Diagnostik und Behandlung der Rechenstörung
Literaturliste

AWMF-Register-Nr.: 028-046
Klassifizierung: S3 (evidenz- und konsensbasiert)

Bereich „Profil der Rechenstörung“
Hinsichtlich welcher Kompetenzen unterscheiden sich Menschen mit Rechenstörung von Menschen ohne Rechenstörung?

Literatur und Abstracts

Ashkenazi, S., et al. (2013). "Do subitizing deficits in developmental dyscalculia involve pattern recognition weakness?" Developmental Science **16**(1): 35-46.

The abilities of children diagnosed with developmental dyscalculia (DD) were examined in two types of object enumeration: subitizing, and small estimation (5–9 dots). Subitizing is usually defined as a fast and accurate assessment of a number of small dots (range 1 to 4 dots), and estimation is an imprecise process to assess a large number of items (range 5 dots or more). Based on reaction time (RT) and accuracy analysis, our results indicated a deficit in the subitizing and small estimation range among DD participants in relation to controls. There are indications that subitizing is based on pattern recognition, thus presenting dots in a canonical shape in the estimation range should result in a subitizing-like pattern. In line with this theory, our control group presented a subitizing-like pattern in the small estimation range for canonically arranged dots, whereas the DD participants presented a deficit in the estimation of canonically arranged dots. The present finding indicates that pattern recognition difficulties may play a significant role in both subitizing and subitizing deficits among those with DD. (PsycINFO Database Record (c) 2013 APA, all rights reserved). (journal abstract)

Censabella, S. and M. P. Noel (2008). "The inhibition capacities of children with mathematical disabilities." Child Neuropsychology **14**(1): 1-20.

Several authors have argued that mathematical disabilities might result from difficulties in inhibiting irrelevant information. The present study addresses this issue by assessing three inhibition functions in 40 ten-year-old children: suppression of irrelevant information from working memory, inhibition of prepotent responses, and interference control. We found no significant differences between children with math disabilities and typically achieving controls, or between children with arithmetic facts disabilities and children with above-average arithmetic facts skills. These findings, along with other empirical evidence and with theoretical considerations, cast doubt on the inhibition deficit hypothesis.

Ceulemans, A., et al. (2014). "Enumeration of small and large numerosities in adolescents with mathematical learning disorders." Res. Dev. Disabil. 35, No. 1, 27-35 (2014).

Summary: The accuracy and speed in an enumeration task were investigated in adolescents with typical and atypically poor development of arithmetic skills. The number naming performances on small and large non-symbolic numerosities of 18 adolescents with mathematical learning disorders (MLD) and 28 typically achieving age-matched (TA) adolescents were compared. A mixed logistic regression model showed that adolescents with MLD were not significantly less accurate on numbers within the subitizing range than control peers. Moreover, no significant differences in reaction times were found between both groups. Nevertheless, we found that within the control group adolescents with higher ability tended to respond faster when taking into account the whole range (1–9) of numerosities. This correlation was much weaker in the MLD group. When looking more closely at the data, however, it became clear that the correlation between accuracy and speed within the control group differed in direction dependent on the range (subitizing or counting) of the numerosities. As such, our findings did not support a limited capacity of subitizing in MLD. However, the data stressed a different correlation between speed and accuracy for both groups of adolescents and a different behavioral pattern depending on the numerosity range as well. Implications for the understanding and approach of MLD are considered. rv:

Compton, D. L., et al. (2012). "The Cognitive and Academic Profiles of Reading and Mathematics Learning Disabilities." Journal of Learning Disabilities **45**(1): 79-95.

The purpose of this study was to examine the cognitive and academic profiles associated with learning disability (LD) in reading comprehension, word reading, applied problems, and calculations. The goal was to assess the specificity hypothesis, in which unexpected underachievement associated

with LD is represented in terms of distinctive patterns of cognitive and academic strengths and weaknesses. At the start of 3rd grade, the authors assessed 684 students on five cognitive dimensions (nonverbal problem solving, processing speed, concept formation, language, and working memory), and across Grades 3 through 5, the authors assessed performance in each academic area three to four times. Based on final intercept, the authors classified students as LD or not LD in each of the four academic areas. For each of these four LD variables, they conducted multivariate cognitive profile analysis and academic profile analysis. Results, which generally supported the specificity hypothesis, are discussed in terms of the potential connections between reading and mathematics LD.

De Weerdt, F., et al. (2013). "Working memory in children with reading disabilities and/or mathematical disabilities." Journal of Learning Disabilities **46**(5): 461-472.

Elementary school children with reading disabilities (RD; n = 17), mathematical disabilities (MD; n = 22), or combined reading and mathematical disabilities (RD+MD; n = 28) were compared to average achieving (AA; n = 45) peers on working memory measures. On all working memory components, 2 (RD vs. no RD) × 2 (MD vs. no MD) factorial ANCOVAs revealed clear differences between children with and without RD. Children with MD had lower span scores than the AA children on measures of the phonological loop and the central executive. A significant interaction effect between RD and MD was found only for listening recall and had a small, partial effect size. In addition, analyses showed that the best logistic regression model consisted of a visuospatial and a central executive task. The model significantly distinguished between the AA and clinical groups and between the MD and RD+MD groups. Evidence was found for domain-general working memory problems in children with learning disabilities. Management of working memory loads in structured learning activities in the classroom, at home, or during therapy may help these children to cope with their problems in a more profound manner. (PsycINFO Database Record (c) 2013 APA, all rights reserved). (journal abstract)

Endlich, D., et al. (2014). "Verhaltensprobleme bei Kindern mit umschriebener und kombinierter schulischer Minderleistung." Kindheit und Entwicklung **23**(1): 61-69.

The aim of the current study was to investigate and characterize the correlation between learning deficiencies and behavior problems. Out of a sample of N = 929 second graders, a target sample of N = 94 children with isolated literacy problems (LP), isolated calculation problems (CP), combined problems (COM), or no learning problems (CG) were identified. These children were tested periodically between second and fourth grade. Behavior problems were measured by parent judgment (CBCL). Children with learning deficiencies showed more behavior problems than the CG. No differences in the types of behavior problems were found between the LP and CP groups. Results indicated that children with COM and those with constant learning deficiencies showed more behavior problems. It can be concluded that it is already important in primary school to consider combined learning deficiencies and to adopt a comprehensive diagnosis, including behavior problems in children with learning deficiencies.

Der Zusammenhang zwischen Lerndefiziten und Verhaltensproblemen wurde untersucht. Aus einer Ausgangsstichprobe von 929 Kindern wurde zu Beginn der zweiten Jahrgangsstufe eine Zielstichprobe von 94 Kindern identifiziert, die eine Lese-/Rechtschreibschwäche (LRS), eine Rechenschwäche (RS), eine kombinierte Schwäche (KOM) oder keine Schwäche (KG) aufwiesen. Diese Kinder wurden bis zur Mitte der vierten Jahrgangsstufe längsschnittlich untersucht (zum letzten, dritten Messzeitpunkt: 88 Kinder). Verhaltensprobleme wurden über das Elternurteil zu Beginn der vierten Klasse erfasst. Bei Kindern mit einer Lernschwäche zeigten sich mehr Verhaltensprobleme als in der KG. In Bezug auf die Verhaltensprobleme wurden keine Unterschiede zwischen den Gruppen LRS und RS gefunden. Es ergaben sich Hinweise auf vermehrte Verhaltensprobleme bei kombinierten Lernschwächen und bei überdauernder Beeinträchtigung. Die Ergebnisse werden als Hinweis darauf betrachtet, dass eine Berücksichtigung kombinierter Lerndefizite sowie eine umfassende Diagnostik, die Verhaltensprobleme mit einschließt, bereits im Grundschulalter von Bedeutung sind.

Geary, D. C., et al. (1999). "Numerical and arithmetical cognition: Patterns of functions and deficits in children at risk for a mathematical disability." Journal of Experimental Child Psychology **74**(3): 213-239.

Examined the performance on standard achievement tests of 1st-grade children (mean age 6.83 yrs) with IQ scores in the low- to high-average range who were classified as at risk for a learning disability (LD) in mathematics, reading, or both. These 55 at-risk children and a control group of 35 academically normal peers were administered experimental tasks that assessed number comprehension and production skills, counting knowledge, arithmetic skills, working memory, and ease of retrieving information from long-term memory. Different patterns of intact cognitive functions and deficits were found for children in the different at-risk groups. As a set, performance on the experimental tasks accounted for roughly 50% and 10% of the group differences in mathematics and reading achievement, respectively, above and beyond the influence of IQ. Performance on the experimental tasks thus provides insights into the cognitive deficits underlying different forms of LD, as well as into the sources of individual differences in academic achievement. (PsycINFO Database Record (c) 2012 APA, all rights reserved)

Ghesquiere, P., et al. (2004). "Strategy development in children with mathematical disabilities: insights from the choice/no-choice method and the chronological-age /ability-level-match design." Journal of Learning Disabilities **37**(2): 119-131.

This study investigated the strategy characteristics and development of children with mathematical disabilities (MD) in the domain of simple addition and subtraction, in terms of Lemaire and Siegler's model of strategic change, using the choice/no-choice method and the combined chronological-age (CA)/ability-level (AL)-match design. Four groups of children, matched on either CA or mathematical AL, solved a series of 36 problems with the bridge over 10 in four conditions. In the choice condition, children could choose between retrieval, decomposition to 10, and counting on to solve each problem. In the retrieval, decomposition, and counting conditions, they had to answer the same 36 problems using retrieval, decomposition to 10, and counting on, respectively. The results revealed clear differences in the frequency, efficiency, and adaptiveness with which the CA-matched children applied the available strategies. In contrast, we observed no differences in strategy frequency, efficiency, and adaptiveness between the AL-matched children. These results support the hypothesis that the strategy development of children with MD is marked by a delay rather than a specific deficit. Moreover, this study further documents the value of the methodology used to study children's strategy use and development in the domain of simple arithmetic. (Original abstract)

Gold, A. B., et al. (2013). "Cognitive and behavioral attention in children with math difficulties." Child Neuropsychology **19**(4): 420-437.

Cognitive assessments and behavioral ratings of attention were used to examine the relation of inattention to math performance in children. Third grade students with math difficulties (MD; n = 17) and math and reading difficulties (MDRD; n = 35) were administered the Attentional Network Test (ANT), as well as achievement and intelligence measures. Strengths and Weaknesses of ADHD-Symptoms and Normal-Behavior-IV (SWAN-IV) Inattention ratings were collected from teachers. Two comparison groups were also recruited: a typically achieving group (n = 23) and a group that responded to a math-tutoring intervention (responders; n = 54). On the ANT, children with MD and MDRD did not perform significantly different than typically achieving children or responders on measures of alerting and orienting attention and executive control. All subgroups did demonstrate performance patterns that were expected on the ANT. However, performance across blocks of the task was inconsistent, suggesting poor reliability. There were no relations between ANT performance and SWAN-IV behavioral inattention scores, though behavioral ratings of inattention correlated significantly with math performance. Children with MD and MDRD may have more difficulty with distraction and attention to detail in contextual situations, as opposed to impulsive responding in these settings. The lack of relation between cognitive attention and math performance may suggest that either the ANT does not assess the relevant attention constructs associated with math difficulties or may parallel studies of attention

deficit/hyperactivity disorder (ADHD) in which cognitive and behavioral assessments are weakly related. (PsycINFO Database Record (c) 2013 APA, all rights reserved). (journal abstract)

Heine, A., et al. (2013). "An electrophysiological investigation of non-symbolic magnitude processing: numerical distance effects in children with and without mathematical learning disabilities." Cortex **49**(8): 2162-2177.

INTRODUCTION: The aim of the present study was to probe electrophysiological effects of non-symbolic numerical processing in 20 children with mathematical learning disabilities (mean age = 99.2 months) compared to a group of 20 typically developing matched controls (mean age = 98.4 months).

METHODS: EEG data were obtained while children were tested with a standard non-symbolic numerical comparison paradigm that allowed us to investigate the effects of numerical distance manipulations for different set sizes, i.e., the classical subitizing, counting and estimation ranges. Effects of numerical distance manipulations on event-related potential (ERP) amplitudes as well as activation patterns of underlying current sources were analyzed.

RESULTS: In typically developing children, the amplitudes of a late parietal positive-going ERP component showed systematic numerical distance effects that did not depend on set size. For the group of children with mathematical learning disabilities, ERP distance effects were found only for stimuli within the subitizing range. Current source density analysis of distance-related group effects suggested that areas in right inferior parietal regions are involved in the generation of the parietal ERP amplitude differences.

CONCLUSION: Our results suggest that right inferior parietal regions are recruited differentially by controls compared to children with mathematical learning disabilities in response to non-symbolic numerical magnitude processing tasks, but only for stimuli with set sizes that exceed the subitizing range.Copyright 2012 Elsevier Ltd. All rights reserved.

Koontz, K. L. and D. B. Berch (1996). "Identifying Simple Numerical Stimuli: Processing Inefficiencies Exhibited by Arithmetic Learning Disabled Children." Mathematical Cognition **2**(1): 1-23.

Children with arithmetic learning disabilities (n=16) and normally achieving controls (n=16) in grades 3-5 were administered a battery of computerized tasks. Memory spans for both letters and digits were found to be smaller among the arithmetic learning disabled children. Implications for teaching are discussed. (Author/CMS)

Landerl, K., et al. (2004). "Developmental dyscalculia and basic numerical capacities: a study of 8–9-year-old students." Cognition 93, No. 2, 99-125 (2004).

Summary: Thirty-one 8- and 9-year-old children selected for dyscalculia, reading difficulties or both, were compared to controls on a range of basic number processing tasks. Children with dyscalculia only had impaired performance on the tasks despite high-average performance on tests of IQ, vocabulary and working memory tasks. Children with reading disability were mildly impaired only on tasks that involved articulation, while children with both disorders showed a pattern of numerical disability similar to that of the dyscalculic group, with no special features consequent on their reading or language deficits. We conclude that dyscalculia is the result of specific disabilities in basic numerical processing, rather than the consequence of deficits in other cognitive abilities. rv:

Mejias, S., et al. (2012). "Numerical and nonnumerical estimation in children with and without mathematical learning disabilities." Child Neuropsychology **18**(6): 550-575.

There are currently multiple explanations for mathematical learning disabilities (MLD). The present study focused on those assuming that MLD are due to a basic numerical deficit affecting the ability to represent and to manipulate number magnitude (Butterworth, 1999 , 2005 ; A. J. Wilson & Dehaene, 2007) and/or to access that number magnitude representation from numerical symbols (Rousselle & Noel, 2007). The present study provides an original contribution to this issue by testing MLD children (carefully selected on the basis of preserved abilities in other domains) on numerical estimation tasks with contrasting symbolic (Arabic numerals) and nonsymbolic (collection of dots) numbers used as input or output. MLD children performed consistently less accurately than control children on all the estimation tasks. However, MLD children were even weaker when the task involved the mapping between symbolic and nonsymbolic numbers than when the task required a mapping between two nonsymbolic numerical formats. Moreover, in the estimation of nonsymbolic numerosities, MLD children relied more than control children on perceptual cues such as the cumulative area of the dots. Finally, the task requiring a mapping from a nonsymbolic format to a symbolic format was the best predictor of MLD. In order to explain these present results, as well as those reported in the literature, we propose that the impoverished number magnitude representation of MLD children may arise from an initial mapping deficit between number symbols and that magnitude representation.

Micallef, S. and M. Prior (2004). "Arithmetic Learning Difficulties in Children." Educational Psychology **24**(2): 175-200.

This study explored the arithmetic skills of 39 children with arithmetic learning difficulties (ALD), compared to two control groups, one consisting of normally achieving children matched to the ALD sample for chronological age (n = 28), and another comprising younger normally achieving children matched to the ALD sample for arithmetic level (n = 28). To determine the relative contribution of reading impairments to arithmetic performance, the ALD group was further classified according to the presence or absence of reading difficulties into a mixed ALD (n = 24) and specific ALD (n = 15) group, respectively. The ALD group performed well below their chronological age counterparts in terms of the developmental maturity of their arithmetic problem solving. These children demonstrated a reliance on slow, counting-based procedures to solve arithmetic problems and, in this regard, they performed similarly to their younger, arithmetic-matched normal peers. Children with ALD also employed direct fact retrieval reliably less often than their same-age peers, but did not differ from their younger, arithmetic-matched counterparts. There were few significant differences between ALD children with and without accompanying reading problems. (PsycINFO Database Record (c) 2012 APA, all rights reserved)

Morsanyi, K., et al. (2013). "The link between logic, mathematics and imagination: evidence from children with developmental dyscalculia and mathematically gifted children." Developmental Science **16**(4): 542-553.

This study examined performance on transitive inference problems in children with developmental dyscalculia (DD), typically developing controls matched on IQ, working memory and reading skills, and in children with outstanding mathematical abilities. Whereas mainstream approaches currently consider DD as a domain-specific deficit, we hypothesized that the development of mathematical skills is closely related to the development of logical abilities, a domain-general skill. In particular, we expected a close link between mathematical skills and the ability to reason independently of one's beliefs. Our results showed that this was indeed the case, with children with DD performing more poorly than controls, and high maths ability children showing outstanding skills in logical reasoning about belief-laden problems. Nevertheless, all groups performed poorly on structurally equivalent problems with belief-neutral content. This is in line with suggestions that abstract reasoning skills (i.e. the ability to reason about content without real-life referents) develops later than the ability to reason about belief-inconsistent fantasy content.A video abstract of this article can be viewed at http://www.youtube.com/watch?v=90DWY3O4xx8. Copyright © 2013 Blackwell Publishing Ltd.

Mussolin, C., et al. (2010). "Symbolic and nonsymbolic number comparison in children with and without dyscalculia." Cognition **115**(1): 10-25.

Developmental dyscalculia (DD) is a pervasive difficulty affecting number processing and arithmetic. It is encountered in around 6% of school-aged children. While previous studies have mainly focused on general cognitive functions, the present paper aims to further investigate the hypothesis of a specific numerical deficit in dyscalculia. The performance of 10- and 11-year-old children with DD characterised by a weakness in arithmetic facts retrieval and age-matched control children was compared on various number comparison tasks. Participants were asked to compare a quantity presented in either a symbolic (Arabic numerals, number words, canonical dots patterns) or a nonsymbolic format (noncanonical dots patterns, and random sticks patterns) to the reference quantity 5. DD children showed a greater numerical distance effect than control children, irrespective of the number format. This favours a deficit in the specialised cognitive system underlying the processing of number magnitude in children with DD. Results are discussed in terms of access and representation deficit hypotheses.Copyright 2010. Published by Elsevier B.V.

Peng, P., et al. (2012). "Phonological storage and executive function deficits in children with mathematics difficulties." Journal of Experimental Child Psychology **112**(4): 452-466.

Children with mathematics difficulties suffer from working memory deficits. This study investigated the deficit profile of phonological storage and executive functions in working memory among children with mathematics difficulties. Based on multiple instruments and two assessment points, 68 children were screened out of 805 fifth graders. Of these 68 children, 18 were classified as children with only mathematics difficulties (MD), 20 were classified as children with mathematics and reading difficulties (MDRD), and 30 were typically developing (TD) peers matched on age and general ability. Measures for phonological storage, dual-task performance, inhibition, and updating of verbal and numerical materials were administered individually. Results showed that compared with the TD group, children with MD exhibited storage and inhibition deficits specific to numerical information and dual-task deficits of both verbal and numerical information, whereas children with MDRD showed extensive deficits on phonological storage and executive functions on both verbal and numerical tasks. Moreover, executive function deficits were not confined to phonological storage deficits. Implications of the findings for the working memory deficit profile and working memory training among children with mathematics difficulties were discussed. (PsycINFO Database Record (c) 2012 APA, all rights reserved). (journal abstract)

Powell, S. R., et al. (2009). "Do word-problem features differentially affect problem difficulty as a function of students' mathematics difficulty with and without reading difficulty?" Journal of Learning Disabilities **42**(2): 99-110.

This study examined whether and, if so, how word-problem features differentially affect problem difficulty as a function of mathematics difficulty (MD) status: no MD (n = 109), MD only (n = 109), or MD in combination with reading difficulties (MDRD; n = 109). The problem features were problem type (total, difference, or change) and position of missing information in the number sentence representing the word problem (first, second, or third position). Students were assessed on 14 word problems near the beginning of third grade. Consistent with the hypothesis that mathematical cognition differs as a function of MD subtype, problem type affected problem difficulty differentially for MDRD versus MD-only students; however, the position of missing information in word problems did not. Implications for MD subtyping and for instruction are discussed. (PsycINFO Database Record (c) 2012 APA, all rights reserved). (journal abstract)

Rosenberg-Lee, M., et al. (2014). "Brain hyper-connectivity and operation-specific deficits during arithmetic problem solving in children with developmental dyscalculia." Developmental Science.

Developmental dyscalculia (DD) is marked by specific deficits in processing numerical and mathematical information despite normal intelligence (IQ) and reading ability. We examined how brain circuits used by young children with DD to solve simple addition and subtraction problems differ from those used by typically developing (TD) children who were matched on age, IQ, reading ability, and working memory. Children with DD were slower

and less accurate during problem solving than TD children, and were especially impaired on their ability to solve subtraction problems. Children with DD showed significantly greater activity in multiple parietal, occipito-temporal and prefrontal cortex regions while solving addition and subtraction problems. Despite poorer performance during subtraction, children with DD showed greater activity in multiple intra-parietal sulcus (IPS) and superior parietal lobule subdivisions in the dorsal posterior parietal cortex as well as fusiform gyrus in the ventral occipito-temporal cortex. Critically, effective connectivity analyses revealed hyper-connectivity, rather than reduced connectivity, between the IPS and multiple brain systems including the lateral fronto-parietal and default mode networks in children with DD during both addition and subtraction. These findings suggest the IPS and its functional circuits are a major locus of dysfunction during both addition and subtraction problem solving in DD, and that inappropriate task modulation and hyper-connectivity, rather than under-engagement and under-connectivity, are the neural mechanisms underlying problem solving difficulties in children with DD. We discuss our findings in the broader context of multiple levels of analysis and performance issues inherent in neuroimaging studies of typical and atypical development. (PsycINFO Database Record (c) 2014 APA, all rights reserved). (journal abstract)

Rousselle, L. and M. P. Noel (2008). "Mental arithmetic in children with mathematics learning disabilities: the adaptive use of approximate calculation in an addition verification task." Journal of Learning Disabilities **41**(6): 498-513.

The adaptive use of approximate calculation was examined using a verification task with 18 third graders with mathematics learning disabilities, 22 typically achieving third graders, and 21 typically achieving second graders. Participants were asked to make true-false decisions on simple and complex addition problems while the distance between the proposed and the correct answer was manipulated. Both typically achieving groups were sensitive to answer plausibility on simple problems, were faster at rejecting extremely incorrect results than at accepting correct answers on complex addition problems, and showed a reduction of the complexity effect on implausible problems, attesting to the use of approximate calculation. Conversely, children with mathematics disabilities were unaffected by answer plausibility on simple addition problems, processed implausible and correct sums with equal speed on complex problems, and exhibited a smaller reduction of the complexity effect on implausible problems. They also made more errors on implausible problems. Different hypotheses are discussed to account for these results.

Schleifer, P. and K. Landerl (2011). "Subitizing and counting in typical and atypical development." Developmental Science **14**(2): 280-291.

Enumeration performance in standard dot counting paradigms was investigated for different age groups with typical and atypically poor development of arithmetic skills. Experiment 1 showed a high correspondence between response times and saccadic frequencies for four age groups with typical development. Age differences were more marked for the counting than the subitizing range. In Experiment 2 we found a discontinuity between subitizing and counting for dyscalculic children; however, their subitizing slopes were steeper than those of typically developing control groups, indicating a dysfunctional subitizing mechanism. Across both experiments a number of factors could be identified that affect enumeration in the subitizing and the counting range differentially. These differential patterns further support the assumption of two qualitatively different enumeration processes.

Schuchardt, K., et al. (2008). "Working memory deficits in children with specific learning disorders." Journal of Learning Disabilities **41**(6): 514-523.

This article examines working memory functioning in children with specific developmental disorders of scholastic skills as defined by ICD-10. Ninety-seven second to fourth graders with a minimum IQ of 80 are compared using a 2 × 2 factorial (dyscalculia vs. no dyscalculia; dyslexia vs. no dyslexia) design. An extensive test battery assesses the three subcomponents of working memory described by Baddeley (1986): phonological loop, visual–spatial sketchpad, and central executive. Children with dyscalculia show deficits in visual–spatial memory; children with dyslexia show deficits in phonological and central executive functioning. When controlling for the influence of the phonological loop on the performance of the central

executive, however, the effect is no longer significant. Although children with both reading and arithmetic disorders are consistently outperformed by all other groups, there is no significant interaction between the factors dyscalculia and dyslexia. (PsycINFO Database Record (c) 2012 APA, all rights reserved). (journal abstract)

Schuchardt, K. and C. Mähler (2010). "Do subgroups of children with mathematical disabilities differ in their working memory, basic arithmetical knowledge, and numeric competences? (Unterscheiden sich Subgruppen rechengestörter Kinder in ihrer Arbeitsgedächtniskapazität, im basalen arithmetischen Faktenwissen und in den numerischen Basiskompetenzen?)." Z. Entwicklungspsychol. Pädagog. Psychol. 42, No. 4, 217-225 (2010).

Zusammenfassung: Die vorliegende Studie beschäftigt sich mit kognitiven Merkmalen bei Subgruppen rechenschwacher Kinder. Dabei wurde im Einzelnen überprüft, ob Leistungsbeeinträchtigungen in der bereichsübergreifenden Arbeitsgedächtniskapazität sowie in bereichsspezifischen Fähigkeiten des basalen arithmetischen Faktenabrufs und der numerischen Basiskompetenzen vorliegen und ob Unterschiede zwischen rechenschwachen Kindern mit und ohne zusätzliche Schriftsprachschwierigkeiten bestehen. Hierzu wurden 22 Kinder mit der Diagnose Rechenstörung (F 81.2 nach ICD-10), 30 Kinder mit der Diagnose Kombinierte Störung schulischer Fertigkeiten (F 81.3 nach ICD-10) und 30 nach Alter parallelisierte Kontrollkinder mit einer umfangreichen Testbatterie in Einzelsitzungen untersucht. Die Ergebnisse belegen für alle rechengestörten Kinder Defizite in allen drei Bereichen, wobei die Kinder mit kombinierten Schulleistungsstörungen im Vergleich zu den isoliert gestörten Kindern umfassendere Beeinträchtigungen aufweisen. rv:

Summary: We examined domain-general working memory deficits and domain-specific knowledge deficits in children with mathematical disabilities. An extensive test battery was used to study children showing either only mathematical deficits (n = 22) or mathematical and verbal (reading and writing) deficits (n = 30) and a typically developing control group (n = 30). The results indicated that children with mathematical disabilities show significant deficits in working memory, basic arithmetical knowledge, and numerical competencies. However, children with impairments in just one domain clearly outperformed children with combined arithmetic and reading disorders in the present study. rv:

Silver, C. H., et al. (1999). "Social skills self-appraisal of children with specific arithmetic disabilities." Developmental Neuropsychology **16**(1): 117-126.

Previous research in subtype analysis identified children with specific arithmetic disabilities (AD) who demonstrated social skills deficits in the context of particular pattern of neuropsychological strengths and weaknesses. In this study, social skills of 14 children (aged 10–12 yrs) with AD were measured by parent, teacher, and self-report on the Social Skills Rating System (F. M. Gresham and S. N. Elliott, 1990) to assess for evidence social skills deficits and to compare the children's self-appraisals with the adults' ratings. Ss were also administered the older children's version of the Halstead-Reitan Neuropsychological Test Battery. Comparisons with 13 same-age classmates revealed deficits according to parents' and teachers' ratings, but the AD Ss failed to report their deficits. Discrepancies in the ratings were positively related to visual-spatial dysfunction were not related to left-side sensory-perceptual dysfunction. . (PsycINFO Database Record (c) 2012 APA, all rights reserved)

Swanson, H. L. (2012). "Cognitive profile of adolescents with math disabilities: Are the profiles different from those with reading disabilities?" Child Neuropsychology **18**(2): 125-143.

Adolescents (ages 14–17) with math disabilities (MD, n =12), reading disabilities (RD, n =19), math + reading disabilities (MD+RD, n = 12), and average achievers (n =15) were compared on measures of visual-spatial processing, random generation (inhibition), writing speed, short-term memory (STM), and working memory (WM). Adolescents with MD performed significantly lower than adolescents with RD on measures of visual-spatial processing and visual WM. Adolescents with MD outperformed adolescents with RD +MD on measures of random generation and motor speed. Performance of all three low-achieving groups was inferior to average achievers on measures of random generation, motor speed, and verbal WM. The results were

interpreted within a multicomponent model that attributed deficits related to MD in adolescents to deficits related the visual-spatial sketchpad of WM. (PsycINFO Database Record (c) 2012 APA, all rights reserved). (journal abstract)

Swanson, H. L. (2014). "Does cognitive strategy training on word problems compensate for working memory capacity in children with math difficulties?" Journal of Educational Psychology **106**(3): 831-848.

Cognitive strategies are important tools for children with math difficulties (MD) in learning to solve word problems. The effectiveness of strategy training, however, depends on working memory capacity (WMC). Thus, children with MD but with relatively higher WMC are more likely to benefit from strategy training, whereas children with lower WMC may have their resources overtaxed. Children in Grade 3 (N = 147) were randomly assigned to 1 of 4 conditions: (a) verbal strategies (e.g., underlining question sentence), (b) visual strategies (e.g., correctly placing numbers in diagrams), (c) verbal plus visual strategies, or (d) an untreated control. In line with the predictions, children with MD and higher WMC benefited from verbal or visual strategies relative to those in the control condition on posttest measures of problem solving, calculation, and operation span. In contrast, cognitive strategies decreased problem-solving accuracy in children with low WMC. Thus, improvement in problem solving and related measures, as well as the impairment in learning outcomes, was moderated by WMC. (PsycINFO Database Record (c) 2014 APA, all rights reserved). (journal abstract)

Swanson, H. L., et al. (2013). "Effects of cognitive strategy interventions and cognitive moderators on word problem solving in children at risk for problem solving difficulties." Learning Disabilities Research & Practice **28**(4): 170-183.

This study investigated the role of strategy instruction and cognitive abilities on word problem solving accuracy in children with math difficulties (MD). Elementary school children (N = 120) with and without MD were randomly assigned to 1 of 4 conditions: general-heuristic (e.g., underline question sentence), visual-schematic presentation (diagrams), general-heuristic + visual-schematic, and an untreated control. When compared to the control condition that included children with MD, an advantage at posttest was found for children with MD for the visual-schematic-alone condition on measures of problem solving and calculation accuracy, whereas all strategy conditions facilitated posttest performance in correctly identifying problem solving components. The results also suggested that strategy conditions drew upon different cognitive resources. The General-heuristic condition drew primarily upon the executive component of working memory (WM), Visual-schematic condition drew upon the visual component of WM and the combined strategies condition drew upon number processing skills. (PsycINFO Database Record (c) 2014 APA, all rights reserved). (journal abstract)

Swanson, H. L., et al. (2013). "Cognitive Strategies, Working Memory, and Growth in Word Problem Solving in Children With Math Difficulties." Journal of Learning Disabilities.

This study investigated the role of strategy instruction and working memory capacity (WMC) on word problem solving accuracy in children with (n = 100) and without (n = 92) math difficulties (MD). Within classrooms, children in Grades 2 and 3 were randomly assigned to one of four treatment conditions: verbal-only strategies (e.g., underlining question sentence), verbal + visual strategies, visual-only strategies (e.g., correctly placing numbers in diagrams), or untreated control. Strategy interventions included 20 sessions in both Year 1 and Year 2. The intent-to-treat as well as the “as-treated” analyses showed that treatment effects were significantly moderated by WMC. In general, treatment outcomes were higher when WMC was set to a high rather than low level. When set to a relatively high WMC level, children with MD performed significantly better under visual-only strategy conditions and children without MD performed better under verbal + visual conditions when compared to control conditions.

Szucs, D., et al. (2013). "Developmental dyscalculia is related to visuo-spatial memory and inhibition impairment." Cortex: A Journal Devoted to the Study of the Nervous System and Behavior **49**(10): 2674-2688.

Developmental dyscalculia is thought to be a specific impairment of mathematics ability. Currently dominant cognitive neuroscience theories of developmental dyscalculia suggest that it originates from the impairment of the magnitude representation of the human brain, residing in the intraparietal sulcus, or from impaired connections between number symbols and the magnitude representation. However, behavioral research offers several alternative theories for developmental dyscalculia and neuro-imaging also suggests that impairments in developmental dyscalculia may be linked to disruptions of other functions of the intraparietal sulcus than the magnitude representation. Strikingly, the magnitude representation theory has never been explicitly contrasted with a range of alternatives in a systematic fashion. Here we have filled this gap by directly contrasting five alternative theories (magnitude representation, working memory, inhibition, attention and spatial processing) of developmental dyscalculia in 9-10-year-old primary school children. Participants were selected from a pool of 1004 children and took part in 16 tests and nine experiments. The dominant features of developmental dyscalculia are visuo-spatial working memory, visuo-spatial short-term memory and inhibitory function (interference suppression) impairment. We hypothesize that inhibition impairment is related to the disruption of central executive memory function. Potential problems of visuo-spatial processing and attentional function in developmental dyscalculia probably depend on short-term memory/working memory and inhibition impairments. The magnitude representation theory of developmental dyscalculia was not supported. (PsycINFO Database Record (c) 2014 APA, all rights reserved). (journal abstract)

van Daal, V., et al. (2013). "Specificity and overlap in skills underpinning reading and arithmetical fluency." Reading and Writing **26**(6): 1009-1030.

The aim of this study was to examine unique and common causes of problems in reading and arithmetic fluency. 13- to 14-year-old students were placed into one of five groups: reading disabled (RD, n = 16), arithmetic disabled (AD, n = 34), reading and arithmetic disabled (RAD, n = 17), reading, arithmetic, and listening comprehension disabled (TRIPLE, n = 9), and typically developing students (NON-LD, n = 40). Multivariate analyses of covariance and variance component analyses showed that reading problems are characterised by difficulties with phonological processing and with rapid automatic naming. Problems with executive functioning and with digit span were typical for students with arithmetical fluency difficulties. RAD students had problems with phonological processing, rapid naming, executive functioning, and digit span. Impairments in number fact fluency, digit span, loudness perception, speeded sound manipulation, and coding, which all share a fluency component were common to problems with reading and arithmetical fluency. (PsycINFO Database Record (c) 2013 APA, all rights reserved). (journal abstract)

van der Sluis, S., et al. (2004). "Inhibition and shifting in children with learning deficits in arithmetic and reading." Journal of Experimental Child Psychology **87**(3): 239-266.

The executive functions of inhibition and shifting were studied in arithmetic-disabled children, reading-disabled children, reading plus arithmetic-disabled children, and controls (N = 74). Measures involved the rapid naming of objects, digits, letters, or quantities with or without additional task requirements that reflected inhibition or shifting. Also, the Making Trails task, reflecting shifting, was administered. For tasks without executive demands, arithmetic-disabled children were slower in the naming of digits and quantities, whereas reading-disabled children were slower in the naming of digits and letters. For the executive tasks, arithmetic-disabled children as well as reading plus arithmetic-disabled children were impaired on the Making Trails task and on an object naming task that required both inhibition and shifting. Reading-disabled children exhibited no problems in executive functioning. Furthermore, it was shown that reading plus arithmetic-disabled children experienced the combination of problems that characterize children with a single learning deficit. (PsycINFO Database Record (c) 2012 APA, all rights reserved). (journal abstract)

van der Sluis, S., et al. (2005). "Working memory in Dutch children with reading- and arithmetic-related LD." Journal of Learning Disabilities **38**(3): 207-221.
The aim of the two studies presented in this article was to examine working memory performance in Dutch children with various subtypes of learning disabilities. The performance of children with reading disabilities (RD) was compared to that of children with arithmetic disabilities (AD), children with both reading and arithmetic disabilities (RAD), and chronological age-matched controls (CA). Measures covered the phonological loop, the visuospatial sketchpad, and the central executive. In both studies, the children with RD showed no working memory deficits whatsoever. Children with AD showed a single impairment on the task tapping working memory for dynamic visual information. Children with RAD performed lower only on the digit span backward task. The failure to replicate the expected working memory deficits in children with reading-related disabilities is discussed. (Original abstract)

Wang, L.-C., et al. (2012). "Cognitive inhibition in students with and without dyslexia and dyscalculia." Research in Developmental Disabilities **33**(5): 1453-1461.
The present study presents a comparison of the cognitive inhibition abilities of dyslexic, dyscalculic, and control students. The participants were 45 dyslexic students, 45 dyscalculic students, and 45 age-, gender-, and IQ-matched control students. The major evaluation tools included six cognitive inhibition tasks which were restructured during principal component analysis into three categories: graph inhibition, number inhibition, and word inhibition. Comparisons of the 3 groups of students revealed that in graph inhibition, dyscalculic students performed worst of the 3 groups, with dyslexic students also performing worse than control students in this category. For number inhibition, the control students' performances were equal to those of dyslexic students, with both groups performing better than dyscalculic students. For word inhibition, control students' performances were equal to those of dyscalculic students; both groups had shorter response times and lower incorrect rates than dyslexic students. These results suggest the complexity of the different cognitive inhibition abilities displayed by dyslexic, dyscalculic, and control students. However, some regular patterns occurred. (PsycINFO Database Record (c) 2012 APA, all rights reserved). (journal abstract)

Willburger, E., et al. (2008). "Naming Speed in Dyslexia and Dyscalculia." Learning and Individual Differences **18**(2): 224-236.
In four carefully selected samples of 8- to 10-year old children with dyslexia (but age adequate arithmetic skills), dyscalculia (but age adequate reading skills), dyslexia/dyscalculia and controls a domain-general deficit in rapid automatized naming (RAN) was found for both dyslexia groups. Dyscalculic children exhibited a domain-specific deficit in rapid naming of quantities. This finding is in line with recent assumptions that dyscalculia is associated with a neurobiological deficit in the processing of numerosities. In the dyslexia/dyscalculia group, RAN deficits were additive, that is, the dyslexia/dyscalculia group exhibited the sum of the deficits found in the dyslexia only and dyscalculia only groups. This finding suggests that the cognitive bases of dyslexia and dyscalculia are independent from each other. Within the naming speed paradigm no differential impact of special demands on the executive functions inhibition and shifting was found for any of the four groups.

Wilson, A. J., et al. (2015). "Dyscalculia and dyslexia in adults: cognitive bases of comorbidity." Learn. Individ. Differ. 37, 118-132 (2015).
Summary: The developmental learning disabilities dyscalculia and dyslexia have a combined prevalence of 10\% or more, and a co-occurrence (comorbidity) rate of around 40\%. The causes and consequences of this comorbidity are poorly understood, despite implications for identification and remediation. We examined the cognitive bases of MDRD comorbidity in four groups of 85 adults (dyscalculia only, dyslexia only, comorbid and control), controlling for IQ and attentional difficulties. We used a computerized testing battery including core components of mathematics and reading, plus domain general capacities. Our results provide one of the first descriptions of dyscalculia symptoms in adults, showing that impairment on core numerical tasks continues into adulthood. Dyscalculia and dyslexia showed independent domain specific deficits, however we also found

evidence for domain general symptoms associated with both disorders. We argue that the presence of multiple underlying and additive impairments supports complex multifactorial models of comorbidity. rv: