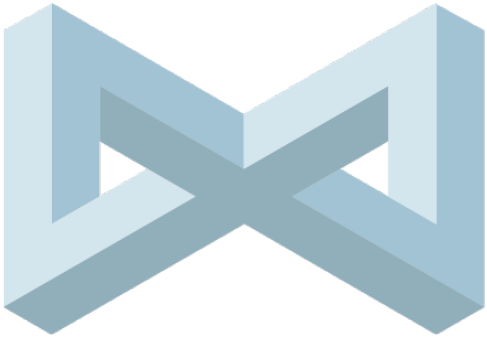

4.4.14

EXPERT MEETING BENELUX

Mathematical Research

Leiden University

Organized by

Universiteit Leiden

The Netherlands

UNIVERSITEIT VAN AMSTERDAM

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General information

Organizing committee

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tinyurl.com/expertmeeting040414

Venue

Meeting

Pieter de la Courtgebouw

Wassenaarseweg 52, Leiden

Dinner

Het Prentenkabinet

Kloksteeg 25, Leiden

For further directions please go to tinyurl.com/expertmeeting040414

Preface

We are pleased to welcome you at the sixth Expert Meeting on Mathematical Thinking and Learning at Leiden University. Like the first meeting in 2008, this meeting is jointly organized by Leiden University and the University of Amsterdam. But many things have changed since this first meeting. The Expert Meeting has developed substantially and is now a truly international meeting, in which we welcome a large group of participants, not only from the Netherlands and Belgium but also from Luxembourg, and, this year for the first time, even from Germany.

We have an outstanding and diverse program for today. There are three thematic symposia: The Mathematical Brain, Large Data Sets and Longitudinal Assessments, and Strategy Use in Mathematics. In-between there is ample opportunity to discuss these and other topics informally. We also invite you join us on the poster tours in one of the two thematically ordered poster sessions on numerical cognition, and on mathematical learning.

For those who subscribed, the day will end with a pleasant dinner in Het Prentenkabinet, located in the old city center of Leiden.

We are looking forward to an interesting day: we hope that you will enjoy the meeting and find opportunities to strengthen international connections with fellow mathematical researchers.

The organizing committee

In Memoriam
Erik van Loosbroek

Our dear colleague Erik van Loosbroek passed away on Easter Sunday the 31st of March 2013 at the age of just 56, after a short battle with cancer.

Erik worked as an assistant professor at Maastricht University from 2000 onwards. He was so dedicated to his work on the development of numeracy and numeracy problems in children that despite his physical discomfort he underwent the long trip from Nijmegen to Luxembourg to attend last year's Expert Meeting on Mathematical Thinking, which took place less than a month before his passing. He was very happy with the grant that he received in 2009 to start a PhD project and it is very sad that he will not be around to see this work through. He was also a dedicated teacher who took his students to heart, and they in turn valued him for his commitment and time.

Although we badly miss Erik's teaching and research contributions, we equally miss him as the social and loyal colleague that he was, always willing to listen to other people's stories, in both a personal and a professional setting. We will keep alive our warm and precious memories of the many dinners and group outings we had with Erik, during which his dry humor always created an atmosphere of enjoyment and good company.

On behalf of all colleagues from Maastricht University,
Lisa Jonkman, Linda Essers, and Tamara Schleepen

Program

09:30 – 10:00 Registration and coffee

10:00 - 10:15 Opening

10:15 – 11:45 SYMPOSIUM 1: THE MATHEMATICAL BRAIN

10:15 – 10:45 Contributions of research into the mathematical brain to the field of Neuroscience and Education
Linda van Leijenhorst, Leiden University

10:45 – 11:05 (A) Left fronto-parietal white matter correlates with individual differences in children's ability to solve additions and multiplications: A tractography study
Leen van Beek, KU Leuven

11:05 – 11:25 (B) Neural representations in visual cortex for numerical magnitudes presented in different formats
Lien Peters, KU Leuven

11:25 – 11:45 (C) Number processing via the mental eye: Number notation affects intraparietal sulcus involvement
Frauke van der Ven, Radboud University Nijmegen

11:45 - 12:45 POSTER SESSION 1: NUMBER REPRESENTATION

12:05 Tour 1: Spatial representations of numbers and magnitude

12:25 Tour 2: Symbolic and non-symbolic representations of numbers

12:45 - 13:30 LUNCH

13:30 – 15:00 **SYMPOSIUM 2: LARGE DATA SETS & LONGITUDINAL ASSESSMENT**

13:30 - 14:00 Big data in education: the Math Garden project
Han van der Maas, University of Amsterdam

14:00 - 14:20 (D) Age-related changes in the predictive value of visual-spatial and verbal working memory for math abilities in different domains
Eva van de Weijer, Utrecht University

14:20 - 14:40 (E) Assessing mathematical competencies within the Luxembourgish school monitoring program: Covering the range from 1st to 9th grade
Philipp Sonnleitner, University of Luxembourg

14:40 - 15:00 (F) Attitude towards mathematics: Its development in the early primary school years, and its relation with mathematics achievement, gender, and playing mathematics computer games
Marjoke Bakker, Freudenthal Institute

15:00 - 16:00 **POSTER SESSION 2: LEARNING MATHEMATICS**

15:15 Tour 3: Math problems / Measurement instruments

15:35 Tour 4: Intervention studies / Miscellaneous

16:00 – 17:30 SYMPOSIUM 3: STRATEGY USE IN MATHEMATICS

16:00 - 16:30 "It's all about strategies, stupid"
Lieven Verschaffel, KU Leuven

16:30 - 16:50 (G) Third graders' verbal reports of multiplication strategy use: How valid are they?
Helen Reed, Free University Amsterdam (VU)

16:50 - 17:10 (H) Inhibiting the natural number bias in rational number tasks: towards a comprehensive test instrument
Jo van Hoof , KU Leuven

17:10 - 17:30 (I) Do students choose adaptively between mental and written division strategies? A choice/no-choice experiment
Marije Fagginger Auer, Leiden University

17:30 – 17:40 Closing and poster award

18:15 **CONFERENCE DINNER AT HET PRENTENKABINET**

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Spatial Representations of Numbers and Magnitude

(1) **Counting direction in Dutch preschool children is not congruent with left-to-right number-space mapping**
Jaccoline van 't Noordende, Chiel Volman, Evelyn Kroesbergen, & Paul Leseman
Utrecht University

(2) **Canonical finger numeral configurations are perceived holistically**
Samuel Di Luca, Mauro Pesenti, Christine Schiltz, & Goedele Van Belle
University of Luxembourg & Université Catholique de Louvain

(3) **Task-irrelevant numbers influence conscious perception during binocular rivalry**
Dennis Croonenberg, Tom de Graaf, Alex Sack, Romain Martin, & Christine Schiltz
University of Luxembourg & Maastricht University

(4) **The influence of body motion on random number generation**
Charlotte Sosson, Mathieu Guillaume, Amandine Van Rinsveld, Anne-Marie Schuller, & Christine Schiltz
Institute of Cognitive Science and Assessment, University of Luxembourg

(5) **Spatial coding of a number is determined by its immediate context**
Bart Anseeuw, Jean-Philippe Van Dijck, & Wim Fias
Ghent University

(6) **Testing the bi-directionality in the link between numbers, working memory and space**
Maya de Belder, Jean-Philippe van Dijck, Elger Abrahamse, & Wim Fias
Ghent University

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(7) **How is numerical magnitude processing related to multi-digit subtraction strategies in children? A study on mental calculation and the application of the written algorithm.**
Sarah Linsen, Lieven Verschaffel, Bert Reynvoet, & Bert De Smedt
KU Leuven

(8) **Adults' arithmetic builds on fast and automatic processing of Arabic digits**
Delphine Sasanguie, Bert De Smedt, & Bert Reynvoet
KU Leuven

(9) **Neural representations of numbers in the human cortex**
Jessica Bulthé, Hans Op de Beeck, & Bert De Smedt
KU Leuven

(10) **Bringing number sense to the supermarket: The relationship between number line estimation performance and the accuracy of price estimates**
Koen Luwel & Annelies De Pauw
KU Leuven & HU Brussel

(11) **Adults' use of number line estimation strategies**
Dominique Peeters, Lieven Verschaffel, & Koen Luwel
KU Leuven & HU Brussel

(12) **Longitudinal development of number line estimation in primary school children**
Ilona Friso-van den Bos, Evelyn Kroesbergen, & Hans van Luit
Utrecht University

(13) **Four-and-twenty blackbirds: The effect of number word structure at different ages**
Sanne van der Ven, Jonathan Klaiber, & Han van der Maas
University of Amsterdam

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(14) **Observation list for levels of mathematical acting in the lower classes of the primary school in the Netherlands**
Els Terlien & Marie-José Bunck
Hogeschool Utrecht

(15) **Impact of dyscalculia in young adulthood: First results on the Dyscalculia Impact Scale**
Ilse Smits
Thomas More University College

(16) **Developing a math large-scale assessment for children at the beginning of first grade in Luxembourg**
Caroline Hornung, Danielle Hoffmann, Dalia Lorphelin,
& Antoine Fischbach
University of Luxembourg

(17) **CODY: A computer-based assessment and training for children with developmental dyscalculia**
Jörg-Tobias Kuhn, Heinz Holling, Julia Raddatz, & Christian Dobel
University of Muenster

(18) **Evidence for a global access deficit to the meaning of numerical symbols in people with Williams syndrome.**
Laurence Rousselle
University of Liège

(19) **Arithmetic strategy development and its domain-specific and domain-general cognitive correlates: A longitudinal study in children with persistent mathematical learning difficulties**
Kiran Vanbinst, Pol Ghesquière, & Bert De Smedt
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(20) **Exploring the feasibility and effectiveness of assessment techniques to improve student learning in primary mathematics education**
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Freudenthal Institute for Science and Mathematics Education, Utrecht University

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Magda Praet & Annemie Desoete
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(23) **Role of home numeracy environment in predicting early numeracy skills**
Tijs Kleemans, Eliane Segers, & Ludo Verhoeven
Radboud University Nijmegen

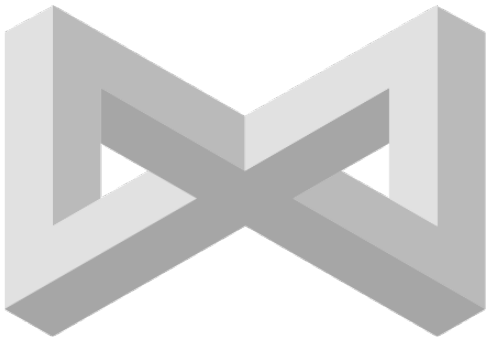
(24) **Quantitative analogical reasoning in mathematically neutral word problems: about Flemish children solving 'Greek' word problems**
Tine Degrande, Lieven Verschaffel & Wim Van Dooren
KU Leuven

(25) **Gender differences in mathematics achievement in 3rd and 9th grade students: A large-scale study in Luxembourg**
Sylvie Gamo, Philipp Sonnleitner, Ulrich Keller, Caroline Hornung, & Romain Martin
University of Luxembourg

(26) **The impact of language on mathematical problem solving in German-French bilinguals**
Sonja Ugen, Amandine Van Rinsveld, Christine Schiltz, & Martin Brunner
University of Luxembourg & Free University of Berlin and Berlin-Brandenburg Institute for School Quality

(27) **An investigation of the relation between self-efficacy, experience of success, and the motivation to practice math**
Brenda Jansen, Alexander Savi, Nadine Bürmann, & Han van der Maas
University of Amsterdam

(28) **Can training on one number sense skill be generalized to overall improved number sense? Results from an intervention study with a new tablet game.**
Bieke Maertens, Bert Reynvoet, Bert De Smedt, & Jan Elen
KU Leuven



4.4.14
EXPERT MEETING BENELUX
Mathematical Research

Presentation abstracts

SYMPOSIUM 1 - INTRODUCTORY LECTURE

Contributions of research into the mathematical brain to the field of Neuroscience and Education

Linda van Leijenhorst
Leiden University

Knowledge of numbers is a basic and near universal aspect of cognition. Nevertheless mathematical ability is relatively slow to develop, and a source of frustration for many students. In recent years the development of neuroimaging techniques has enabled us to explore how the human brain enables mathematics. However, adult neurocognitive models dominate current theorizing and empirical work on the mathematical brain, and relatively little consideration is given to the roles of individual differences and age-related changes. Considering both these factors is crucial for the emerging field of neuroscience and education. In this introductory talk I will discuss how research on the mathematical brain, such as the work presented in this session, contributes to, and informs this new field.

Left fronto-parietal white matter correlates with individual differences in children's ability to solve additions and multiplications: A tractography study

Leen Van Beek, Pol Ghesquière, Lieven Lagae,
& Bert De Smedt
KU Leuven

fMRI data have pointed to the activation of a fronto-parietal network during calculation. This network is modulated by arithmetic operation and arithmetical competence. As the cortical brain regions of this network are distant, it is crucial to investigate the white matter connections between them. By using diffusion tensor imaging tractography in eighteen 12-year-olds, we tested whether white matter pathways connecting these distant regions were related to children's arithmetical competence and how this association was modulated by operation. We delineated the three subcomponents of the arcuate fasciculus, a bundle of pathways linking frontal and temporo-parietal regions that are commonly active during calculation tasks. Fractional anisotropy in the left arcuate fasciculus-anterior was positively correlated with addition ($r = .704$; $p < .01$) and multiplication ($r = .722$; $p < .01$), but not with subtraction and division, suggesting a specific role of this left anterior segment in the solution of those problems that are expected to be solved with fact retrieval. The observed correlation was not explained by age, intelligence and working memory. Follow-up control analyses revealed that the observed correlation disappeared when measures that draw heavily on phonological processing, such as non-word reading, were controlled for, suggesting that the association between the left arcuate fasciculus-anterior and addition/multiplication reflects the involvement of phonological processing. These results are the first to demonstrate that individual differences in fronto-parietal white matter are associated with arithmetical competence in healthy 12-year-olds and that this association is modulated by operation.

Neural representations in visual cortex for numerical magnitudes presented in different formats

Lien Peters, Jessica Bulthé, Hans Op de Beeck,
& Bert De Smedt
KU Leuven

Lately there has been a boost of neuroimaging research in the field of numerical cognition in order to reveal the neural mechanisms underlying number processing. In this study, we were interested in how numerical magnitudes in different formats are represented in the visual cortex. We looked for regions with selectivity for formats, and examined how the representations for these formats evolve across the visual processing hierarchy.

The study consisted of two fMRI-experiments. In the first experiment, subjects had to subtract magnitudes up to 20 and compare the result with a reference magnitude. Stimuli were presented as dot patterns, Arabic digits and number words. We found greater activity for number words than for dot patterns in VWFA, whereas the activity for Arabic digits was intermediate. Furthermore, we consistently found an area in the lateral occipital (LO) cortex that responded more to digits than number words.

In Experiment 2, we manipulated format (letter versus digit) and string length (2 or 5 characters). Subjects performed an ordinal task. In VWFA, we found clustering of letter and symbol strings, respectively, with higher mean activity for the letter arrays. The number of characters thus did not influence activity in VWFA. The LO preference for symbols versus number words was not replicated in this experiment and might reflect a task-dependent preference for digits over number words. Furthermore, we found a shift in the representation of letters and digits throughout the visual processing stream from grouping based on number of characters to grouping based on stimulus category.

Number processing via the mental eye: Number notation affects intraparietal sulcus involvement

Frauke van der Ven, Atsuko Takashima, Eliane Segers, Guillén Fernández, & Ludo Verhoeven
Radboud University Nijmegen

Addition problems can be solved by making use of the numerical quantity system in the intraparietal sulcus (IPS), and/or by retrieving the solution from verbal rote memory, possibly via the angular gyrus (AG). Do we use magnitude processing in the IPS to solve easy addition, or do we use the memory system through the AG, especially for those problems presented in the familiar Arabic number notation? In the present fMRI study, we investigated whether number notation affects addition related IPS activity, and to what degree IPS activity is specific for magnitude processing. Twenty-five participants performed simple arithmetic (addition, subtraction) and a memory baseline task, with problems in non-symbolic (Dots: '::') or symbolic (Arabic: '4'; Words: 'four') notation. Also non-magnitude formats (Japanese katakana-Characters; Colors) were included in order to reveal magnitude specific IPS activity. As for addition, we observed IPS activity only for non-symbolic addition. Conversely, activity in the AG/perisylvian areas appeared to be more prominent for addition of symbolic numbers, suggesting that symbolic number addition utilizes fact retrieval rather than calculation through the quantity system. Against expectations, IPS activity was not magnitude specific; IPS activity was present for non-magnitude operands that appeared to be processed in a visual-spatial style. Our findings suggest that the strategies used for solving simple addition problems depend on number notation and that number processing and visual-spatial processing are intrinsically linked. Addition problems, if they are presented in non-symbolic format, are visually-spatially processed as reflected in an IPS activity increase.

SYMPOSIUM 2 - INTRODUCTORY LECTURE

S2

Big data in education: the Math Garden project

Han van der Maas
University of Amsterdam

The developing cognitive system is prime example of a complex system. In the science of complex systems accurate high frequent measurement of the behavior of the system is essential. We started the Math Garden project to collect such data. Math Garden is web-based adaptive practice and monitoring system based on a new algorithm for computer adaptive testing and explicit scoring rules for accuracy and speed. Schools and parents use Math Garden as a practice and monitoring tool. Researchers use Math Garden data for the study of cognitive, math and language development. Currently, more than 1000 schools in the Netherlands and Belgium use Math Garden or Language Sea (the language variant of Math Garden). We collected over 300 million item responses, currently at a speed of one million items per day. In this talk I discuss the advantages and disadvantages of Math Garden as a scientific instrument. Examples of results on math, reasoning and memory development will be presented.

Age-related changes in the predictive value of visual-spatial and verbal working memory for math abilities in different domains

Eva van de Weijer-Bergsma, Evelyn Kroesbergen,
& Hans van Luit
Utrecht University

In this study, age-related changes in the relationship between visual-spatial and verbal working memory and various math domains (i.e. addition, subtraction, multiplication and division) during primary school are investigated.

A total of 4303 children from grades 2 through 6 participated. Math ability in the different domains was assessed at the start, middle and end of the school year. Visual-spatial and verbal working memory was assessed using computerized, self-reliant assessment in the classroom at the start and middle of the school year, respectively. First, Latent growth modeling was used to model individual differences in the level and developmental rate of change of math abilities within each grade. Second, the predictive value of visual-spatial and verbal working memory for level and rate of change in the different math domains was examined.

Preliminary results indicate that the predictive value of visual-spatial working memory for math ability decreased with age, while the predictive value of verbal working memory increased. These age-related changes were stronger in some math domains than in others. The results will be discussed in the light of three explanations (i.e., development, novelty and domain specificity). According to the developmental explanation younger children rely more on visual-spatial representations (e.g. number lines) and use more visual-spatial strategies (e.g. finger counting). According to the novelty explanation, the shift from visual-spatial to verbal strategies is caused by novelty of the material. According to the domain specificity explanation, the relation between math and visual-spatial working memory differs between math domains.

Assessing mathematical competencies within the Luxembourgish school monitoring program: Covering the range from 1st to 9th grade

Sonnleitner, P., Gamo, S. , Hornung, C. , Fischbach, A. , Dierendonck, C. , Ugen, S. , Keller, U. , Lorpehlin, D. , & Martin. R.
University of Luxembourg

As a direct reaction to alarmingly poor student performance in PISA, like many other European countries Luxembourg started to establish a very ambitious school monitoring program: the Épreuves Standardisées (ÉpStan). One of the core competencies that are measured is, of course, mathematical achievement. Beginning with grade 1 and continued in grade 3 and grade 9, students' proficiency in several mathematical sub-competencies is assessed. Students have to demonstrate their mathematical problem solving skills in theoretical as well as applied contexts. This design not only allows for tracking individual students' development of mathematical abilities but also allows for a better understanding of factors that influence this process– a rich and valuable source for the determination of risk factors and the implementation of individual support programs. However, due to the early beginning of this comprehensive program and the heterogeneity of Luxembourg's students in terms of cultural background and spoken language, several challenges arise, especially for test development. We will present and discuss the theoretical framework of mathematical competencies that is assessed within the ÉpStan and we will show how we are currently using possibilities of computer-based assessment and test design in order to respond to these challenges.

F Attitude towards mathematics: Its development in the early primary school years, and its relation with mathematics achievement, gender, and playing mathematics computer games

Marjoke Bakker (1), Marja van den Heuvel-Panhuizen (1), and Alexander Robitzsch (2)
(1) Freudenthal Institute (Utrecht University)
(2) Federal Institute for Education Research, Salzburg

In a large-scale study the development of primary school students' attitude towards mathematics was investigated. Students' attitude towards mathematics was conceptualized as their liking, or enjoyment, of the subject of mathematics. A longitudinal design was employed, in which 932 students from 45 Dutch primary schools were followed from the end of Grade 1 ('groep 3') to the end of Grade 4 ('groep 6'). Students' attitude towards mathematics was measured at six time points, using a questionnaire. At each time point also students' mathematics achievement was measured. First of all, it was found that in the early grades of primary school the students' mathematics attitude was moderately positive, but that it decreased with age, which has been found in other research as well. Such a decline was also apparent for attitude towards reading and towards school in general, but for mathematics attitude the decline was more pronounced. Furthermore, in contrast to several earlier research findings, girls' attitude towards mathematics was higher than boys'. This gender difference did not change over the grades. In addition, our results revealed significant correlations between mathematics attitude and mathematics achievement at the same time point. A cross-lagged path analysis indicated that, on average over the time points, prior mathematics achievement was a marginally significant predictor of subsequent attitude towards mathematics, but prior attitude did not predict subsequent achievement. Finally, using an extended cross-lagged path model, we found some evidence for a positive influence, albeit weak, of playing mathematics computer games on students' later attitude towards mathematics.

SYMPOSIUM 3 - INTRODUCTORY LECTURE

"It's all about strategies, stupid"

Lieven Verschaffel
KU Leuven

The goal of this introductory paper is to reflect upon some major theoretical and methodological issues related to children's strategy use in (elementary) arithmetic. In the first part, I will discuss some major issues with respect to the strategy parameters variability, efficiency and flexibility. Second, I will look critically at various ways to identify children's strategy use. The relationship between children's strategic performance and their number sense will be addressed in a third part. I will end with a brief more fundamental reflection upon the notion of arithmetic strategies and the central place we gave it in our theorizing about children's arithmetical thinking and learning.

Third graders' verbal reports of multiplication strategy use: How valid are they?

Helen Reed, Claire Stevenson, Marije Broens-Paffen, Paul Kirschner, & Jelle Jolles
VU University Amsterdam, Open University of the Netherlands

Children use a variety of strategies to solve multiplication problems and performance is known to be related to strategy use. Typically developing children progress from relying on procedural strategies to increasing use of memory-based strategies, yet this progression is delayed in some children. It is therefore important to identify children who consistently use more immature strategies than their peers, so that early remedial action can be taken. A practicable way to assess strategy use would be to ask children how they solve multiplication problems. Yet, it is not established whether what children report is veridicial. The present study therefore investigates the extent to which verbal reports accurately represent third graders' thinking processes during simple multiplication problem-solving. The approach taken is to assess the degree to which verbal reports predict children's performance in ways that correspond to known patterns of solution speed, accuracy and errors, taking account of problem characteristics that are known to affect multiplication performance. In addition, the effects of child characteristics (i.e., math ability, verbal ability and phonological skill) are investigated. The study involves 106 Grade 3 students from mainstream primary schools in the Netherlands. Reported strategies were found to predict performance in ways that are largely consistent with expectation, with one exception - namely the speed of executing different procedural strategies. Nonetheless, the results are overwhelmingly consistent with what is known about other aspects of children's multiplication learning. Implications for research into children's multiplication learning and for educational practice will be presented.

H Inhibiting the natural number bias in rational number tasks: towards a comprehensive test instrument

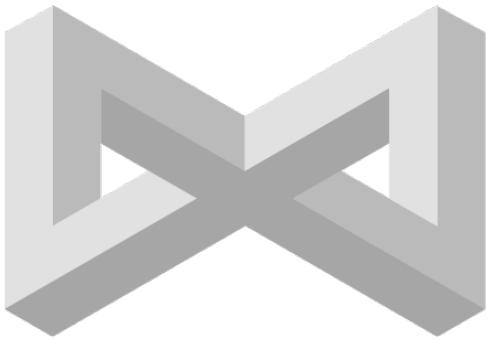
Jo Van Hoof, Lieven Verschaffel, and Wim Van Dooren
KU Leuven

While rational numbers form an essential part of mathematical literacy, research has repeatedly shown that they form a stumbling block in education. A big source of difficulty is the inappropriate application of natural number knowledge. Problems and misconceptions occur when the rules counting for natural numbers are no longer applicable for rational numbers. The research literature points out different aspects on which natural numbers differ from rational numbers: density, operations, and size. While there has been a large number of studies about each of the aspects, there is, to our knowledge, no test instrument that combines all of them. Based on an extensive literature review and an analysis of the school curriculum of Flanders, a comprehensive paper-and-pencil test was created that includes the three aspects. By conducting an IRT-analysis, we aimed at creating a valid instrument that measures the capacity of persons of different age levels to inhibit their natural number knowledge in tasks with rational numbers. Students from the fourth, sixth, eighth, tenth and twelfth grade were tested (200-300 for each age group). A fitting scale was found for the sixth graders which leads to the conclusion that 'natural number inhibition' can be considered a one-dimensional construct in 6th graders. The analysis further showed that several items behaved differently according to age, which makes it necessary to use Differential Item Functioning in the construction of the IRT scales in the other grades.

Do students choose adaptively between mental and written division strategies? A choice/no-choice experiment

Marije Fagginger Auer, Kees van Putten,
& Marian Hickendorff
Leiden University

Previous correlational research indicated that Dutch sixth graders' declined performance on multidigit division might be related to an increase in their choices for relatively inaccurate mental strategies, at the cost of more accurate written strategies for which calculations are written down. The present study investigates the adaptivity of these strategy choices experimentally with a choice/no-choice design. A total of 162 sixth graders participated in the experiment and solved three sets of eight division problems: one set with free choice between mental and written calculation strategies, one with required mental calculation, and one with required written calculation. Students freely chose mental calculation on 29 percent of the problems, and when comparing required mental to required written calculation, mental calculation was found to be less accurate than written calculation (especially for below average ability students), but also faster (especially for boys). Students were found to adaptively choose mental calculation more frequently in the choice condition when it was relatively more accurate for them than written calculation in the no-choice conditions, but no consistent effects of relative speed were found. Requiring students who chose mental calculation to use written calculation slowed them down, but did appear to improve accuracy when mathematical ability was below average. So, the explanation of students' declined division performance in terms of non-adaptive choices for mental calculation does not appear to apply to all students, but may do so for the weaker students.



4.4.14
EXPERT MEETING BENELUX
Mathematical Research

Poster abstracts

1 Counting direction in Dutch preschool children is not congruent with left-to-right number-space mapping

Jaccoline van 't Noordende, Chiel Volman,
Evelyn Kroesbergen, & Paul Leseman
Utrecht University

A large amount of studies has shown that numbers are mapped onto space. A common assumption based on this research is that numbers are mapped from low to high on a horizontal axis. The mapping direction – left to right or right to left – depends on cultural practices like reading and counting direction. Several studies have shown that even counting direction of most preschool children is congruent with left-to-right number-space mapping (e.g. Opfer & Furlong, 2011; Shaki, Fisher, & Goebel, 2012). The aim of the current study was to replicate these findings with preschool children in the Netherlands.

Fifty 3.5-year-old Dutch preschool children completed a counting task in which they counted a horizontal array of five blocks. Furthermore, they had to add a block to an array of three blocks and remove a block from an array of three blocks. It was ensured that the placement of the blocks did not give indications of counting or ordering direction.

Results showed that most children added and removed an object from a horizontal array consistent with left-to-right ordering. However, most children counted in the opposite direction, namely from right to left. Counting and ordering direction were related to the hand the children used for task performance. These results are not in agreement with findings from other studies, that found most preschool children count from left to right. The current study suggests that counting and ordering direction in young children is task-dependent; children grasp and transfer the blocks predominantly with the ipsilateral hand.

2 Canonical finger numeral configurations are perceived holistically

Samuel Di Luca, Mauro Pesenti, Christine Schiltz,
& Goedele Van Belle
University of Luxembourg
Université Catholique de Louvain

Sooner or later human beings represent or see numerosities represented by hands. This handling of small numerosities by prototypical finger configurations has been the focus of many experiments investigating the possibility that semantic representations of numbers are motor-rooted. Canonical finger configurations (i.e. the culturally determined way to express numerosity with fingers) are for instance recognized faster (Di Luca et al., 2006), and give direct access to number semantics (Di Luca et Pesenti, 2008). It is also known that these effects are not due to a visual facilitation of canonical configurations (Di Luca et Pesenti, 2010), but to a different inner representation (Di Luca, Lefèvre and Pesenti, 2010). However, a precise characterization of their visual processing is currently lacking. We addressed this shortcoming by using an eye-tracking method based on gaze-contingent stimulus presentation (Van Belle et al., 2010). While participants named numerosities expressed by canonical and non-canonical finger numeral configurations presented in upright or inverted orientations, we selectively impaired analytical or holistic visual perception by respectively masking (in real time) peripheral or focal vision. Our data confirm the results found in literature: canonical configurations are processed faster than non-canonical ones, upright configurations are processed faster than inverted ones and holistic perception is faster than analytical one. Most importantly, we also demonstrate that canonical configurations are impaired by the peripheral mask (i.e. holistic vision hindered) whereas non-canonical ones are impaired by the foveal mask (i.e. analytical vision hindered). These results confirm that the practice of finger numeral configurations modifies not only the way human beings process and represent numerosities but especially the way to visually perceive them.

3 Task-irrelevant numbers influence conscious perception during binocular rivalry

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Prior research has shown that centrally presented Arabic digits can direct spatial attention to the left or right depending on their numerical magnitude. The current study combines this attentional modulation with a novel method to suppress stimuli from conscious visual perception during binocular rivalry. By physically removing a rivaling stimulus from a single eye a stimulus on the other eye can be suppressed for up to several seconds (De Graaf, Van Ee, Croonenberg, Klink & Sack, in review) Participants were asked to report on their conscious percept via button-press, indicating whether a stimulus to the left or right of fixation had returned first after both were suppressed. We found that a task-irrelevant number that is maintained in working memory affects the duration during which a stimulus is suppressed from consciousness. More specifically, the suppression gets significantly shorter on the left side for low numbers (1,2) and on the right for high numbers (8, 9). Similarly, the first side on which one of the two suppressed stimuli reappears (i.e. left or right) is also affected by the magnitude of the presented number. The current results reaffirm the modulation of visuo-spatial attention that accompanies the processing of numerical magnitude and show the effect it can have on early visual processes such as binocular rivalry. We further propose that the Disrupted Rivalry Effect as used in the current study offers an interesting tool for measuring attentional modulation due to numerical information and could be applied to a multitude of research questions.

4 The influence of body motion on random number generation

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Knowledge and thinking are constrained by sensory-motor processes. This increasingly influential view has been termed the "embodiment theory" and proposes that bodily actions directly impact the quality of mental representations. The present study specifically aimed to investigate the influence of passive whole-body movement on numerical cognition. Two recent studies (Loetscher, et al., 2008; Hartmann, et al., 2011) indeed indicate that head or body movements can induce a shift of the attention on the mental number line. More precisely, leftward movements seemed to enhance small number generation while rightward movements led to larger number generation. The current study investigated this effect by using a non-motorized rotating chair. Concretely, while seated, participants were cyclically rotated 40 times for a movement amplitude of 90° from left to right and vice versa at an average frequency of 0.3 Hz. During each 90° movement segment they had to randomly produce numbers ranging between 1 and 30, but for methodological reasons the six extreme numbers were excluded from the analysis. The results indicate that the average number produced during leftward movement was smaller than the average number produced during rightward movement. These findings confirm the impact of passive whole-body movement on the production of numerical stimuli, indicating that rotation-movements of the body can displace attention on the mental number line.

5 Spatial coding of a number is determined by its immediate context

Bart Anseeuw, Jean-Philippe Van Dijck, & Wim Fias
Ghent University

Number-space associations are typically attributed to long-term representations like a mental number line. Recent evidence, however, suggests that the associations may be of a more temporary nature in which the spatial code associated with a number depends on the context in which a number appears, like the range of numbers in the experiment (Dehaene et al., 2003). Our study takes this idea to the limit and investigates the possibility that spatial coding of a number, as established in the SNARC effect, is determined by the number immediately preceding it on the previous trial. Our initial analysis of RTs in a typical parity judgement task, in which numbers are serially presented and responded to, found faster left- than right-hand responses when the target was preceded by a larger number and faster right- than left-hand responses when the target was preceded by a smaller number, irrespective of the target's magnitude. No effects of numerical value proper on response preference was observed. A series of dedicated experiments further investigate the underlying mechanisms of this phenomenon give a more nuanced view with evidence for both number proper and the preceding target influencing the lateralization of responses. These results reinforce the idea that spatial coding of number is at least partly determined by short term memory traces. Implications for current theories of number-space associations are discussed.

6 Testing the bi-directionality in the link between numbers, working memory and space

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Ghent University

It is generally accepted that the processing of numbers and space closely interact. Rather than reflecting a long-term memory construct of a mental number line, it has been proposed these interactions are constructed in working memory (WM) during the course of the task execution. Supporting evidence comes from studies showing that retrieval from serial order WM elicit shifts of spatial attention: the retrieval of later items of a sequence stored in WM produces covert attentional shifts towards the right (van Dijck et al., 2013; submitted). In a series of experiments, we provide further evidence for the intrinsic link between numbers, WM and space by demonstrating bi-directional links between the three domains. Implications for current theories on number processing and WM are discussed.

7 How is numerical magnitude processing related to multi-digit subtraction strategies in children? A study on mental calculation and the application of the written algorithm.

Sarah Linsen, Lieven Verschaffel, Bert Reynvoet,
& Bert De Smedt
KU Leuven

When solving multi-digit subtraction problems, children are instructed to use different types of strategies, including mental calculation and the application of the written algorithm. It has been contended that these subtraction strategies differentially rely on numerical magnitude processing, an assumption that has not been tested empirically. Therefore, in the present study, we aimed to examine the relationship between the ability to represent numerical magnitudes, and, on the other hand, mental calculation and the use of the written algorithm. This was investigated in fourth grade children by using numerical magnitude processing tasks and an arithmetic task with items that elicit either mental calculation strategies or the application of the written algorithm. Results showed that both types of strategies were associated with symbolic numerical magnitude comparison, indicating that children who were faster in comparing digits, where also faster in solving multi-digit subtraction items. On the other hand, only mental calculation, and not the application of the written algorithm, was associated with nonsymbolic numerical magnitude comparison, showing that children who were more accurate in comparing dots, were more accurate in solving mental multi-digit subtraction items. All associations remained when intellectual ability and motor speed were controlled for. Furthermore, we investigated whether associations between numerical magnitude processing and multi-digit subtraction could be explained by children's elementary arithmetic fact knowledge. Results showed that both numerical magnitude processing and elementary arithmetic fact knowledge have a unique role in the development of mental calculation and the written algorithm.

8 Adults' arithmetic builds on fast and automatic processing of Arabic digits

Delphine Sasanguie, Bert De Smedt, & Bert Reynvoet
KU Leuven

Several studies have shown that performance on symbolic number tasks is related to individual differences in arithmetic. However, it is not clear which specific (early or late) process in the 'symbol processing chain' is responsible for this association (e.g., fast, automatic processing of symbols per se or access to the underlying non-symbolic representation of the symbols?). To shed light on this black box, we let participants perform several symbolic and non-symbolic numerical as well as non-numerical tasks. Results indicated that tasks in which numerical (but not other) symbols are processed per se – which means that the underlying magnitude is not being activated - contribute most to the variance in arithmetical abilities.

9 Neural representations of numbers in the human cortex

Jessica Bulthé, Hans Op de Beeck, & Bert De Smedt
KU Leuven

Introduction: During the last couple of years there has been a boost of neuroimaging research about numerical cognition in order to reveal the underlying neural mechanisms of number processing. However, most research has mainly focused on the activation of the parietal lobe. To increase knowledge about number processing, there is a need for understanding the qualitatively divergence of the neural representations between symbolic and non-symbolic numbers not only in the parietal lobe, but also in other brain regions.

Methods: We did two fMRI studies (study 1: n = 16 & study 2: n = 12). The participants were given a number comparison task in the scanner. We analyzed the data by applying multi-voxel pattern analysis, which allowed us to focus on the neural representations of the different symbolic and non-symbolic numbers we presented to the participants. We looked into different regions of interest in the occipital lobe, frontal lobe, temporal lobe and parietal lobe.

Results: In the study 1 we found different neural representations for symbols and dots in all the ROIs. There was no evidence for overlapping neural representations, suggesting a format-dependent representation of numbers. In the study 2, we showed that the link between symbols and dots was the number of visual elements on the screen and not the numerical magnitude underlying both formats. These results were observed in several ROIs in the human cortex, including the IPS.

Conclusion: In these two studies we present strong evidence against a format-independent processing of numbers in the human cortex.

10 Bringing number sense to the supermarket: The relationship between number line estimation performance and the accuracy of price estimates

Koen Luwel & Annelies De Pauw
KU Leuven & HU Brussel

Previous research has demonstrated that the linearity of children's number line estimation patterns (R^2Lin) is positively related to their math achievement (Booth & Siegler, 2006), suggesting that an individual's underlying mental number representation might be a key factor in his/her mathematical performance. The present study tested whether our mental representation of numbers would also be related to our knowledge of product prices, another domain which require a good sense of the magnitude of numbers. We asked 50 students to estimate the price of 40 supermarket products, the price of which ranged between 0 and 10 euros. In addition, they had to position several numbers on 0-1000 number line. Finally, they rated the frequency and recency with which they bought each of the 40 products. Results showed a significant correlation (.r = .34, p = .02) between number line estimation accuracy of and price estimation accuracy. The correlation between R^2Lin and number line estimation accuracy was in the expected direction but did not reach significance (.r = -.21). A hierarchical regression analysis in which we controlled for age, gender, and buying frequency and recency indicated that the accuracy of number line estimations could explain 11% of unique variance in price estimation accuracy. The implications of these results will be discussed at the meeting.

11 Adults' use of number line estimation strategies

Dominique Peeters, Lieven Verschaffel,
& Koen Luwel
KU Leuven & HU Brussel

Subjects' estimation pattern on a number line estimation task is usually interpreted as the reflection of their underlying mental number line. However, recent findings (Barth & Paladino, 2011; Huber, Moeller, & Nuerk, 2013) challenge this widespread assumption and suggest that individuals might rely on strategies when solving this task. The present study tested this assumption by varying the number of landmarks on the number line to elicit potential landmark-based estimation strategies. Sixty-three adults were asked to estimate positions on a 0 to 1000 number line, while reaction times and trial-by-trial verbal strategy reports were gathered. Participants were assigned to one of three conditions based on the number of benchmarks on the number line: a number line on which: (a) only the origin and endpoint were indicated (control condition); (b) an extra benchmark at the midpoint (500) was presented (midpoint condition); (c) three additional benchmarks (250, 500, and 750) were specified (quartile condition). Preliminary results showed that participants in both midpoint and quartile condition estimated more accurately than in the control condition. Moreover, a marginally significant difference was found between the midpoint and quartile condition. Contour analyses (Ashcraft & Moore, 2012) revealed that subjects estimated more accurately around the midpoint in the midpoint and quartile condition compared to the control condition. Also, absolute estimation error at the third quartile was smaller in the quartile condition compared to both control and midpoint condition. The reaction time data showed a similar pattern. The implications of these results will be discussed at the meeting.

12 Longitudinal development of number line estimation in primary school children

Ilona Friso-van den Bos, Evelyn Kroesbergen,
& Hans van Luit
Utrecht University

Recent accounts of number sense as a predictor of later mathematics achievement have designated number line placements as an important indicator of number processing skills and are thought to be indicative of skills such as number estimation and comparison. A fierce debate has emerged concerning the shape of number line placements in young school-aged children: whereas some researchers have argued that young children's placements take a logarithmic shape, others have argued that they can better be modeled using a power function. In the current study, the shape of children's number line placements was investigated longitudinally in Dutch children from kindergarten (N = 442) until second grade of primary school (N = 354), and the longitudinal contribution of number line shape to development of mathematical skills was modelled. The logarithmic model was compared to a simple power model, a one-cycle power model, and a two-cycle power model. Analyses indicated that the number of children better fitting a power model was at least five times higher than the number of children better fitting a logarithmic model. Shifts from simple power models to one-cycle power models and linear models were made across timepoints. The use of reference points as a determinant of the shape the number line placements is highlighted in the discussion.

13

Four-and-twenty blackbirds: The effect of number word structure at different ages

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University of Amsterdam

Decade-unit inversion of number words, or pronouncing 24 as 'four-and-twenty', is a characteristic of many languages. In the present study the effects of this characteristic on number transcription are investigated in Dutch. Analyses were performed both on the problem level and on the child level, in a large sample ranging in age from kindergarten to the end of primary school.
On the item level it was found that the presence of an inversion made numbers more difficult, although this effect was weaker in numbers with irregular unit pronunciation. On the child level, it was found that the degree of inversion error making decreased with age, but despite earlier claims, inversion errors were made in all years: even at the end of primary school we found an inversion error rate around 10%. The degree of inversion error making served as a partial mediator explaining the relationship between visuospatial working memory and mathematics. This effect was most pronounced around grade 2.

14 Observation list for levels of mathematical acting in the lower classes of the primary school in the Netherlands

Els Terlien & Marie-José Bunck
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During learning mathematics children pass through different levels of acting: doing together, informal acting (IA), using illustrations of the reality (IR), representing in models or in combining with text or numbers (RM) and at the most highest level symbolic or formal acting (FA). Besides, children need to communicate their actions to help them to a higher level of performance bij mathematics. Children go through these processes in order to develop mental (formal) acting by mathematics achievements. For helping the child by the this development it is necessary that the teacher knows on which level the child is acting. This model of levels is diverted from the theory of acting of Gal'perin.

We are developing a diagnostic instrument based on the levels of acting. This instrument is helping the teacher by using several items created per group on which the teacher can analyze the way of acting of the children during doing mathematics. There is no instrument like this in our country.

The goal of this research will be to develop an valid and reliable observation list so that teachers (particularly remedial teachers or specialized teachers) can help children to develop their mathematics.

This research will take place in the first five groups of the primary school (ages of children four to nine years old) during four years. After this research the instrument will be developed for the next four groups (aged 8-12) of the primary school.

15 Impact of dyscalculia in young adulthood: First results on the Dyscalculia Impact Scale

Ilse Smits, Sanne Vermeulen, Jolien Patteet,
& Eline Pauwels
Thomas More University College

Research shows that the impact of a learning disability on daily live activities may not be underestimated (Hellendoorn e.a., 2000). Young adults with dyscalculia or arithmetic problems suffer from a lack of automated skills, weak abstract concepts, a deficit in the short term memory and/or working memory in performing mental procedures or weak visual special skills (Desoete, 2005).

But, the impact of dyscalculia and arithmetic problems goes further than the mathematical problems that arise. On the whole there will be a negative influence on the psychosocial functioning, their emotional wellbeing and their behavior (Barton & Fuhrma, 1994). The results on the Dyscalculia Impact Scale can be useful in therapy to help young adults to understand their problem better (psycho-education) and to get a clear picture of their strengths and weaknesses.

To get this clear picture of the global impact of dyscalculia in young adults the Dyscalculia Impact Scale was developed in 4 categories. It offers a profound investigation of math specific task related characteristics, somatic characteristics, social-emotional characteristics and behavioral characteristics. With an overall score (200) and a sub score for each category the impact can be mapped.

The results of a first study in a restricted sample (n=300), showed a significant difference, both on the overall score as on the 4 sub scores of the scale, between controls and students with dyscalculia (n=35).
The Topics integrated in the scale will be showed. Findings of the results on the first studies and details on the reliability of the instrument will be presented.

16 Developing a math large-scale assessment for children at the beginning of first grade in Luxembourg

Caroline Hornung, Danielle Hoffmann,
Dalia Lorphelin, & Antoine Fischbach
University of Luxembourg

In 2009, an educational reform in Luxembourgish elementary schools aimed to improve school and teaching quality. Since, this reform has been complemented by yearly large-scale assessments in mathematics and language competencies in all 3rd and 9th grade students. The findings have repeatedly shown that large interindividual differences already exist in 3rd grade, especially when comparing different migration and socio-economic backgrounds. In 2012, this large-scale project has therefore been extended to first grade in order to study math and language competences of students when entering formal schooling. Test items for first grade have been developed in 3 different learning domains: mathematics, Luxembourgish listening comprehension and early literacy. Researchers from the University of Luxembourg developed the test framework and item formats. During 6 months, they met with teachers on a regular basis to develop test items, based on the national education standards. These initial test items have been pretested in 34 classes distributed over the country in November 2013. Focusing on basic mathematics skills at the beginning of formal schooling, we will present first results from the pretest (N=597). In November 2014, the finalized test will include every first-grade student in Luxembourg. We hope that such national assessments will give a better understanding on the basic math and language skills students rely on when they start first grade and on how schools and teacher may adapt to their educational needs.

17 CODY: A computer-based assessment and training for children with developmental dyscalculia

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University of Muenster

Developmental dyscalculia (DD) is a specific learning disability that comprises difficulties in basic mathematical skills (e.g., counting, comparing numerosities) and arithmetical skills in otherwise-normal children. Although research on DD has gained momentum in recent years, only few interventions for elementary school children with DD have hitherto been scientifically evaluated.

The main goal of the project CODY is the development of a computer-based assessment of children with DD along with a computer-based, adaptive training of basic mathematical skills that are usually impaired in children with DD. The evaluation of the training is based on both behavioral data as well as neurophysiological measures (magnetoencephalography, MEG).

Results indicate that that the CODY assessment (core markers, number processing, calculation, working memory) has satisfactory psychometric properties (N = 1,175 children). Further, we show results from a training evaluation study (N = 64 children with DD), highlighting that a daily training over six weeks (20 minutes/day) resulted in substantial training gains in children with DD compared to a control group (posttest gains of d = .57 – 1.10 in basic numerical capacities and calculation).

18 Evidence for a global access deficit to the meaning of numerical symbols in people with Williams syndrome

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Recent studies suggest that patients with Williams syndrome (WS) present specific deficit in processing numerical magnitude (Krajcsi et al., 2009; O'Hearn & Landau, 2007; Paterson et al., 2006). Contradictory evidence has nevertheless been reported about a possible impairment of their subitizing abilities (Ansari et al., 2007; O'Hearn et al., 2005, 2011). As patients with WS were always tested in the visual modality, it remains unclear whether their deficit is specific to the processing of numerical magnitude or result from their basic visuo-spatial impairment (main characteristic of the WS cognitive phenotype). Our results support the second hypothesis as people with WS were shown to have lower numerical acuity only in numerical tasks with high visuo-spatial processing requirements (i.e. comparing two lengths or two arrays of elements but not when comparing two durations or two sequences of dots flashed in a single location; Rousselle & Noël, 2013). Recently, we tested whether the same dissociation would be observed in processing the meaning of numerical symbols. Patients with WS were thus asked to compare the numerical magnitude of two Arabic numbers (visual) vs two spoken verbal numerals (non-visual). They were also asked to enumerate sets of 1 to 7 dots shown for 250 ms to explore their subitizing abilities. Participants with WS were compared to two groups of children, one matched on verbal and the other matched on nonverbal mental abilities. Our results indicate that people with WS have difficulties in accessing the meaning of numerical whatever the format and present smaller subitizing range.

19 Arithmetic strategy development and its domain-specific and domain-general cognitive correlates: A longitudinal study in children with persistent mathematical learning difficulties

Kiran Vanbinst, Pol Ghesquière, & Bert De Smedt
KU Leuven

Deficits in arithmetic fact retrieval constitute the hallmark of children with mathematical learning difficulties (MLD). It remains, however, unclear which cognitive deficits underpin difficulties in this arithmetic strategy development. Most prior studies investigated one cognitive deficit at a time rather than exploring domain-specific and domain-general cognitive deficits simultaneously. Also these studies typically defined MLD by considering low achievement criteria and not by additionally taking the persistence of the mathematical difficulties into account. Therefore, the present longitudinal study contrasted children with persistent MLD (MLD-p; mean age: 9 years 2 months) and typically developing (TD) children (mean age: 9 years 6 months) at three time points, to explore whether differences in arithmetic strategy development are associated with differences in numerical magnitude processing, working memory and phonological processing. Our longitudinal data revealed that children with MLD-p have persistent arithmetic fact retrieval deficits at each time point. Children with MLD-p showed persistent impairments in symbolic, but not in nonsymbolic, magnitude processing at each time point. The two groups differed in phonological processing, but not in working memory. Our data indicate that both domain-specific and domain-general cognitive correlates contribute to individual differences in mathematics achievement, and that the symbolic processing of numerical magnitudes might be a particular risk factor for children with MLD-p.

20 Exploring the feasibility and effectiveness of assessment techniques to improve student learning in primary mathematics education

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For teachers to teach their students mathematics in the best possible way, they need to know their students' understanding and use of mathematical strategies in order to adapt their teaching accordingly. Classroom assessment techniques provide a means to get access to students' knowledge and thinking. The improvement of teachers' use of classroom assessment techniques has been described as one of the most effective interventions in education, especially for lower achieving students. In the present study we investigated to what extent teachers' improved employment of classroom techniques in mathematics had an effect on students' achievement in mathematics. The study was carried out in the Netherlands. During two school years, ten primary school teachers of Grade 3 (with 212 students) participated in workgroups, aimed at using and improving different classroom assessment techniques in mathematics education. Qualitative and quantitative measures were used to investigate the feasibility and effectiveness of these techniques. Teachers and students reported enjoying the techniques and finding them useful. In terms of mathematics achievement, preliminary results indicate students improving considerably, with the largest effects for low-achieving students. A tentative conclusion at this moment: the use of classroom assessment techniques improves student achievement in mathematics remarkably.

21 Improving preschoolers arithmetic thanks to a number magnitude training: Impact of a non-symbolic and a symbolic training

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There is no consensus in the literature concerning the factors underlying the numerical development; some authors assume that the approximate number system (ANS) is the basis for further numerical learning while others propose that it is the ability to build an exact representation of symbolic numbers that allows the learner to enter arithmetic. In this study, we confronted these hypotheses by developing two numerical trainings, based on each of the two theories. 56 preschoolers were randomly assigned to one of three training conditions: (1) a non-symbolic training, aiming at improving the ANS, (2) a symbolic training, aiming at enhancing the exact representation of number and (3) a control auditory attention training. To examine the effects of the trainings on the numerical development, children's abilities to process non-symbolic and symbolic quantities and to perform calculations were assessed both before and after the 10-session training. Both numerical trainings were more efficient than the control training to improve magnitude processing and arithmetic. However, the symbolic training led to a significantly larger improvement in arithmetic than the non-symbolic training.

22

Enhancing young children's arithmetic skills

Magda Praet & Annemie Desoete
Ghent University

Studies have reported that long before the onset of formal education large individual variation in engagement in the value of numbers and in early numerical skills existed among children.
There is evidence that early numeracy interventions can also effectively improve the numeracy in children at risk. Therefore one hundred and thirty two children in kindergarten were randomly assigned to adaptive computerized counting or comparison interventions, or to a business-as-usual control group. A pretest, posttest and delayed posttest was used. Children in both intervention groups, including children with poor calculation skills at the start of the intervention, performed better than controls in the posttest. The effects of training on number knowledge or mental arithmetic held in grade 1. Therefore it allows to conclude that playing serious counting games improves number knowledge and mental arithmetic performances in grade 1. Playing serious comparison games, only enhanced the number knowledge proficiency in grade 1. The value of these short periods of intensive gaming in kindergarten are discussed as a look-ahead approach to enhance arithmetic proficiency.

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Role of home numeracy environment in predicting early numeracy skills

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The home numeracy environment (HNE) has been shown to be related to early numeracy in young children. Both parental activities and expectations play an important role, even after controlling for cognitive and linguistic child factors. This is in line with the relevance of the home literacy environment (HLE) for the development of emergent literacy. However, there is a verbal factor in numeracy, and HNE may not be a unique predictor of early numeracy after controlling for HLE. In the present study, we therefore examined in what way HNE uniquely predicts early numeracy; or whether it draws on the same underlying concept as the HLE. Participants were 60 kindergartners in the year prior to grade 1. We assessed their cognitive (nonverbal reasoning, working memory) and verbal abilities (phonological awareness), as well as their early numeracy. Parents received both a HLE and a HNE questionnaire. Stepwise regression analyses revealed that both parent-child numeracy activities and parents' numeracy expectations uniquely predicted early numeracy skills, even after controlling for child factors and HLE. This finding suggests that the HNE can be seen as a distinguishable factor in the home environment in predicting numeracy outcomes.

24 Quantitative analogical reasoning in mathematically neutral word problems: about Flemish children solving 'Greek' word problems

Tine Degrande, Lieven Verschaffel,
& Wim Van Dooren
KU Leuven

Different from most previous research on students' transition from additive to proportional reasoning, this study departs from the basic idea that both additive and proportional reasoning are types of quantitative analogical (QA) reasoning. We investigated the development and nature of primary school children's QA reasoning by offering two word problems containing three numbers, to 325 third, fourth, fifth and sixth graders. In one problem, ratios between given numbers were integer, in the other they were non-integer. Except for these numbers, these word problems were written in the Greek alphabet, and thus totally incomprehensible to the children. Results revealed that the percentage of QA answers considerably increased with age. Among the QA answers, it was found that younger children focused more frequently on additive relations while the focus of older children was more on proportional relations. Moreover, problems in which the numbers formed integer number ratios evoked more proportional answers, whereas problems with non-integer ratios evoked more additive answers. This effect of numbers was strongest in the fifth grade. The implications of these findings for further research and educational practice are discussed.

25 Gender differences in mathematics achievement in 3rd and 9th grade students: A large-scale study in Luxembourg

Sylvie Gamo, Philipp Sonnleitner, Ulrich Keller, Caroline Hornung, & Romain Martin
University of Luxembourg

Since 2008, the University of Luxembourg conducts a large-scale assessment project called "Épreuves Standardisées (ÉpStan)", currently implemented in 1rst, 3rd and 9th grade to evaluate Luxembourg's school system concerning students' achieved competency level in mathematics and languages (Luxembourgish, German, and French listening and reading comprehension). PISA 2012 data revealed again a large national gender gap among 15-year-olds in mathematics: boys are on average more efficient in mathematics than girls. We now make use of the rich ÉpStan 2013 data (available for 3rd and 9th grade) to further shed light on Luxembourg's gender gap in mathematics achievement. More precisely, the present study attempts to answer the following questions: Does a gender gap already exist in 3rd grade students? If it is the case, is the gender gap less or more pronounced than in 9th grade students? Furthermore is the gender gap in 9th grade students comparable with the PISA gender gap in 15-year-old students? Finally, we investigate which content domains contribute the most to the found gender differences?

26 The impact of language on mathematical problem solving in German-French bilinguals

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This study analyzes the influence of language on curricular-based mathematical problems using structural equation modeling. In Luxembourg, the teaching languages are German and French. Mathematics are taught in German at primary school and in French at secondary school. Language effects on mathematical problem solving are therefore studied with respect to the German and French reading comprehension competency as well as the linguistic background of students (Germanic vs. Romance language). Data were drawn from the national standardized tests that are yearly performed in grade 9. The tests involved German and French reading comprehension, mathematics, as well as a questionnaire. The sample included 1727 students (Germanic: 1363; Romance: 346) of the highest academic track. The statistical models were designed to examine these questions: (1) How do students with a Germanic or Romance language background differ in their German and French reading comprehension? (2) Does the linguistic background have an effect on mathematical problem solving when German and French reading comprehension is controlled for? (3) Does the language background impact on the effect of German or French reading comprehension on mathematical problem solving? Results show that (1) the mean differences between the Germanic and the Romance students are significant for reading comprehension only, but not for mathematics. Germanic students have an advantage in German and Romance students have an advantage in French. (2) The linguistic background of students however, does not have an impact on the mathematics performance over and above reading comprehension. The regression coefficient from French reading comprehension on mathematics is significantly larger for the Romance than for the Germanic students; whereas the regression coefficient from German reading comprehension on mathematics is not significantly different. (3) German reading comprehension influences mathematics competency independently of the linguistic background. However, for the Romance group, French reading comprehension has a stronger effect on mathematics than for the Germanic students.

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An investigation of the relation between self-efficacy, experience of success, and the motivation to practice math

Brenda Jansen, Alexander Savi, Nadine Bürmann, & Han van der Maas
University of Amsterdam

Practicing math is a prerequisite for developing math skills but is inevitably linked to making errors. Making errors and the associated negative feedback may lower motivation and the confidence in one's own capacities. Children may differ in their tolerance for negative feedback. Hence, allowing children to choose their own success rate may increase their motivation to practice math, and their feelings of self-efficacy. Math Garden is a web-based system for practicing math.. The system is computer-adaptive and within this adaptive environment, children can choose between an easy or a difficult level, tailored to their own level, thereby manipulating the rate of errors.

In this study, children from grades 3 to 6 (N = 198; ages: 8-12 yrs) were assigned to one of four conditions: 1) Self-selecting success rate; 2) Easy condition; 3) Medium condition; 4) Difficult condition. Children practiced math problems for a period of nine weeks. Before and after this period, self-efficacy and math skills were measured.

A low level of success rate was associated with less practice. However, level of success rate nor the possibility to self-select the difficulty level affected change of math skills, or self-efficacy. Further, children who were good at math practiced more than children who were less good at math. Moreover, children who were confident of their capacities (regardless of their actual skills) also practiced more. Future studies might focus on increasing self-efficacy of children less able at math in order to increase their level of practice and thereby indirectly improving their math skills.

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Can training on one number sense skill be generalized to overall improved number sense? Results from an intervention study with a new tablet game.

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Previous research underlined the importance of basic number processing skills (e.g. number comparison and number line estimation), its predictive value for later mathematics achievement. Therefore, a lot of intervention studies focused on improving these skills. However, as it has recently been questioned whether both skills measure the same number sense ability, we designed an intervention study with a new tablet game.

Playing with this 'Dudeman & Sidegirl! Operatie propere wereld'-game, kindergarteners practiced either their comparison skills (group 1) or their estimation skills (group 2). In the comparison condition, kindergarteners have to go through 14 different levels in which they have to solve 24 comparison trials each time. The levels vary on three aspects: (1) the use of (non-)symbolic stimuli or the combination of both, (2) the time the stimuli are visible, and (3) the numerosities used. Kindergarteners in the estimation condition have to go through 18 levels in which they have to solve 18 number line estimation trials each time. The levels also vary on three aspects: (1) the use of (non-)symbolic stimuli or the combination of both, (2) the time the stimuli are visible, and (3) the amount of benchmarks placed on the number line.

By means of a pre- and post-training testing consisting of (non-)symbolic comparison and number line estimation tasks, it was measured whether training on one of these basic number processing skills could be generalized to the other. The data collection has just been finished, but the results will be available at the conference.

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4.4.14
EXPERT MEETING BENELUX
Mathematical Research

PROGRAM IN A NUTSHELL

09:30 – 10:00	Registration and coffee
10:00 – 10:15	Opening
10:15 – 11:45	**SYMPOSIUM 1: THE MATHEMATICAL BRAIN**
11:45 – 12:45	**POSTER SESSION 1: NUMBER REPRESENTATION**
12:05	Tour 1
12:25	Tour 2
12:45 –13:30	Lunch
13:30 – 15:00	**SYMPOSIUM 2: LARGE DATA SETS & LONGITUDINAL ASSESSMENT**
15:00 –16:00	**POSTER SESSION 2: LEARNING MATHEMATICS**
15:15	Tour 3
15:35	Tour 4
16:00 – 17:30	**SYMPOSIUM 3: STRATEGY USE IN MATHEMATICS**
17:30 – 17:40	Closing and poster award
18:15	Conference dinner at Het Prentenkabinet

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