male); 7–11 years; ADHD
Egeland et al. (2013)	3 (pre-post-follow-up)	Treatment as usual	Academic skills (reading, math)	ADHD symptoms *(e)*, behavior problems (i & e), attention	Executive functions	*N* = 67 (73% male); 10–12 years; ADHD
Evans et al. (2016)	6	Community care	Grades, academic competence, academic progress, academic performance	Symptoms of ADHD *(e)*, conduct disorder *(e)* and oppositional defiant disorder *(e)*	Organizational skills, homework problems,	*N* = 326 (71.2% male); 6th – 8th grade; ADHD
Langberg et al. (2008)	<54	Waiting control	Academic performance, grades		Homework problems, organizational skills	*N* = 37 (83.8% male); 9–14 years; ADHD
Langberg et al. (2012)	3 (pre-post-follow-up)	Waiting control	Homework problems, school grades	ADHD symptoms *(e)*	Organizational skills, homework problems	*N* = 47 (76.7% male); 11–14 years; ADHD
Mautone et al. (2012)	4 (pre-interim-post-follow-up)	Coping with ADHD through Relationships and Education (CARE)		Symptoms of ADHD *(e)* and oppositional defiant disorder *(e)*	Academic enablers	*N* = 61 (72% male); kindergarten or first grade; ADHD
The MTA Cooperative Group (1999)	4 (pre-interim-post)	Community care	Academic achievement (reading, math, spelling)	ADHD symptoms *(e)*, aggressive/oppositional symptoms *(e)*, internalizing symptoms		*N* = 579 (80% male); 7–9 years; ADHD
Schramm et al. (2016)	2 (pre-post)	Progressive muscle relaxation OR waiting control		ADHD symptoms *(e)*, behavior problems *(i & e)*	Academic enablers, metacognitive skills	*N* = 113 (85% male); 12–17 years; ADHD
Shalev et al. (2007)	2 (pre-post)	Placebo (computer games and paper-pencil activities)	Math, writing, reading comprehension	ADHD symptoms *(e)*		*N* = 36 (83.3% male); 6–13 years; ADHD

(Continued)

TABLE 1 (Continued)

Reference	Measuring points	Control	Dependent variable			Sample
			Learning	Behavior	Related competence	
Sibley et al. (2013)	3 (pre-interim-post)	Treatment as usual	Grade point average, academic problems	Symptoms of ADHD *(e)* and oppositional defiant disorder *(e)*	Organization of school materials,	*N* = 36 (72.25% male); 11–15 years; ADHD
Pre-Post (with control group)						
Evans et al. (2005)	*Study 1:* 2; *Study 2:* 9	*Study 1:* Community care *Study 2:* -	Academic functioning, grades	ADHD symptoms *(e)*		*Study 1*: *N* = 27 (78% male); 11–14 years; ADHD *Study 2*: *N* = 35 (83% male); 11–14 years; ADHD
Miranda et al. (2006)	2 (pre-post)	Medication OR no intervention	Learning problems	ADHD symptoms *(e)*, antisocial behavior *(e)*, anxiety *(i)*	School maladjustment	*N* = 50 (88% male); 8–9 years; ADHD
Owens et al. (2005)	3	Waiting control	Grade Point Average (spelling, writing, math, science, social studies)	Behavior problems *(i & e)*		*N* = 42 (71.4% male); *M* = 8.58 years; behavior problems
Owens et al. (2008)	3	Waiting control	Grade Point Average (spelling, writing, math, science, social studies)	(Mainly disruptive) behavior problems *(e)*		*N* = 72 (79.1% male); *M* = 7.8 years; behavior problems
Pre-Post (without control group)						
Evans et al. (2004)	2 (pre-post)	–	Grades, academic progress	ADHD symptoms *(e)*	Classroom functioning	*N* = 7 (71.4% male); 11–13 years; ADHD
Multiple baseline						
Barry and Messer (2003)	27 (last one is follow-up)	Single case experimental design (A-B-A-B-A-B)	Academic performance (completed and correct assignments)	Disruptive behavior (physical and loud behavior) *(e)*	On-task behavior (seated and attention behavior)	*N* = 5 (100% male); 12 years; ADHD
Carboni et al. (2013)	53 (on-task behavior), 2 (pre-post; ADHD symptoms)	–		ADHD symptoms *(e)*	On-task behavior	*N* = 4 (100% male); 8 years; ADHD
Murphy et al. (2019)	≤ 30	–		Disruptive behavior *(e)*	Student engagement	*N* = 22 (77.3% male); kindergarten to 6th grade; SEN students; emotional and behavioral disorders

(e), externalizing behavior; *(i)*, internalizing behavior.

LDif and BP. Almost 40% of the included studies (39.58%) did not indicate any theoretical or methodological reference to the comorbidity of LDif and BP, but included measures related to LDif and BP in the study design.

The included studies were further grouped along the research design that was applied. In total, five different groups of design were distinguished: (1) randomized controlled trials (47.92%), (2) pre-post-designs with control group (20.83%), (3) pre-post-designs without control group (8.33%), (4) multiple baseline studies (14.58%), and (5) alternative forms of single case studies (8.33%). All included studies used a quantitative approach; no distinction was thus made between qualitative and quantitative designs.

3.1. Addressed competencies

During the screening process, it became clear that it was not always possible to distinguish between dependent variables that address dimensions of learning from variables that address dimensions of behavior [e.g., on–/off-task behavior (Lee et al., 1999; Wehby et al.,

TABLE 2 Extracted information on characteristics of the implemented intervention.

Reference	Implemented program	Sessions	Implementation mode	Addressed competencies	Causal Assumptions	Results
Explicit comorbidity						
Randomized controlled trials						
Elias et al. (2003)	I can problem solve (Shure, 1992) + reading/ writing activities OR language workshop	Children: 18 × 2 h (weekly); Parents: 10 × 1 h (biweekly)	Out of school group training (3–4 per group) + counseling for parents	Interpersonal problem solving, reading and writing (in single activities)	Reciprocal relationship	Improvement of problem behavior and school achievement in both conditions; but stronger effects in problem-solving condition
Gray et al. (2012)	Cogmed RoboMemo OR Academy of Math	45 min. (4–5 x per week; 5 weeks)	In-school computerized individual training	Working memory capacity	Working memory influences learning and ADHD	Working memory training leads to improvements in facets of working memory; no transfer effects
Sibley et al. (2016)	Supporting Teen's Academic Needs Daily (STAND)	Family-teen sessions: 10 × 50 min. (10 weeks) Parent sessions: 4 monthly sessions	Out-of-school intervention for adolescents and parents	Parenting skills, organizational skills, time management, note-taking, preparing for assignments	Neurocognitive deficits of ADHD might hinder school success	Improvement of ADHD symptoms (parent rating), organizational skills, disruptive behavior; maintenance for parent-rated ADHD symptoms and organizational skills, no effect on grades
Tamm et al. (2017)	Reading treatment OR medication and parent training (ADHD) OR combination of both	Reading: 64 × 45 min. (16 weeks) ADHD: 9 × 90 min. (10 weeks)	In-school group training: 1–2 (reading) or 4–13 families (ADHD parent training) per group	Reading treatment: (phonics, word identification, spelling, reading fluency and comprehension) ADHD: behavior management of parents (and medication)	Reciprocal relationship	Improvement in ADHD symptoms for ADHD training and combination; improvement in reading for reading and combined group; effects remained significant for 3–5 months (except word reading)
Tannock et al. (2018)	Reading: Phonological Analysis and Blending/Direct Instruction (PHAB/DI); Word Identification and Strategy Training (WIST) (Lovett et al., 1994, 2000) OR General Cognitive and Academic Strategy Training (GCAST)	35 × 1 h (10 weeks)	In-school group training (2–3 per group)	PHAB/DI: phonological analysis, phonological and blending and letter-sound association; WIST: metacognitive decoding strategies GCAST: metacognitive skills	Increased risk for comorbidity (due to genetic factors)	Medication improves ADHD symptoms, but not reading; reading training increases reading skills (regardless of medication)
Pre-Post (with control group)						
Everatt et al. (2011)	Combination of 1) cognitive behavior therapy OR 2) relaxation training AND 3) multisensory training OR 4) copying of words	3 × 30 min. (3 weeks)	In-school training, group size unclear	Depends on condition: Spelling of word list, relaxation techniques, self-regulation, strategy learning based on cognitive behavioral therapy principles	Reciprocal relationship	Larger improvement in spelling in experimental groups; improvement regarding off-task behavior depends on condition

(Continued)

TABLE 2 (Continued)

Reference	Implemented program	Sessions	Implementation mode	Addressed competencies	Causal Assumptions	Results
Keller and Brunstein (2022)	Self-Regulated Narrative Writing Training (Glaser and Palm, 2014) and attention training (Lauth and Schlottke, 2009)	Writing: 8 × 45 min. (4 weeks) Attention: 8 × 45 min. (4 weeks)	In-school group training (2–4 per group)	Story writing skills; different components of attention (e.g., selective attention, inhibitory control) and metacognitive skills	Attention and self-regulatory problems increase risk of writing problems	Writing training improved writing skills; no effects of attention training on attention; no superiority of combined group
Pre-Post (without control group)						
Koenigs et al. (2019)	Combined training of writing, spelling and self-regulatory skills	10 × 90 min. (weekly) parent training: 5 × 90 min.	Out of school group training (2–4 per group)	Reading and spelling; different strategies to manage ADHD-symptoms (e.g., if-then plans), stress regulation	Causality unclear; underlying cognitive functions might influence both	Reduction of inattention; improvement of spelling (parent rating); improvement in reading; improvement in structured solving of tasks
Multiple baseline						
Mautone et al. (2005)	Math Blaster Ages 6–9 (Davidson and Associates, 1997)	Up to 19 × 10–15 min. (2–3 x per week)	In-school computerized individual training	Math skills	ADHD increases the risk of academic problems	Improvement of math performance and on-task behavior, decrease of off-task behavior
Ota and DuPaul (2002)	Math Blaster Ages 9–11 (Davidson and Associates, 1999)	Different due to multiple baseline; 20 min. (3–4 x per week)	In-school computerized individual training	Math skills	ADHD often co-occurs with academic difficulties	Improvement of active engaged time and math performance, decrease of off-task behavior
Single Case						
Lee et al. (1999)	Academic instruction	Max. 35 sessions	In-school individual training	Instruction on how to solve math tasks	Academic difficulties may lead to problem behavior	Decrease in problem and off-task behavior as well as an increase in accuracy on difficult tasks
Schieltz et al. (2020)	Phase 1: contingent positive reinforcement; Phase 2: instructional strategies; Phase 3: contingent negative reinforcement	Not clear; weekly sessions	Out-of-school individual training	Reading fluency, math computation, problem behavior	Unclear	Combination of instructional strategies & positive reinforcement improves task accuracy, reading fluency and reduces problem behavior for one participant; for the other participant negative reinforcement in combination with instructional strategy increased on-task behavior as well as task-accuracy and decreased problem behavior
Implicit comorbidity						
Randomized controlled trials						
Hechtman et al. (2004)	Multimodal psychosocial training (MPT) plus medication	Different per MPT module	In-school individual training as well as group training + parent training and counseling	Multimodal psychosocial training: Organizational skills, reading, writing and math training, study skills, self-esteem, perception of social experiences, problem solving	ADHD increases risk of school problems	No advantage of combined training in comparison to methylphenidate alone; but improvement across all domains in every condition

(Continued)

TABLE 2 (Continued)

Reference	Implemented program	Sessions	Implementation mode	Addressed competencies	Causal Assumptions	Results
Rabiner et al. (2010)	Captain's Log (attention training) OR Destination Reading and Math	28 × 75 min. (14 weeks)	In-school computerized group training (4–6 per group)	Attention: auditory and visual sustained attention Reading: vocabulary, phonics, fluency, comprehension, phonemic awareness Math: counting, number sense, calculating, geometry, patterns, ordering and comparing	Attention problems lead to academic problems	Both interventions reduced attention problems; reading and math training improved reading fluency and academic functioning; no follow-up effects of either intervention on academic achievement
Pre-Post (with control group)						
Paananen et al. (2018)	Malttti (Paananen et al., 2011)	20 × 60–75 min. (7 months)	In-school group training (4–7 per group)	On-task behavior, attention control, inhibition, academic skills, social-problem solving	Executive function deficits are related to academic and attention problems	Effects on executive functioning and attention control for children with moderate symptoms; improvement in basic arithmetic and reading skills, no long-term effects
Roberts et al. (2015)	Different per tier; combination of different reading interventions	Number of sessions depends on tier, length per session: 50 min.	In-school group training (2–12 per group; depends on tier)	Different reading competencies (depending on tier); e.g. word reading, text comprehension, fluency	Reading problems and attention problems share a common risk factor	Intervention improved reading achievement which in turn influenced attention
Pre-Post (without control group)						
Kopelman-Rubin et al. (2012)	I can succeed	13 × 50 min. (3 months), 6 sessions in 18 months as follow-up	Out-of-school individual training; contains two sessions of parent training	Organizational skills, interpersonal communication, problem solving, self-awareness, goal setting, self- advocacy skills	Learning disorders increase risk of behavior problems	Significant decrease in externalizing and internalizing behavior; majority found that the skills they learned were useful; significant improvements in hope; investment and effort in studying; as well as achieving academic and personal goals
Multiple baseline						
Casale et al. (2017)	Essay training for 4th to 6th grade (Glaser and Palm, 2014)	12 × 45 min. (4 weeks)	In-school individual training	Writing skills, metacognitive skills, self-regulation, behavior management	Symptoms of ADHD might diminish writing skills	Moderate to strong effects on writing skills; mixed results concerning academically engaged behavior
Wehby et al. (2003)	Open Court Reading Curriculum (Adams et al., 2000) AND Peer Assisted Learning Strategies (Fuchs et al., 1997)	36 × 30–45 min. (9 weeks) each	In-school group training (max. 8 per group)	Reading skills (e.g., phonemic awareness, reading comprehension, letter-sound correspondences, reading fluency)	Emotional and behavioral disorders co-occur with reading problems	Improvements of some aspects of reading (e.g., sound naming; blending and nonsense words) but not general reading ability, no effect on problem behavior

(Continued)

TABLE 2 (Continued)

Reference	Implemented program	Sessions	Implementation mode	Addressed competencies	Causal Assumptions	Results
Indirect comorbidity (not theoretically assumed but information on comorbidity rate in sample description)						
Randomized controlled trials						
Evans et al. (2011)	Family Check-Up (FCU; Dishion and Kavanagh, 2003) and Challenging Horizon Program (CHP)	FCU: 3 × 90 min. CHP: 135 min., twice per week (5 months)	FCU: Out-of-school family meetings CHP: Out-of-school group training	FCU: Family coping, family interaction, family problem solving CHP: study skills, note taking, individual goal setting, social problem solving, social skills, sport skills	ADHD increases the risk of academic problems.	No effect on social impairment and grades; signs of an improvement of academic functioning and classroom performance as well as ADHD symptoms (parent ratings)
Fabiano et al. (2010)	Daily Report Cards (DRC) (including teacher and parent training)	Number of sessions for students: unclear (daily behavior ratings) 3 x parent training (8 months)	In-school individual training; teachers and parents were trained in the usage of DRC	Individual for each child	ADHD symptoms lead to academic problems	Improved classroom behavior, symptoms of conduct disorder as well as oppositional defiant disorder, academic productivity and academic success in DRC group (teacher ratings), no improvement on academic achievement and ADHD symptoms
Langberg et al. (2006)	Challenging Horizon Program (Evans, 2001)	2 h x 4 days a week (one semester)	In-school group training (max. 12 per group)	Note taking, study skills, literacy skills, (individual) classroom behavior, organizational skills, time management, academic remediation	Learning problems lead to behavior problems	Improvement of academic progress, self-esteem & overall severity of problems (parent rating); no effects in teacher ratings
Power et al. (2012)	Family-School Success (Soffer & Power, 2005).	Parent group meetings: 6 × 90 min. (initial session: 3 h) Family therapy: 4 × 60 min. Family-school consultation: 2 × 45 min.	Combination of parent group training (2–6 per group), individual family therapy and family school consultation; mainly out-of-school	Parenting skills, student engagement, student productivity, family-school collaboration, family involvement in education	ADHD leads to educational impairments	Improvement of parenting behavior, homework performance and family-school relationship
Schultz et al. (2017)	Challenging Horizon Program	135 min., twice per week (one school year)	Out-of-school group training	Organizational skills, study skills, assignment tracking, social problem solving	Unclear	Improvements of organizational skills, homework performance and some social skills; improvement of grades if participation was at least 80%
Pre-Post (with control group)						
Freilich and Shechtman (2010)	Art therapy AND academic assistance	66 × 3 h (22 weeks)	Out-of-school individual training	Academic assistance: learning strategies, knowledge, basic skills; Art therapy: expression, exploration and reflection of feelings and concerns	Increased risk of having both learning disabilities and social emotional problems	More positive effect on behavior in art therapy group; both groups improved in academic achievement

(Continued)

TABLE 2 (Continued)

Reference	Implemented program	Sessions	Implementation mode	Addressed competencies	Causal Assumptions	Results
Friedman et al. (2019)	Child Life and Attention Skills (Pfiffner et al., 2014)	Parent training: 10 × 90 min. Family sessions: ≤6 × 30 min. Child training: 10 sessions x 90 min. Teacher meetings: ≤ 5	In- and out-of-school group training (6–8 families or 5–8 children per group)	Organizational skills, academic skills, emotion regulation, social skills, behavior management (parents and teachers)	Reciprocal effects; comorbidity leads to more severe symptoms	Improvement in inattention, organizational skills and study skills, greater improvements without learning disorder (teacher ratings)
Pre-Post (without control group)						
Antshel et al. (2012)	Cognitive-behavioral treatment (adaptation of Safren et al., 2005)	Number of sessions depends on the participant; session length: 50 min.; some sessions with parents	Out-of-school individual training	Learning skills, communication skills, planning and organizational skills, anger and frustration management	ADHD increases risk for academic problems	Improvements in inattention, school attendance, learning problems, grade point average, academic progress, relationship with peers & self-esteem
Single case						
Dursun et al. (2021)	Listening therapy	30 × 2 h (3 months)	Out-of-school individual training	Listening skills	ADHD is associated with risk of academic difficulties and learning disorders	All cases indicated decreased symptoms but persisting problems
Walter and Döpfner (2006)	SELBST (Walter et al., 2006); achievement problems module	Different for each teenager; $M = 25.4$ sessions ($M = 10.7$ months)	Out-of-school individual therapy; includes parental training and cooperation with teachers	Learning strategies, planning skills, learning engagement, metacognitive skills, disruptive behavior, parental behavior	Learning disorders increase risk of behavior problems	Reduction of achievement problems, internalizing as well as externalizing behavior
No comorbidity in sample or no/unclear information provided						
Randomized controlled trial						
Boyer et al. (2015)	Plan my life (PML; Kuin et al., 2013) OR Solution-Focused treatment (SFT; Boyer et al., 2014)	Adolescent sessions: 8 × 45–60 min. Parent sessions: 2 x	Out-of-school individual training + parent sessions	PML: planning and organizational strategies SFT: Discussion of individual problems	ADHD leads to difficulties that impair academic achievement	PML and SFT improve ADHD symptoms, planning, comorbid symptoms, general functioning and executive functions; no superiority of PML
Chacko et al. (2014)	Cogmed Working Memory Training	25 × 30–45 min. (5 weeks)	Out-of-school computerized individual training	Working memory	Working memory deficits are linked to ADHD symptoms and underachievement	Improvement of working memory capacity, but neither of academic achievement nor of ADHD symptoms
Egeland et al. (2013)	Cogmed RoboMemo	25 × 30–45 min. (5–7 weeks)	In-school computerized individual training	Working memory	Working memory deficits might be linked to ADHD symptoms and academic performance	Improvement of processing speed and reading skills, no effects on other measures

(Continued)

TABLE 2 (Continued)

Reference	Implemented program	Sessions	Implementation mode	Addressed competencies	Causal Assumptions	Results
Evans et al. (2016)	Challenging Horizon Program (After School; CHP-AS) OR Challenging Horizon Program (Mentored; CHP-M)	CHP-AS: 135 min.; twice per week (1 school year); 3 parent meetings CHP-M: M = ~ 25 sessions; individual length	CHP-AS: Out-of-school group training (6–10 per group) including individual counseling and parent meetings CHP-M: In-school individual training	CHP-AS: study skills, organizational skills, writing skills, note-taking, social skills, sport skills CHP-M: Parts of the CHP-AS program; individually chosen	ADHD is associated with adverse school outcomes	Improvements of organizational skills, time management, homework problems, academic functioning and symptoms of inattention in CHP-AS group, most effects persist into the next school year; more beneficial effects of CHP-AS compared to CHP-M and community care
Langberg et al. (2008)	Organizational skills training	16 × 75 min. (8 weeks); 2 × 1 h parent sessions	Out-of-school; combination of individual and group training (3 per group)	Organizational skills, homework completion, academic tasks	ADHD leads to academic impairment	Improvement of organizational and homework skills as well as grades; decrease of homework problems (parent rating)
Langberg et al. (2012)	Homework, Organization, and Planning Skills Intervention (HOPS; Langberg et al., 2011)	16 × 20 min. (11 weeks)	In-school individual training	Organization of school materials, homework management and recording, planning/ time management	Organizational skills deficits are part of ADHD and lead to academic difficulties	Improvements in managing materials, planning, organizational skills and homework problems (parent ratings); higher grade point averages; effects maintain at follow-up
Mautone et al. (2012)	Family-School Success- Early Elementary (FSS-EE)	Parent sessions: 6 × 90 min (1st session: 3 h) Family therapy: 4 × 60 min. Family-school consultation: 2 × 45 min.	Combination of parent group training (2–6 per group), individual Family therapy and family school consultation; mainly out-of-school	Parent–child relationship, parenting skills, involvement of the family in education, collaborative problem solving of the school and the family	ADHD increases the risk of academic difficulties.	FSS-EE superior in reduction of behavior problems in school as well as improving parenting skills and student-teacher relationships; no effect on academic enablers
Sibley et al. (2013)	Supporting Teen's Academic Needs Daily (STAND)	Family sessions: 8 × 60 min. (weekly) Problem solving sessions (optional): <3 Group parent sessions: 4 Teacher meeting (optional)	Out-of-school intervention for adolescents and parents	Academic skills, organizational skills, parenting skills, behavior management, homework problems	Students with ADHD often experience academic problems	Improvement of academic problems, daily planner use, ADHD symptoms and symptoms of oppositional defiant disorder (parent-rating) as well as parent-teen conflict (student-rating), no effects on grades and teacher ratings
The MTA Cooperative Group (1999)	Behavioral treatment OR medication OR both	Parent training: 35 sessions; child training: 40 sessions (8 week summer camp), 12 week training in school; teacher consultation: 10–16 sessions	Combination of in-and out of school individual and group training	Social skills, problem solving, sports skills, classroom behavior, academic skills	ADHD leads to impairment in academic functioning	Medication and combination superior to behavioral treatment or community care for ADHD symptoms; combination is superior compared to behavioral treatment alone and community care with regard to: oppositional/aggressive behavior, internalizing symptoms, social skills, reading achievement

(Continued)

TABLE 2 (Continued)

Reference	Implemented program	Sessions	Implementation mode	Addressed competencies	Causal Assumptions	Results
Schramm et al. (2016)	Learning Skills Training for Adolescents with ADHD (Linderkamp et al., 2011)	Max. 20 × 60 min.; Parent/ teacher training sessions: 3 × 90 min.	Individual training	Organizational, learning and problem-solving skills	Increased risk of having both ADHD and learning difficulties	Reduction of ADHD symptoms and internalizing symptoms (parent and teacher rating); improvement of academic enablers (teacher ratings), effective learning behavior (self-rated), no superiority of behavioral treatment in comparison to relaxation training
Shalev et al. (2007)	CPAT (computerized progressive attentional training)	16 × 1 h (8 weeks)	Computerized individual training	Different areas of attention	Attention deficits lead to academic difficulties	Improvement in reading comprehension, passage copying & inattention
Pre-Post (with control group)						
Evans et al. (2005)	Challenging Horizon Program	3 days per week; monthly parent meetings	Combination of out-of-school group training and individual counseling for students and parents	Educational skills (e.g., note -taking; study skills), organizational skills, social skills (e.g., problem-solving; conversation)	ADHD enhances risk of learning difficulties	*Study 1:* 38–60% (depending on the measure) of the participants who started in the impaired range ended in the normal range of academic functioning, social functioning, and overall functioning (parent rating) *Study 2*: No change on ADHD ratings; majority of participants improved in academic, social and overall functioning; but great variability
Miranda et al. (2006)	Psycho-pedagogical intervention for teachers	8 × 3 h (4 months)	Teacher training	Psychoeducation on ADHD, behavior modification and management, teaching techniques, cognitive-behavioral techniques, token systems	ADHD leads to academic problems.	Intervention and medication reduce ADHD symptoms compared to no treatment; medication reduces learning problems and school maladjustment compared to no treatment
Owens et al. (2005)	Youth Experiencing Success in School	Daily behavior rating, biweekly parent sessions, 6 h teacher session before start of the program, biweekly teacher sessions á 30 min. over the course of a school year	In-school individual training for each child; parent and teacher sessions	Individualized target behavior; psychoeducation about mental health problems and information on behavior modification and interventions (for teachers)	Behavior problems impact education	Improvement in behavior problems (teacher and parent rating); improvement in academic and social functioning; grades in control group declined whereas grades in experimental group stayed the same
Owens et al. (2008)	Youth Experiencing Success in School (Owens et al., 2005) (with high OR low university involvement in in the implementation)	Daily behavior rating, 6 h teacher session before start of the program, biweekly teacher sessions, biweekly parent sessions	In-school individual training for each child; parent and teacher sessions	Individualized target behavior, classroom management strategies (teachers)	Unclear	No differences between high and low university involvement; reduction of ADHD symptoms and overall impairment as well as improvements in social relationships and classroom functioning

(Continued)

TABLE 2 (Continued)

Reference	Implemented program	Sessions	Implementation mode	Addressed competencies	Causal Assumptions	Results
Pre-Post (without control group)						
Evans et al. (2004)	Challenging Horizon Program (Evans, 2001)	130 min.; 3 days a week	Out-of-school group training (but with individual sessions); family counseling and parent training	Goal setting (individualized goals), interpersonal skills, sport skills, study skills, writing skills, organizational skills	Academic problems are associated with ADHD symptoms	Improvement of ADHD symptoms, classroom behavior, social relationships, self-esteem, academic functioning and grade point average
Multiple baseline						
Barry and Messer (2003)	Self-management techniques	Daily ratings (26 days); self-management ratings different for each boy due to multiple baselines	In-school individual intervention	Self-management of behavior	ADHD might hinder school success	Increase of on-task behavior, decrease of disruptive behavior and improvement in academic performance; effects remained stable over a month
Carboni et al. (2013)	Mindfulness training	10 × 30–45 min. (5 weeks)	In-school individual training	Mindfulness, attention, and awareness	Attention problems result in academic difficulties	Increasement in on-task behavior; no changes concerning the ADHD symptoms
Murphy et al. (2019)	Social skills training AND good behavior game	Social skills training: approx. 10 min (3 weeks), number of lessons unclear Good Behavior Game: "played" in intervals of 5 min. (3 weeks)	In-school group training (6–8 per group; class-wide intervention)	Social skills	Problem behavior impacts learning	Improvement in engagement and decrease in disruptive behavior across all classrooms

2003; Everatt et al., 2011; Carboni et al., 2013); executive functions (Egeland et al., 2013; Paananen et al., 2018)]. It was decided to include those studies as well in cases that had dependent variables in at least one of the target areas.

The interventions in the included studies addressed a broad range of competencies. Due to the multitude of interventions, only an overview of the addressed competencies is provided here. More detailed information can be found in Table 2.

About 30% of the included studies aimed to address some sort of literacy skills such as different reading competencies (e.g., Wehby et al., 2003; Hechtman et al., 2004; Roberts et al., 2015; Tamm et al., 2017; Tannock et al., 2018) or writing skills (e.g., Evans et al., 2004; Everatt et al., 2011; Casale et al., 2017; Keller and Brunstein, 2022). In comparison, math competencies were only considered in about one eighth of the studies. These studies either addressed broad range of (academic) competencies or targeted individual difficulties (e.g., Hechtman et al., 2004; Tannock et al., 2018; Schieltz et al., 2020). Only three studies (Lee et al., 1999; Ota and DuPaul, 2002; Mautone et al., 2005) explicitly aimed to increase mathematical competencies solely. Other academic skills addressed were study skills (e.g., Hechtman et al., 2004; Langberg et al., 2006) or learning strategies (Walter and Döpfner, 2006; Freilich and Shechtman, 2010). Some studies did not further specify the learning or academic skills (e.g., Evans et al., 2005; Langberg et al., 2006; Friedman et al., 2019).

Just over a quarter of the interventions targeted social skills in particular. These include training in interpersonal problem solving (e.g., Elias et al., 2003; Evans et al., 2011; Schultz et al., 2017), interpersonal communication (Kopelman-Rubin et al., 2012), conversation (Evans et al., 2005) or not further specified social skills (e.g., The MTA Cooperative Group, 1999; Evans et al., 2016; Friedman et al., 2019; Murphy et al., 2019). In addition to academic and social skills, a third area targeted across multiple studies are cognitive skills such as working memory skills (Gray et al., 2012; Egeland et al., 2013; Chacko et al., 2014), executive functions (Paananen et al., 2018), metacognitive skills (e.g., Langberg et al., 2012; Casale et al., 2017; Tannock et al., 2018) and attention (e.g., Shalev et al., 2007; Rabiner et al., 2010; Paananen et al., 2018; Keller and Brunstein, 2022).

About a third of the interventions included training of organizational skills (e.g., desk organization, managing materials). Different forms of behavior such as on-task behavior (Paananen et al., 2018), disruptive behavior (Walter and Döpfner, 2006), classroom behavior (The MTA Cooperative Group, 1999; Langberg et al., 2006) and forms of behavior management (e.g., Miranda et al., 2006; Sibley et al., 2013; Tamm et al., 2017; Koenigs et al., 2019) were targeted as well. In addition to competencies that appeared in multiple interventions some topics were only addressed in few studies. These topics include mindfulness (Carboni et al., 2013), listening skills (Dursun et al., 2021), the use of art therapy (Freilich and Shechtman, 2010), relaxation techniques (Everatt et al., 2011; Schramm et al., 2016), self-esteem

(Hechtman et al., 2004), emotion regulation (Friedman et al., 2019) and self-awareness (Kopelman-Rubin et al., 2012).

3.2. Description of the target groups

The target groups of the interventions described were diverse. In all included studies, the majority of participants was male. Nine of the included studies even had a sample including only boys (Lee et al., 1999; Ota and DuPaul, 2002; Barry and Messer, 2003; Elias et al., 2003; Wehby et al., 2003; Mautone et al., 2005; Carboni et al., 2013; Casale et al., 2017; Schieltz et al., 2020). These studies mainly used some kind of single case design so that sample sizes are rather small. In the included studies, the whole school age was covered. The majority of participants was between seven and fourteen years old. Only a sixth of the studies comprised a sample that was completely over 12 years of age (Barry and Messer, 2003; Walter and Döpfner, 2006; Antshel et al., 2012; Gray et al., 2012; Boyer et al., 2015; Schramm et al., 2016; Casale et al., 2017; Dursun et al., 2021). Some studies included samples with a broad age range, such as seven to fifteen (Freilich and Shechtman, 2010; Everatt et al., 2011) or six to twelve (Fabiano et al., 2010) or 13 (Shalev et al., 2007) years. Nine studies did not provide any information on the exact age. They aimed target groups from kindergarten to grade 8. The participants are almost equally distributed between primary and secondary school. Some interventions explicitly addressed students, who were in a special education program (Lee et al., 1999; Ota and DuPaul, 2002; Fabiano et al., 2010; Everatt et al., 2011; Gray et al., 2012; Casale et al., 2017; Murphy et al., 2019; Keller and Brunstein, 2022).

Most studies (83.3%) involved participants diagnosed with ADHD or showing ADHD-related symptoms (e.g., attention problems). Moreover, some studies reported to include participants showing emotional and behavioral disorders (Lee et al., 1999; Wehby et al., 2003; Casale et al., 2017; Murphy et al., 2019; Keller and Brunstein, 2022) as well as not further specified or combined behavior problems (Elias et al., 2003; Langberg et al., 2006; Owens et al., 2008). Additional participants were described as showing problem and disruptive behaviors (Owens et al., 2005; Schieltz et al., 2020). Academic difficulties were mostly apparent in forms of not further specified learning problems or LD (31.25%). Few studies included students with reading (Roberts et al., 2015; Tamm et al., 2017; Tannock et al., 2018; Koenigs et al., 2019) or writing difficulties (Koenigs et al., 2019; Keller and Brunstein, 2022). Students with math difficulties were only included in two studies (Lee et al., 1999; Mautone et al., 2005).

When solely focusing studies that explicitly take comorbid samples into account, ADHD or attention problems and associated difficulties in reading or writing (Tamm et al., 2017; Tannock et al., 2018; Koenigs et al., 2019; Keller and Brunstein, 2022) as well as comorbid learning disabilities or academic impairment and ADHD (Ota and DuPaul, 2002; Everatt et al., 2011; Gray et al., 2012; Sibley et al., 2013) comprise the most common groups of participants. In addition, comorbid learning and behavior problems (Elias et al., 2003; Schieltz et al., 2020) were included. The combination of math and behavior problems did only appear in one study (Lee et al., 1999). The same is true for math difficulties in combination with ADHD (Mautone et al., 2005).

3.3. Description of the interventions

The interventions that were applied in the studies varied a lot. Detailed information on the interventions can be found in Table 2.

3.3.1. Intervention mode and setting

Group training and individual training was implemented approximately equally often. Within the studies that contained forms of group training, only one study implemented a class-wide intervention (Murphy et al., 2019). However, class sizes were six to eight students, which is comparable to the other group interventions that typically had group sizes of three to eight students. Seven studies did not provide clear information on the group sizes. Around one seventh of the studies used a combination of individual and group training. Approximately 37.5% of the interventions additionally included some form of parent training and around one eighth applied different versions of teacher training or counseling.

The length of the interventions varied greatly. While some interventions lasted only for 3 weeks (Everatt et al., 2011; Murphy et al., 2019), others lasted for up to two or three years (Hechtman et al., 2004; Roberts et al., 2015). Approximately one third of the articles did not provide enough information to extract the exact length of the interventions. In line with differences concerning the lengths of the intervention, the number of sessions and the duration of one session differed greatly. The number of sessions varied between only three sessions (Evans et al., 2011; Everatt et al., 2011) and more than 65 sessions (Freilich and Shechtman, 2010). Sessions were between 10 minutes (Murphy et al., 2019) and 3 hours (Miranda et al., 2006; Freilich and Shechtman, 2010) long. Most of the interventions had sessions between 30 and 90 min ($M = 61.16$ min.). Almost a third of the articles did not provide enough information on the number of sessions, the length of one session or both.

Most of the interventions took place in a face-to-face setting. Only seven interventions were computerized. These interventions aimed to improve either working memory capacities (Gray et al., 2012; Egeland et al., 2013; Chacko et al., 2014), math skills (Ota and DuPaul, 2002; Mautone et al., 2005) or attention (Shalev et al., 2007; Rabiner et al., 2010). The studies of Rabiner et al. (2010) and Gray et al. (2012) additionally included a group that participated in computerized reading and/or math training.

3.3.2. Components of the interventions

As described before, a variety of competencies was addressed in the interventions. This is also reflected in the components of the interventions. Some interventions applied multi-modal or multi-tiered approaches. The interventions ranged from pre-existing formalized programs to newly developed programs.

With regard to academic skills, modules of the interventions included many different approaches to improve reading and writing skills. For example, Casale et al. (2017) as well as Keller and Brunstein (2022) used a training which aims to enhance text writing skills by teaching writing (e.g., typical structure of a text) and metacognitive strategies such as planning how to write a text. In the study of Everatt et al. (2011), participants either just copied words or used multi-sensory learning techniques (e.g., saying the word, naming the letters of the word and tracing the word) in order to improve spelling skills. Reading skills were targeted by teaching how to decode words (e.g.,

Tamm et al., 2017) or blend sounds into words (Wehby et al., 2003; Tannock et al., 2018), using repeated reading practice (e.g., Tamm et al., 2017) and modeling reading strategies (e.g., Wehby et al., 2003). Mathematical competencies were mainly addressed by using instructional strategies on how to solve math tasks (Lee et al., 1999; Schieltz et al., 2020) or by computerized trainings (Ota and DuPaul, 2002; Mautone et al., 2005).

To address behavioral problems, contingency systems and Daily Report Cards (DRC) were implemented across multiple studies. For example, Koenigs et al. (2019) used a Response Cost Token system within the child sessions. Children could gain points that they could swap for toys at the end of the program. In the study of Rabiner et al. (2010), students could earn marbles for following behavior rules. After reaching a certain level, participant groups earned rewards such as pizza parties. Similarly, students in the study of Casale et al. (2017) could collect points that they could use to gain time for pleasant activities like time to read. Most often, DRC were combined with a reward system at home. For example, Fabiano et al. (2010) implemented DRC at school and trained parents to install a reward contingent at home (e.g., time on the computer). Similar approaches are described by Owens et al. (2005, 2008) as well as Hechtman et al. (2004). In the study by Friedman et al. (2019), DRC were mainly used to discuss the achievement of personal treatment goals with parents, students and teachers.

Another component, which appeared in multiple studies, were elements of parent training. These included different kind of topics such as psychoeducation (e.g., Evans et al., 2005; Tamm et al., 2017; Koenigs et al., 2019), managing difficult situations (e.g., Evans et al., 2004) and information on contingency management (e.g., Schramm et al., 2016; Tamm et al., 2017; Koenigs et al., 2019) or behavior management (e.g., Tamm et al., 2017). Teacher training or consultation addressed behavior management strategies (e.g., The MTA Cooperative Group, 1999; Owens et al., 2005; Friedman et al., 2019) such as contingency management (e.g., Miranda et al., 2006; Schramm et al., 2016) or Daily Report Cards (Friedman et al., 2019) as well as psychoeducation (e.g., Owens et al., 2005; Miranda et al., 2006).

Most of the computerized interventions were used to improve aspects of the working memory. For example, Egeland et al. (2013) implemented an adaptive working memory training that consisted of different tasks, which aimed to address the auditory-verbal (e.g., letter or digit spans) and visual–spatial working memory (e.g., remembering positions of objects). The difficulty of tasks was adjusted to meet the working memory capacity of each participant. In total, 13 different tasks were trained. Participants received daily feedback on their achievement and could earn a digital reward. Almost identical approaches are described by Gray et al. (2012) and Chacko et al. (2014).

3.4. Causal assumptions

Across all publications, five groups of causal assumptions were identified. The scenario of LDif leading to BP (scenario 1) was described in 10.41% of the included studies. In addition, the majority of studies assumed that BP would compromise learning (scenario 2) (45.83%). A part of the studies that were included assumed that LDif and BP have a reciprocal relationship and influence each other (scenario 3) (8.33%). Some studies identified a third variable [e.g., executive functions (Paananen et al., 2018)] that has an impact on both areas (scenario 4) (14.58%). 20.83% of the studies further described an increased risk of having difficulties in the two areas without specifying the causal direction or just contained unclear information on the causal assumptions (scenario 5).

4. Discussion

The aim of this review was to give an overview of the body of research in intervention research that addresses learning difficulties as well as behavioral problems. These insights seem to be of relevance with regard to the importance of specific interventions for this group of students.

Overall, the scoping review at hand identified a broad variety of studies. This variety did not solely manifest in the competencies that were addressed, but also in the approaches, the target group and the underlying causal assumptions. This observation seems plausible against the background that co-occurring learning difficulties and behavioral problems can manifest in many different ways, resulting in an infinite number of potential variations of interventions that combine both target areas. Despite the underlying heterogeneity of the included studies, it has been possible to identify overarching patterns within the studies. These can provide important starting points for further research.

The studies included indicate that co-occurring LDif and BP are of relevance across the entire childhood and adolescence. Despite the limitation, that we decided to focus on school-aged participants, it became clear that all school-levels were addressed. A focus however laid on the transition from childhood to adolescence as well as the first years of adolescence. This might be discussed against the background of additional insights from previous research that indicates that prevalence estimates of BP increase with the onset of adolescence (e.g., Avenevoli et al., 2008; Danielson et al., 2018; Steinsbekk et al., 2022), which might be reflected in the increased numbers of interventions in that age group. Interventions took place in and out of school.

Additionally, some of the interventions are rather complex, both in terms of the components as well as in terms of the duration of the intervention, which stresses the potential complexity of addressing co-occurring problems. Multiple studies include parent and/or teacher training, which shows that not only variables on the child-level were addressed. Parent training can impact the parenting style (environmental level) and teacher training might influence the instructional level, which depict important variables in the explanation of LDif and BP.

On child-level, most studies addressed academic and/or social/behavioral skills. Only few studies focused general variables explaining both phenomena (e.g., self-regulation skills). Regarding BP, many studies applied and combined Daily Report Cards or variations of contingency systems. Both are well investigated, empirically evaluated and effective methods to induce behavior change (e.g., Vannest et al., 2010; Soares et al., 2016). Furthermore, most of the studies using a DRC procedure aimed to involve parents as well, which is in line with results of the meta-analysis by Vannest et al. (2010), who stress that this is an important factor to ensure the effectiveness of such interventions.

In the area of LDif, arithmetic difficulties are underrepresented. This is supported by argumentations that research on developmental dyscalculia appears to be less popular than research on dyslexia (e.g., Kaufmann et al., 2013). Similarly, Visser et al. (2019) argue that research on comorbidity of dyscalculia and BP is limited. These findings underline the importance of gaining more insights into the co-occurrence of arithmetic difficulties and behavior problems in order to develop effective interventions for affected students; e.g., by considering variables such as anxiety in mathematics (e.g., Balt et al., 2022).

One of the most noticeable results of this review is the proportion of articles, which included a target group with ADHD or attention problems. Multiple explanations might have caused this finding. Firstly, LDif and attention problems co-occur on a regular basis. For example, DuPaul et al. (2013) reviewed multiple studies that investigated the comorbidity between LDif and ADHD and found comorbidity rates between 31 and 45%. Thus, appropriate interventions targeting both areas might be highly relevant in educational practice and research. A second explanation might be seen in the fact that attention processes seem to play a crucial part in the interplay of LDif and BP. In this regard, Barriga et al. (2002) found that the relationship between problem behavior and academic underachievement was mediated by attention. Similar, Willcutt and Pennington (2000) described that ADHD functions as a mediator between reading difficulties and oppositional disorder as well as conduct disorder.

However, the frequency of ADHD in the studies included might potentially reflect a limitation of the search approach applied. The inclusion of *ADH** and *attention* in the search syntax could have led to an overrepresentation of studies including a sample with ADHD. The number of studies focusing participants with ADHD could have further influenced at least two findings of this review. Boys are more often diagnosed with ADHD (e.g., Huss et al., 2008), which might have caused the gender imbalance across all included studies. To a similar extend, the high number of ADHD-related studies might have influenced the pattern of causal assumptions that became clear across this review. ADHD symptoms were rated as form of BP, so it was assumed that interventions targeting ADHD related behaviors might have a subsequent impact on LDif.

In some studies, it became clear that the presence of comorbid difficulties prior to the intervention affected the effectiveness of the applied intervention. Friedman et al. (2019) found that students with ADHD and LDif benefit less from a behavioral treatment than students with ADHD alone. Gray et al. (2012) describe that students with comorbid LDif and ADHD profit less from a working memory training if they are rated as being more inattentive and hyperactive. These results are in line with results by Rabiner et al. (2004), who found no effect of reading tutoring on the reading skills of children with reading difficulties and attention problems. Children with difficulties in only one area showed moderate to substantial improvements. Concerning arithmetic difficulties a similar effect was found by Herzog and Casale (2022), who described that students with co-occurring internalizing or externalizing BP benefited less from a computerized math intervention. In addition, externalizing BP led to the least intervention effects.

Across all included studies, it became clear that most studies assumed a one-directional or reciprocal relationship between LDif and BP and vice versa. Only few studies focused common explanatory variables of LDif and BP. Future studies should consider such variables in more detail. Some potentially relevant factors on child-level, such as emotions (e.g., Pekrun et al., 2017) and their regulation (e.g., Kopelman-Rubin et al., 2020) were barely considered. At the same time, common explanatory variables might also be located on environmental level (e.g., socio-economic background, parenting style) or institutional level (e.g., instructional quality). It is not surprising that such variables were not addressed in the identified studies, as variables of social inequalities manifest themselves in manifold ways and can hardly be addressed in the context of short-term interventions. Aspects of social and institutional inequalities appear to be key common variables in explaining LDif and BP. This effect should not be underestimated by purely focusing on the identified target processes in this review. Addressing and considering institutional inequalities in the context of LDif and BP remains a key challenge for practitioners and researchers.

4.1. Limitations

The results of this study need to be discussed against the background of major limitations. Firstly, the decisions concerning the search syntax applied as well as data bases searched might have influenced the body and type of studies that were found. The same applies for the inclusion and exclusion criteria. Especially the decision to include studies in which the sample only had difficulties in one of the target areas prior to the intervention led to the inclusion of a range of studies in which the second area of interest was only briefly included (e.g., as potential transfer effects). Although the assumption of potential transfer effects somehow reflects an underlying hypothesis of a relevant relation between constructs, such studies do not fall within the original narrow interest of the review. Nevertheless, we find that relevant studies provide some guidance for the design of effective support in both areas (LDif and BP).

Secondly, a major limitation is the decision that the main part of data extraction was carried out by only one person. Despite the use of single choice options, piloting of the data extraction template, additional coding by a student assistant of a share of all documents, subsequent discussion of disagreements, and adaption of the extraction template, the extracted information remains subjective. This becomes particularly clear as the resulting interrater agreement after the piloting of the extraction template was comparatively low. Hence, the extracted information needs to be interpreted carefully, as reliability might not be adequate. In addition, it became clear that it was not always possible to distinguish between dependent variables that target LDif and such that target BP. It was decided to code those variables in a third category, which comprised constructs related to both target areas (e.g., on- and off-task behavior). This might have led to an overlap with variables in the other primary categories and consequently complicated the comparison of results. A relevant portion of articles did not provide all relevant information so that the information on the implemented programs might not be complete. This could have led to an additional bias in the extracted information.

4.2. Conclusion and implications for research and practice

The findings of this review demonstrate the complexity of dealing with the co-occurrence of LDif and BP in practice and research. A variety of interventions and approaches were identified in the findings. Hence, LDif and BP reflect a variety of difficulties that do not call for a 'one size fits all' approach. This has implications for research and practice. In practice, teachers need to become aware of the causal assumptions that guide their decision making in designing interventions. Only if there is a fit between causal assumption and factual reality, sustainable effects can be expected. Our results indicate different interventional approaches. Firstly, most studies assume that LDif and BP are reciprocally or unidirectionally related which may be associated with models of a single deficit. Such assumptions call teachers to address one domain in a first step to influence the second domain of interest. Secondly, given the more recent ideas of multiple deficit models, addressing overlapping variables to influence LDif and BP may be another promising approach for teachers in practice. However, the results of our scoping review indicate, that so far, only the minority of studies addresses such overarching competencies. Combining academic and behavioral elements in an intervention might be a third approach, however identifying the active components of such multimodal intervention programs additionally asks for future dismantling research designs. Future intervention research should address this gap by extending the body of research on the usefulness of potential overlapping explanations (e.g., working memory, self-regulation skills).

In addition, it became clear that certain facets were underrepresented. Arithmetical competencies were only addressed in a handful of studies. Similar, interventions for students with internalizing behavior problems are lacking. Additionally, information on how other risk factors like social economical disadvantages influence the effect of such interventions are missing. Future research might also focus variables on an environment level (e.g., socio-economic background, parenting style) or institutional level that might impact both LDif and BP, as they, depending on the conception of disability applied, play a crucial role in the development of disability/special needs.

Despite the lack of clarity in the results, this review of existing interventions might nonetheless serve as an orientation for the future development of appropriate interventions that target students with co-occurring LDif and BP.

Author contributions

TG: Conceptualization, Writing – original draft, Writing – review & editing, Investigation and Formal analysis. MB-R: Conceptualization, 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.

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