TSG21 Agenda

TSG 21: Neuroscience and mathematics education / Cognitive Science

Session [2]: 19:30-21:00 Beijing time, July 14th (Wednesday)

- 19:30-19:45

  INTRODUCTION & GENERAL DISCUSSION

  Inge Schwank[1], Marie-Line Gardes[2]
  [1]University of Cologne, Germany; [2]Lyon Neuroscience Research Center (CRNL), University of Lyon 1, France

- Time: 19:45─20:00 /// Short oral

  GENERAL SPATIAL ABILITY OTHER THAN SPECIAL MATHEMATICAL ABILITY CORRELATES WITH ILL-STRUCTURED PROBLEMS IN JUNIOR STUDENTS

  Zhou Xinlin, Qi Chunxia, Wang Li, **Cao Chen**
  Beijing Normal University, China

  Ill-structured problem solving was an important aspect in math, which depending on the comprehensive use of mathematical thinking, mathematical methods, and general cognitive ability, etc.. In the present study, we explore whether the general cognitive or special mathematical ability paly an essential role in the ill-structured problem solving. 192 junior students (mean age 14.26 years old) complete the ill-structured problem solving, standard mathematical test and four cognitive tests (i.e., nonverbal matrix reasoning, paper folding, spatial 2-back, and verbalized arithmetic principles). Results showed that paper folding and spatial 2-back played a significant role in illstructured problem solving ($\Delta R2=.109$, $p<.001$; $\Delta R2=.065$*, $p<.001$, respectively). And the verbalized arithmetic principles have a significant role in standard mathematical achievement while not in ill-structured problem solving. Moreover, as the difficulty increases, spatial ability played a more and more important role while spatial working memory has the opposite effect. Present results indicated that the ill-structured problem solving depending on general spatial ability rather than special mathematical ability. Illustrate the necessity of general cognitive ability improvement in higher education.

- Time: 20:00─20:15 /// Short oral

  BEHAVIORAL PROCESSING OF FRACTIONS IN ADULTS WITH AND WITHOUT MATHEMATICS LEARNING DIFFICULTIES

  Parnika Bhatia, Jessica Leone, Jerome Prado, **Marie-Line Gardes**
  Lyon Neuroscience Research Center (CRNL), University of Lyon 1, France

  Understanding fractions is challenging for adults in general and more so for adults with mathematic learning difficulties (MLD). We conducted two studies to understand better how fraction knowledge and competencies are processed in adults with MLD. In the first study, we examined the different fraction competencies in adults with and without MLD. In the second study, we investigated whether processing exact magnitude of symbolic fractions relies on an intuitive, perceptual pathway. In summary, we can infer that different pathways are utilized for accessing the magnitude of non - symbolic line ratios and symbolic fractions. Furthermore, adults with MLD struggle significantly with fraction skills that require calculation and estimation but do not differ from adults without MLD in representing symbolic fractions in verbal form and vice versa.

- Time: 20:15─20:30 /// Short oral

  CONSIDERATION OF CHARACTERISTICS OF EYE MOVEMENT AND BRAIN ACTIVITY DURING MENTAL ROTATION TASKS

  Tatsuki Kondo[1], Naoko Okomato[2], Yasufumi Kuroda[3]
  [1]Graduate school of Education, Kyoto University of Education, Japan; [2]Department of Social Sciences, College of Social Sciences, Ritsumeikan University, Japan; [3]Department of Mathematics, Faculty of Education, Kyoto University of Education, Japan

  Spatial Geometry is one of the most difficult aspects to understand in mathematical education. A vast volume of research conducted through paper and interview survey methods revealed difficulty factors in Spatial Geometry. However, recent expectations are to analyze the solving process using biological information. Eye movement and brain activity data are biological information. Lately, some research papers have been written on mental rotation using eye movement or brain activity data. However, there is a possibility of more precise analysis using these data. Thus, this study investigated the characteristics of eye movement and brain activity during mental rotation tasks. The

mental rotation tasks that required lesser time involved a high frequency of looking at the same parts of left and right solids and reached max activation time quickly.

- Time: 20:30─20:45 /// Short oral

  LEARNING REPRESENTATIONS OF MATHEMATICAL OBJECTS IN COMPUTATIONAL MODELS OF MATHEAMTICAL COGNITION

  Trygve Solstad, Silvester Sabathiel, Celestino Creatore
  Norwegian University of Science and Technology, Norway

  Can our mathematical abilities be explained in neuroscientific or computational terms? The distance from the electro-chemical exchanges between neurons to the socio-cultural exchanges of the classroom spans several orders of magnitude of spatial scale and their connection might seem “a bridge too far”. Starting from the view of mathematical learning as a representation learning process we investigate and describe some of the properties of representations generated by idealized neural network models for numbers and discuss how computational tools can contribute to a greater understanding of the relation between mathematics education and neuroscience.

- Time: 20:45─21:00 /// Short oral

  ELECTROPHYSIOLOGICAL CHARACTERISTICS OF FIRST-GRADE CHILDREN AT DIFFERENT LEVELS OF NUMBER SENSE

  Yuqing Zhao[1], Feidan Yu[2], Zikun Gong[1]
  [1]Hangzhou Normal University, China; [2]Yuhang Chongxian First Primary School, China

  The present study examined the electrophysiological characteristics in the first-grade children at different levels of number sense in a number comparison task. Seventy-four first-grade children were tested and divided into three levels of number sense based on the score in a number sense test. Results in the ERP experiment showed that children with high level of number sense showed a right-lateralized N170 response in the difficult number comparison task but not in the easy task. However, a right-lateralized N170 was found in children at middle or low level of number sense regardless of the task difficulty. In addition, in children with high level of number sense, a larger N170 was found in the difficult task compared with that in the easy task, and this effect was found only in the right hemisphere but not the left hemisphere. No such effect was found in children at

middle or low level of number sense. These results suggest that children with different levels of number sense show different electrophysiological characteristics during number sense processing.

Session [3]: 21:30-23:00 Beijing time, July 17th (Saturday)

- Time: 21:30─22:10 /// Long oral

  DECLARATIVE KNOWLEDGE AND PROCEDURAL KNOWLEDGE: LEARNING PROCESSES IN THE CASE OF POUND ARITHEMTIC

  Roland Grabner[1], Stefan Halverscheid[2], Jochen A. Mosbacher[1], **Kolja Pustelnik**[2]
  [1]Institute of Psychology, University of Graz, Austria; [2]Mathematics Institute, University of Göttingen, Germany

  Declarative and procedural knowledge are compared concerning pound arithmetic tasks. A series of 196 tasks comprises both a mixture of repeatedly occurring tasks and varying tasks. Both follow the same pound arithmetic procedure. A total of 140 participants worked on these tasks while they are exposed to different types of non-invasive brain stimulation. The learning processes of facts and procedures have to be characterized by quite different models. For fact learning, a power-law function is suitable but does not fit for the procedural learning processes. For that latter process, the learning development can be well described by the number of correct answers in every episode. However, the correlations between the two learning processes turn out to be weak, adding to the point of view that both types of knowledge and their interaction deserve further research interest.

- Time: 22:10─22:50 /// Long oral

  EVEN YOUNG CHILDREN ARE ABLE TO GRASP AND APPLY LOGICAL RULES IN MATHEMATICALLY STRUCTURED ENVIRONMENTS. THE PUZZLE OF COGNITION.

  Inge Schwank[1] & Elisabeth Schwank[2]
  [1]University of Cologne, Germany; [2]University of Münster, Germany

  This contribution provides a summarizing insight into the theoretical and empirical research resulting in participation in the project ‘Future Strategy Teacher Education – Shape Heterogeneity and Inclusion’, funded by the German Federal Ministry of

Education and Research and implemented by members of all four faculties of the University of Cologne involved in teacher training. Main foci are types of logical thinking as well as the large range from gifted children to children with special needs.

- 22:50-23:00

  GENERAL DISCUSSION & CLOSING

  Inge Schwank[1], Marie-Line Gardes[2]
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