



**THE LATIN AMERICAN SCHOOL FOR EDUCATION, COGNITIVE AND
NEURAL SCIENCES
JAMES S. MCDONNELL FOUNDATION - UNIVERSIDAD DE CHILE**

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Project abstracts

NEUROCOGNITIVE EFFECTS OF CASUAL GAME TRAINING ON EXECUTIVE FUNCTION

Pauline Baniqued

We study whether widely available web-based casual games can improve executive control (EC) and reasoning ability. In Phase I, we employ factor analytic techniques to assess the overlap in cognitive constructs between selected games and normed neuropsychological tasks. For Phase II, we use these results to design a training protocol that employs casual games with quantitatively-derived association with cognitive constructs to enhance transfer of training to EC abilities. We compare the EC-reasoning training group to control groups that only undergo working memory, attention and no training, respectively. We expect the EC-reasoning group to show the biggest behavioral and neural benefits.

BRAIN SURFACE MORPHOLOGY AND WORD READING ABILITY IN CHILDREN WITH READING DISORDER

Jesse Bledsoe

The cause of reading disorder (RD) is unknown. Neurobiological studies suggest abnormalities in brain regions and reduced functional activation of important networks for reading in those with RD. The purpose of the current study is to use a new technique, surface-based cortical mapping (FreeSurfer), to determine if children with RD's show cortical thinning and reduced surface area of cortical networks important for reading. The study will also determine the extent to which cortical thickness predicts word reading ability. Results have the potential to help explain neurobiological contributions to RD and may have implications for the development of treatment interventions.

NUMERICAL FRACTIONS: DIFFICULT ONLY FOR CHILDREN?

Mario Bonato

When mastering fractions, children show several difficulties, one of the most known being the tendency to consider the magnitude of a fraction as related to the magnitude of the components and not to their relative ratio. Adults are thought to process effectively numerical fractions but some evidence suggests that difficulties in mastering fractions extend well beyond childhood. We will study the processing of fractions and proportions in children and adults in order to achieve to opposite goals: 1. Demonstrate that children aged 4-8 can effectively compute the ratio between two non symbolic quantities and 2. Demonstrate that also adults can have severe deficits in comparing the numerical magnitude of two fractions when no componential strategies are allowed.

We aim to show that the access to the exact ratio of two arabic digits in fraction processing is all-but automatic. A better understanding of fraction processing is highly relevant for improving teaching methods of a numerical format particularly difficult to understand.



NEUROSCIENCE AND EDUCATION: THE ROLE OF EMOTIONS IN THE ACCEPTANCE OR REJECTION OF A SCIENTIFIC MODEL.

Guilherme Brockington

The different theoretical models of conceptual change ignore the influence of emotions when a student needs to decide between a scientific representation and a misconception. However, neuroscience evidence suggests that rational decision-making, in fact, depends on prior accurate emotional processing. Thus, the aim of the present study is to investigate the role of emotions in adhering to, or rejecting, a scientific representation. Precisely we will investigate how the brain areas underlying emotional process are related with decision-making about scientific representations and misconceptions of the physical world.

THE DEVELOPMENT OF CONCEPTS: BRIDGING INFORMATION TECHNOLOGY AND EDUCATION

Diego Fernandez Slezak

With the development of information technology, the contrast between traditional educational approaches and real-world challenges is becoming starker. Here we propose to help bridge this gap, capitalizing on recent initiatives delivering low-cost laptops to every primary and secondary school students. From the perspective of information technology, the challenge is how to interface with this vast corpus of cognitive development to convert conceptual questions relevant to educational practice into quantifiable, analytic queries by (1) explore the statistics of occurrence of words relevant to abstract and social thought and (2) use of Topic Models to investigate the formation of semantic clusters in texts

IN THE SEARCH OF A FUN AND EFFECTIVE CRITICAL THINKING PROMOTER

Andrea Goldin

Critical thinking is a human right that must be taught, a task that seems to be difficult to accomplish. Here I propose a rigorous yet fun way to promote it, directed mainly to adolescents in social risk, but also to their teachers. By solving an 'everyday' problem, they would use scientific reasoning tools, including finding the question, thinking and testing hypothesis, and peer discussion and review. All activities will be closely guided by tutors (mainly teachers) and supervised by actual scientists. This project could be the beginning of an effective new way of teaching something as essential as reasoning.

TRACKING WORD LEARNING IN A NEW LANGUAGE FROM LEARNING TO RETRIEVAL.

Annika Hulten

In the proposed project we seek to compare different learning strategies and track the neural correlates during three training days, subsequent retrieval and the long-term retention one-week later. The neural dynamics of these processes are obtained using Magnetoencephalography (MEG) which is accurate both in time and space. The results will help to understand neural mechanism of successful long-term language learning, which may have direct educational implications.



THE EFFECTS OF INTERSENSORY REDUNDANCY ON EARLY NUMERICAL COGNITION

Kerry Jordan

I have recently shown that preschool children perform more accurately in a numerical matching task when given multisensory rather than unisensory information about number (Jordan and Baker, 2010). Here, I address three novel aims:

- 1) What are the cognitive mechanisms underlying this increase in children's numerical matching accuracy?
- 2) Does performance of preschool children on school-relevant addition and subtraction tasks increase when provided with multisensory vs. unisensory information about number?
- 3) Does analysis of high-density EEG/ERP recordings reveal differential impacts of multisensory vs. unisensory numerical information on neural correlates of preschool children's attention and numerosity comparisons?

Cited Literature

Jordan, Kerry E., - Baker, Joseph (2010). Multisensory information boosts numerical matching abilities in young children. *Developmental Science*, 14, 1467-7687.

EARLY SPATIAL CATEGORIES: CREATING AN UNDERSTANDING THAT CAN INFORM SCIENCE EDUCATION

Audrey Kittredge

Much prior research suggests that infants process interactions between physical objects categorically. However, we still do not know how such "event categories" are initially formed. We propose to uncover the learning mechanism that gives rise to these categories by inducing infants to create a new event category (burying). This will not only advance our understanding of infant event processing, but allow an extension of the research to older children. As older children are constantly learning about new physical events, especially in science classes, this research has the potential to significantly inform educational practice.

HOW COGNITIVE CONFLICT WORKS ON DELAYING GRATIFICATION?

Myung-Jin Lee

Self-regulation is important to learning motivation. The brain activation of self-regulatory mechanism will be investigated through delaying gratification behavior using intertemporal choice task. And the individual's inhibition and working memory ability are also going to be examined whether those affect to delaying gratification behavior and neural subtraction. The result of the current study will contribute to make clear the definition and key components of self-regulation and propose an intervention practice for improving self-regulatory behavior through inhibition and working memory ability improvement.

DEVELOPMENT OF MENTAL MODELS AND CHILDREN'S UNDERSTANDING OF TECHNOLOGY

Ana Maria Marhan

Research in cognitive science, science education, and developmental psychology has long investigated how children, based on their everyday experience, construct an intuitive understanding of their social and physical world. The youth of today's generation grasps the



Internet and text messaging with little to no teaching, and use complex technology instruments even before they were taught. The project we propose intends to investigate the nature of children's understanding of their technological environment, and to explore the characteristics of the mental models they construct in order to learn and use concepts that are newly emerged and highly complex.

LANGUAGE VARIATION AND LITERACY DEVELOPMENT

Karen Muller

The goal of this research proposal is to examine the interaction between Labovian-type variation (i.e., sociolinguistic variation) and literacy development. Our goal is twofold. First, we will address the effect that variation has on children's initial orthographic representations for words. Second, we will investigate whether phonological awareness and learning to spell can alter children's underlying linguistic (i.e., phonological and grammatical) representation.

CONCEPT-VISUALIZATION FOR MULTIVARIABLE CALCULUS

Duane Nykamp

I propose to continue development of a system of teaching multivariable calculus and vector analysis that combines online interactive components with traditional lecture based instruction. The interactive components of the course are designed to help students understand

and visual the complex concepts underlying multivariable calculus and vector analysis. This proposal aims to determine how to best combine the different components of the course as well as how to evaluate its effectiveness compared to other approaches.

SHARING KNOWLEDGE FOR CREATIVE SOLUTIONS.

*Fabrcio Pamplona**

Aiming to prepare individuals to work in teams looking for co-creative solutions, this project proposes the use of complex real-life scenarios to investigate the role of socially-shared knowledge on problem solving. The board game Scotland Yard will be used to test the capacity of participants to solve a realistic crime case, individually or in groups. The performance of groups that have access to static information (individual responses) or dynamic information (collective construction) will be compared to the performance of solitary individuals. Our objective is to identify which aspects of complex problems solving benefits from the co-creation approach.

A TRAINING STUDY ON NUMERACY ACQUISITION WITH THE MUNDURUCU : TOWARDS THE DEFINITION OF A DIFFERENTIAL EDUCATION FOR INDIGENOUS POPULATIONS

Pierre Pica

Taking into consideration the fact that a large part of the mundurucu's population is now engaged in an education process through the efforts of Funai (Project Ensino Medio Integrado of Coordenacao geral da educacao, Funai), the aims are a) defining the best way the mundurucu can achieve their goal in the domain of the numeracy b) try to evaluate the impact of this education for our understanding of key notions involved in the processes of learning and education. The results



achieved should provide useful hypotheses to improve the concept of differential education for *mundurucu* and indigenous populations.

OVERCOMING INTUITIVE INTERFERENCE IN GEOMETRIC REASONING. – A PROPOSAL FOR AN FMRI STUDY WITH A PRIME-PROBE VERSION OF THE PERIMETER TASK.

Franziska Preusse

Intuition sometimes interferes with correctly applying the rules of logic in geometric reasoning. For example, many students believe that geometric shapes with a larger area must have a larger perimeter, although this area-perimeter-relation is not conditional. Previous behavioral findings showed that overcoming intuitive interference impedes reasoning in subsequent congruent trials in a prime-probe version of the perimeter task.

We seek to elucidate the cerebral correlates of overcoming intuitive interference by applying the new prime-probe version of the established perimeter task on a sample of high school students. Involvement and functional connectivity of prefrontal and parietal brain regions will be analyzed.

VERB LEARNING: THE ROLE OF VARIABILITY AND SLEEP IN GENERALIZATION

Michelle Sandoval

Previous language acquisition studies have found that high variability can lead to good or bad generalization (Gomez, 2002; Maguire, Hirsh-Pasek, Golinkoff, & Brandone, 2008). In addition, nap studies have found that sleep can lead to the formation of abstract representations that promote generalization (Gómez, Bootzin, & Nadel, 2006; Hupbach, Gómez, Bootzin, & Nadel, 2009). The proposed studies examine the respective roles of variability and naps for generalization in 3-year-old children in a verb learning paradigm.

Cited Literature

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RECONNECTING WITH GAIA: HOW LEARNING AND EDUCATION MAY BE IMPROVED BY ACTIVITIES IN NATURAL ENVIRONMENTS.

Eduardo Schenberg

Our deep, global ecological crisis affects water sources, food resources, energy supplies, causes biodiversity loss, ecosystems degradation and global warming.

This crisis is rooted in a poor understanding of how nature really operates and of what's our role in it. Modern societies live in an era of rapid industrialization and unprecedented urbanization, and thus most human beings now live far from nature. This trends tend to aggravate our culturally misunderstandings about the systemic and dynamic features of the web of life, and thus disconnect us from our life supporting systems and make it harder to revert current degradation trends. We thus have an urgent need to revert the present situation, and the



approach proposed here is to use the tools and knowledge of cognitive neuroscience to assess what people (kids and adults) really know about living systems and how increased interaction with nature can improve not only knowledge about living systems per se, but also general cognitive capacities, such as attention and memory, as already shown by previous research in the field of cognitive neuroscience. The obtained results may then be applied to educational environments to help establish a regenerative culture.

THE DEVELOPMENT OF THE APPROXIMATE NUMBER SYSTEM IN 4-YEAR AND 6-YEAR OLD CHILDREN WITH DIFFERENT SOCIAL BACKGROUNDS

Marc Schipper

The acquisition of arithmetical skills is essential in a numerate society. Low numeracy is a serious handicap for individuals.

Behavioral, neuropsychological and brain imaging research points to a dedicated system for representing numbers, the approximate number system (ANS). It has been shown that the resolution of the ANS, as specified by a Weber fraction, increases throughout childhood (Halberda & Feigenson 2008).

Subpopulations which do not frequently engage in numerical discrimination might show increasingly reduced acuity with age relative to subpopulations which do frequently engage with numerical discrimination.

Here the identification of the Weber fraction of the ANS is proposed in 4-year and 6-year old children with different social backgrounds. The assumption is made that children from a socially disadvantaged population might show increasingly reduced acuity as compared to children from a regular population. To investigate possible origins of this assumed reduced acuity the study makes use of quantitative as well as qualitative research paradigms.

The results of this investigation may force the implementation of training and intervention strategies and procedures aiming to increase the resolution of the ANS in socially disadvantaged children.

MOTION ALONG THE MENTAL NUMBER LINE

*Caspar Schwiedrzik**

It has been proposed that our ability to estimate numerosity is based on 'recycling' of parietal circuits usually coding for space. In particular motion area VIP contains neurons tuned for numbers. Here, we will explore whether and how the processing of motion direction is linked to that of numbers. We will investigate psychophysically whether the presence of visual motion leads to systematic misestimation of numerosity. Furthermore, we will test whether number and motion rely on the same receptive fields using adaptation paradigms. These paradigms can be extended to probe whether number and motion receptive fields share their frame of reference.

MANIPULATING THE INFLUENCE OF REM SLEEP ON CREATIVE PROBLEM SOLVING

Peter Simor

Various anecdotic reports suggest that dreaming can facilitate insights for different tasks requiring creative problem solving. While the dream inspirations for these famous discoveries and achievements arose from extraordinarily brilliant minds, recent research indicates that the beneficial effect of sleep and dreaming for creative problem solving is present in less exceptional minds as well. Sleep and especially REM sleep seems to foster creative problem solving in case



of previous exposure with the task during waking (Wagner, et al, 2003; Cai, et al, 2009). The beneficial influence of REM sleep on creative thought processes may derive from the altered neurochemical state - monoaminergic demodulation and cholinergic activation - characteristic of this sleep stage. Since monoaminergic deactivation reduces the signal/noise ratio and thus enhances hyperassociative processes and the formation of novel semantic associations, REM sleep and the co-occurring vivid dream experiences may foster creative thinking. Nevertheless, studies examining the relationship between sleep and creativity are based on mere correlations and can not address the question of causality. Therefore our aim is to examine the effect of REM sleep on creative problem solving by applying an experimental design that is able to control for the causal relationship between the variables of interest. The Cuing Method, based on a simple associative learning is a potential technique in order to enhance information processing during different sleep stages. With the Cuing Method we aim to extend and modify Cai and colleagues (2009) original experiment, in order to examine the causal links between REM sleep and creative thought processes. We consider that our design would shed more light on the mechanism underlying the relationship between REM sleep, dreaming and creative problem solving.

Cited Literature

Wagner U, et al. (2004). Sleep inspires insight. *Nature* 427:352–55.

Cai DJ, et al. (2009). REM, not incubation, improves creativity by priming associative networks. *PNAS*,106(25):1013-4..

DOES MUSICAL INSTRUMENT TRAINING ENHANCE LANGUAGE SYNTAX PROCESSING? AN ERP STUDY.

Angel Tabullo

Several studies have addressed the impact of early music training on cognitive domains such as mathematics or language. It has been proposed that language and music share a partially overlapping network for syntax processing which includes inferior frontal and superior temporal gyrus. A recent ERP study found larger right anterior negativities for irregular music sequences, and more developed left anterior negativities for ungrammatical sentences in musically trained children. The present project aims to compare to effects of teaching musical instruments at school over the neurocognitive development of language syntax processing.

SLEEP TO LEARN? ONLY IF YOU LEARN HOW TO SLEEP!

Paula Tiba

The literature has shown that sleep is important for cognitive processes. Some studies verified the impact of sleep disturbances on school achievements for children and adolescents, showing that poor sleep negatively affects school functioning. Nonetheless, parents, teachers and the children itself are unaware of it, or even that most of the causes can be easily reverted. Some sleep scientists have tried to spread sleep science knowledge in collaboration with The World Association of Sleep Medicine (<http://www.worldsleepday.org/>). In this project we aim to: gather information about the comprehension that this population have about this issue; diagnose and treat eventual sleep disorders; teach about circadian rhythmicity and sleep functioning; evaluate the impact of the project on school performance, measuring reading, writing, and arithmetic grades.



EMOTION IN THE MUSIC CLASSROOM: A TEACHING STRATEGY BASED ON DEVELOPMENTAL PRINCIPLES OF MUSIC PERCEPTION

Anna Tirovolas

In this study, first grade music students will be exposed to a novel teaching strategy focused on the perception and production of emotional cues in music. This project is based on a literature review of developmental studies published in a single journal, Music Perception, which presents mixed evidence regarding the proficiency of children in this age range at interpreting and producing emotional cues in music.

ENHANCEMENT OF FUTURE THINKING IN PRESCHOOLERS BY TRAINING: DEVELOPING A PROGRAM TO STIMULATE THINKING ABOUT TIME.

Alejandro Vasquez

Components of future thinking play a key role in developmental well being, as they predict future outcomes, especially in educational performance, and it is related to theory of mind development. Also, evidence-based programs to promote early psychological development were proved to be beneficial if integrated into educational and/or health systems. This project is conceived to implement and evaluate a program to address late acquisition of future thinking competencies in at-risk groups. It is posited that early training on linguistic, narrative and mathematical competencies could enhance episodic future thinking and theory of mind development in 3- and 4 years-old preschoolers. Effectiveness of the program may lead to its regular implementation and improvement of educational results in these populations.

NUMERICAL ESTIMATION: TRANSLATING MENTAL REPRESENTATIONS INTO STRATEGY BEHAVIOURS IN ORDER TO INFORM EDUCATION.

Sonia White

This project systematically investigates the processes that underpin numerical estimation and its development during the first years of primary school; with the view of determining the implicit behaviours of a skilful estimator. The research design has multiple phases, beginning with the cognitive foundations and then elaborating this understanding through the use of eye tracking technology to reveal children's implicit strategy behaviours during numerical estimation. This insight of implicit strategy use represents a meaningful contribution to educators who are creating and shaping skilful estimators in the classroom.

COLLABORATIVE PROPOSALS

BEING IN AND OUT OF SYNCH: LETTER-SPEECH SOUND INTEGRATION IN DYSLEXICS AND NORMAL READERS

Irene Altarelli & Lucia Melloni

A basis to achieve proficient reading in alphabetic languages is the acquisition/automation of letter-speech sound associations. Theories link deficits in letter-speech sound integration with reading disabilities, as in dyslexia. The superior temporal cortex and planum temporale/Heschl's sulcus are involved in letter-speech sound integration in healthy



adults, whereas reduced integration in these regions has been shown in dyslexic adults and children. However, the neuronal mechanisms underlying multisensory integration of letter-sound pairs are unknown. Neuronal synchronization in local and distant networks is believed to integrate uni/heteromodal information. Here, we test the role of neuronal synchrony for letter-sound integration, using local electrocorticographic recordings in healthy adults. Furthermore, we explore the consequences of its potential impairment in dyslexic children, using a learning paradigm in MEG.

ASSESSMENT OF THE IMPACT OF A COGNITIVE-GUIDED COMPUTER GAME IN CHILDREN WITH NUMERICAL DIFFICULTIES FROM 4 LATIN AMERICAN COUNTRIES: A COLLABORATIVE STUDY

*Joana Bisol Balardin, Nancy Estévez, Ana Karla Monzalvo López, Yamaya Sosa**

A Various forms of numerical difficulties are prevalent among Latin American (LA) adolescents (56.5% Mexicans & 72% Brazilians) (PISA, 2006). In Cuba, two large-scale studies have reported that the prevalence of arithmetic learning disabilities range from 7.19% (N= 11, 836 children) to 8.17% (N= 16, 097 children) in the school age population (Reigosa et al. 2004, 2006 respectively). Previous intervention studies demonstrated that adaptive games designed to teach number sense in children with learning difficulties have an impact on core numerical processing (Wilson et al., 2008; Räsänen et al., 2009). The effect of cognitive-based interventions in LA children of low socioeconomic status is unknown. The aim of this study is to assess the efficacy of a cognitive-guided computer game in children with numerical difficulties from Brazil, Cuba, Dominican Republic & Mexico, and to evaluate the impact of cross-cultural variables in the efficacy of the intervention. In each country, thirty six 2nd-grade children with normal IQ and performance below 2 SD of the mean in numerical skills tests will be randomly assigned to one of 3 intervention groups (experimental 1–Number Race 1st version; experimental 2–Number Race 2nd version; control–game without numerical component). Outcome measures include accuracy and reaction time in enumeration, symbolic and non symbolic comparisons, addition and subtraction and number line estimation tasks. Results from this study should draw LA's attention to the feasibility of remediation of numerical difficulties using cognitive-guided games; expand curriculum content to include free access scientific-based tools; encourage cross-country collaborations and discuss bridging the gap between educational systems of developed and developing economies.

FROM NEUROSCIENCE TO EDUCATION (AND BACK): THE TIME FOR COMMUNICATION

Silvia Benavides-Varela, Ricardo Bion, David Gómez, Jean Remy Hochmann, Liuba Papeo

Bridging the gap between scientific research and educational practices requires: (i) to increase interdisciplinary work and (ii) to communicate effectively the advances in research that can be useful to improve educational practices. However, there are few instances where the dialog between researchers and educators can be done efficiently and in a systematic way. Our project consists in setting up a website to foster communication of cognitive and neural research relevant for teachers and educators, presenting short notes available in English, French, Italian, Portuguese, and Spanish. Researchers will be encouraged to reflect about potential implications of their work for the classroom. Educators will be given access to basic research findings written in lay terms, promoting also the discussion of the merits and significance of these works in a forum. Further interaction will be stimulated by the inclusion of video interviews to relevant researchers, with questions posed by the educational community.



THE EFFECTS OF COMMUNICATION ON RULE LEARNING IN YOUNG PRESCHOOLERS: LA SCHOOL PROJECT PROPOSAL

Hanna Marno & Mikolaj Hernik

Education and teaching are inherently communicative phenomena. While the influence of communication on even very early learning has been the topic of considerable body of research, some recent results point to, what can be called, “a double blessing” of communication in early learning. On one hand communication can facilitate fast-mapping and transfer it can also induce biases in young children which can lead to underestimating of their early competencies and could temporarily hinder learning (Futo, et al, 2010; Topal, et al, 2009). This paradoxical and still understudied impact of communication on learning is accounted for by a recent theoretical proposal of Natural Pedagogy theory (Csibra & Gergely, 2009). According to this theory, communication cues children (as well as infants and adults) towards extracting and encoding generalizable semantic information (rather than merely transient episodic information). As a result, the same mechanism which makes teaching by communication (both in schooling and in parent-child interactions) an extremely efficient way of passing general semantic knowledge, may come at a cost of inducing biases which in turn need to be overcome by teaching itself.

The proposed series of 3 studies further investigates the “double-blessing” role of communication in learning. It is designed to assess how communicative context can impact early learning by inducing 3 biases stemming from rule-based, semantic encoding: (i) disregarding real statistical regularities; (ii) disregarding counterexamples; (iii) overgeneralization. All the 3 experiments with preschool-aged participants (5-7 years old) will use similar basic stimuli: children will watch animated displays involving occurrence of some simple graphic signs followed by occurrence of particular events (e.g. dog barking), or lack of thereof, either in the presence of communicative cues, or without them. Across all the three experiments the child’s task is to choose the card, which is more likely to be predictive of the target event.

By investigating the impact of communication on basic learning processes our project will hopefully shed more light on mechanisms, which are at the core of teaching and educational practices in one-on-one child-adult interactions.

APPLYING REPRESENTATIONAL MAPPING IN THE DEVELOPMENT OF A COMPUTER-BASED EDUCATIVE GAME: THE CASE OF TEACHING ECOLOGY IN ELEMENTARY SCHOOLS.

Daniel Opazo & Javier Nuñez-Huasaf

We propose to test whether the Representational Mapping Hypothesis applied to the design of a computer-based educational game (cb-EG) will increase the children’s understanding of relationships between components in a natural ecosystem.

Two different designs of cb-EG, that differ in the way of representing relationships through the gameflow will be tested: i) network-like and ii) linear. Quantitative and qualitative measures of learning will be obtained before and after the intervention.

This approach could have potential implications in education of environmental sciences and also it could be generalized to other fields of knowledge in which it is important to understand both, concepts and their relationships, fundamental in the approach to complex systems.

* Awarded projects



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