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LABORATORY NOTE

Laboratory of the Neuropsychology and Cognitive Neurosciences Research Center of Universidad Católica del Maule, Chile

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Abstract

The Laboratory of the Neuropsychology and Cognitive Neurosciences Research Center (CINPSI Neurocog), located in the "Technological Park" building of the Catholic University of Maule (Universidad Católica del Maule, UCM) campus in Talca, Chile, has been established as "Psychology Lab" recently in July, 2016. Our lines of work include basic and applied research. Among the basic research, we study executive functions, decision-making, and spatial cognition. In the applied field, we have studied neuropsychological and neurobehavioral effects of pesticides exposure, among other interests. One of our aims is to develop collaboration both national and internationally. It is important to mention that to date there are only few psychology laboratories and research centers in Chile involved with the fields of neuropsychology and neurosciences. Thus, this scientific effort could be a groundbreaking initiative to develop specific knowledge in this area locally and interculturally through its international collaborations.

Keywords Executive functions · Spatial cognition · Neuropsychology

Introduction

The Laboratory of the Neuropsychology and Cognitive Neurosciences Research Center (CINPSI Neurocog), located in the "Technological Park" building in the Catholic University of Maule (Universidad Católica del Maule, UCM) campus in Chile, has been established as "Psychology Lab" recently in July, 2016 with funding from an Academic Development Grant according to an internal institutional plan of improvement. An overview of location, facilities, and ongoing projects, as well as people collaborating in the laboratory is available on the laboratory's Web site (https://www.labpsicologiaucm.com; see Fig. 1). The Head of Laboratory is Dr. prof. Boris Lucero, who is mainly interested in the neurocognitive effects of environmental exposures and the study of executive functions and is also involved in a number of ongoing projects, which we will define better further in this note. Co-Founder of the Laboratory is Dr. Maria Teresa Muñoz-Quezada, former Director of the Department of Psychology. In December 2017, it became the facility of the Research Center in Neuropsychology and Cognitive Neurosciences (CINPSI Neurocog). Considering this fast expansion, the laboratory is open to international collaborations and is willing to host researchers from abroad to realize joint studies and projects.

The laboratory is affiliated with the Faculty of Health Sciences of UCM and is devoted to diverse main research areas. A special interest is focused on the executive functions, in particular, attentional networks, and other related topics such as decision-making related to clinical populations (i.e., patients with suicidal behavior history), impulsivity, inhibitory control, etc.; recently, research interests and topics have addressed the spatial cognition area, in particular, spatial planning and navigation, spatial memory, and processing.

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Fig. 1 Laboratory Web site at https://www.labpsicologiaucm.com

Our research center pursues to establish collaborations with centers and laboratories from abroad. Currently, there is a collaboration with the Institute of Global Health in Barcelona (IS Global), specifically with Dr. Jordi Julvez from *ISGlobal* Programme on Child Health. In addition, there is a joint effort with Dr. Philippe Courtet from University of Montpellier, France, to study event-related potentials (ERPs) associated to decision-making and suicidal attempt. Another collaboration has recently started with the cognitive psychology laboratory from the Faculty of Medicine and Psychology of Sapienza, University of Rome.

Additionally, we have been involved on applied research through a series of grants on diverse subjects within our field. For instance, one of these projects addresses the sensible topic of the neuropsychological effects associated with the environmental exposure to chemicals in the crops treatment.

Another aim of our laboratory center is to promote transdisciplinary collaborations through internal institutional agreements of academic collaboration and research. One example of this is the agreement with a program named "*Semilla-UCM*," which receives gifted students from the whole region. Data collections from attentional network test (ANT; Fan et al. 2002, 2005), intelligence battery, and neuropsychological tests (Wechsler Intelligence Scale for Children, Wisconsin Sorting Card Test, etc.) were administered to these children and more are being planned to be performed yet. Recently, we have started a collaboration with the Human Performance Lab, where studies on physical activities, sports, and movement are taking place, envisioning collaborations on the field of sports psychology. Besides the above, new promising collaborations are undergoing with the Laboratory of Technological Research in Pattern recognition (LITRP) and the Master in Computer Science program of our university. These collaborations are devoted specifically to develop a new line of applied research on biometrics and EEG, and we are planning works on BCI devices in the future.

It is important to mention that to date there are only few psychology laboratories and research centers in Chile involved with the fields of neuropsychology and neurosciences, corresponding our center to the only one existing in the Maule Region devoted to those areas. Thus, this scientific effort could be a groundbreaking initiative to develop specific knowledge in this area locally and interculturally through its international collaborations.

Lines of basic research

Executive functions

Attentional networks and intelligence in children

There is evidence that children with greater intellectual resources show performances characterized by a rapid and greater capability of information processing; moreover, they seem to require less repetition for understanding compared

to their peers of average intellectual performance (Rueda et al. 2004). If we consider some constructs of intelligence as intimately connected with executive control and flexibility, this ability may be associated with a greater cognitive executive control in its attentive focus and preconscious selective inhibition dimensions, with a consequent greater cognitive flexibility in task change demands (Diamond 2014).

We are conducting a study through electroencephalography (EEG) record of participants' brain activity during the attention network test (ANT; Fan et al. 2002, 2005), to observe whether children with intellectual performance above average show differences of amplitude in the ERP N1, N2, and P300 (P3a, P3b) when compared to children with average performance. We registered P300 (P3a, P3b), N1, and N2 components amplitude and latency as event-related potentials (ERP), and we also collected behavioral data such as reaction times (RT) and accuracy. Children's intellectual performance was assessed through the Chilean version of the Wechsler Intelligence Scale for children (Ramírez and Rosas 2007a).

Impulsiveness and attentional networks

Many studies report an inverse relationship between general intelligence and impulsivity, which in many cases bring to social failure, antisocial, and aggressive behavior. Given the social importance of this trait, more evidence is needed on the biological bases of impulsivity, in order to get a clearer picture of its interaction with other cognitive measures and predict extreme cases. It has been hypothesized that some of the key features of information processing and behavior of impulsive individuals (difficulties in sustained attention, motor disinhibition, lack of planning; Dickman 1993; Marsh et al. 2002; Russo et al. 2008) may modulate the efficacy of cognitive processing and can negatively affect cognitive performance during intelligence testing. These three dimensions (namely, attentional, motor, and no planning impulsivity) also appear in the impulsivity measure known as the Barratt Impulsivity Scale (BIS-11, Patton et al. 1995) as second-order factors, which would explain the impulsivity trait. We have directly correlated scores of the BIS-11 with performance on the ANT, to investigate the relationship between different aspects of attentional cognitive process and correlate them with impulsive people performance.

Decision-making and suicidal tendencies

Suicide is a multidimensional complex process, which can be determined by the dynamic interaction of diverse biologic, genetic, psychiatric, psychological, economical, sociodemographic, family, and cultural factors (Wasserman et al. 2012; World Health Organization (WHO) 2014). Currently suicide is a serious public health problem, with estimations that about 1,000,000 people kill themselves each year in the world, which represents one dead person each 40 s (WHO 2014). This number is expected to rise, reaching 1,500,000 deaths by the year 2020 (Bertolote and Fleischmann 2002).

One of the collaborators in our laboratory, Pablo Mendez-Bustos, has made an intense review of the topic (Mendez-Bustos et al. 2013a, b, c), to collect evidence on different manifestations of the problem and risk groups, elaborating also intervention strategies (Lopez-Castroman et al. 2015a, b). Currently Dr. Mendez is conducting a research funded by the National Fund for the Scientific Development (FONDECYT), aimed to study the risk of the emergence and attempt of suicide in adolescence and the variability in its evolution. This effort aims to developing a model to identify and predict vulnerabilities in order to suggest differentiated strategies for the prevention and intervention of suicidal attempts. One of the main objectives involves the evaluation of the decision-making process in the case of suicidal tendencies. There is scarce evidence about the relationship between executive functions deficit and the lethal decision to commit suicide, especially in the case of depressed patients, being probably difficult for them to properly evaluate the environmental stressors and find alternative adaptive situations, leading to a suicidal crisis (Bridge et al. 2012).

Spatial cognition

Dr. Chiara Saracini has worked on spatial cognition since 2006, during her doctorate and postdoctorate studies, supervised by Prof. Marta Olivetti-Belardinelli and mostly in collaboration with Dr. Demis Basso, whom has developed a test to assess visuospatial planning ("Maps"; Basso et al. 2001). The development of a tridimensional (navigable) version of the visuospatial planning "Maps" Test back in 2009, called the "3D Maps," showed different involvement of frontoparietal region in performing the same travelling salesman problem (TSP)-like task, but under very different conditions (Saracini et al. 2008a). Navigating in a 3D environment involves parietal and spatial networks activation, which are necessary to perform visuospatial tasks. Moreover, dorsoparietal areas are also involved in the planning task itself. 3D Maps test has produced results showing an even clearer gender differentiation with respect to the 2D original task, showing once again that spatial representation and knowledge are differently engaged in women and men, taking advantage of different abilities, information processing and even showing a different use of heuristics and planning strategies (Saracini et al. 2008a, 2010). Now we are planning to evaluate the same task on Chilean samples coming from different population samples.

Beside the above, Dr. Saracini is planning to work with the Corsi block-tapping task (CBTT; Corsi 1972). This is one of the most used nonverbal tasks for the assessment

of visuo-spatial working memory (VSWM), but it also involves spatial attention (Smyth and Scholey 1994). The Corsi task is a simple and relatively quick test, included usually as part of more complex neuropsychological batteries. It is utilized for the diagnostic and early detection of Alzheimer's disease (Carlesimo et al. 1994), Korsakoff's syndrome (Haxby et al. 1983), schizophrenia (Chey et al. 2002), and as a reinforcement of the hypothesized localization of focal brain lesions in clinical neuropsychology (Milner 1971; De Renzi et al. 1977). In Chile, this tool is not so popular yet, so the idea is to perform an assessment on Chilean wide population sample in order to get an insight of normative data for the assessment of spatial working memory and evaluate its future application in different contexts (education, clinical and training purposes, etc.). We plan to use a tablet version of the Corsi task, similarly as the one developed by Brunetti et al. (eCorsi: 2014), or the version included in the Psychology Experiment Building Language (PEBL) of Mueller and Piper (2014).

Error awareness EEG

This is an ongoing project aiming to observe EEG identification of error awareness in children (aged about 10–12 years) and the ANT task. The error-related negativity (ERN; Gehring et al. 2012) amplitude is considered an indirect measure of the awareness that the subject has of his/her own errors, representing a covert internal performance monitoring process. In fact, ERN is always present (whether the subject is aware or not of having committed an error), but it seemed to show different amplitudes according to the degree of consciousness of the mistake. Nevertheless, the most recent studies showed that ERN differences in amplitude are related rather to a personal motivation, i.e., the importance that a certain person gives to make or not mistakes, or the supposed ability she/he is convinced to have to perform a certain task. Therefore, ERN represents a kind of "delusion" or worrying for having committed an unexpected error. Also, students with more robust ERN achieve a higher grade point average (Hirsh and Inzlicht 2010), suggesting that individuals higher in error monitoring display better self-control. Since ERN has not been extensively studied in children, we are going to observe in a sample of gifted children the error-related waves after incorrect responses in the attentional network test (ANT). There are findings elsewhere that gifted students' superior cognitive skills have a metacognitive advantage relative to typically achieving peers (Snyder et al. 2011). We aim to test the hypothesis that this superior metacognitive abilities account for differences of ERN post-error peaks.

Cultural differences, cognition, and emotions

Human reasoning and logic

The study of human reasoning is a major field in cognitive psychology. One of its central paradigms is deductive reasoning, which describes the derivation of a logically valid conclusion from a given set of premises. In recent years, however, a paradigm shift within the psychology of reasoning took place (over 2009). People do not always stick to the formal rules of classical logic but sometimes reject a conclusion if the validity of their initial conclusion appears to be questionable. This is called "defeasible reasoning" (Pollock 1987) and can be influenced by different factors.

Among the international collaborations, our laboratory is a part of an ongoing project called "The Negativity Bias: Evolutionary Basis or Cultural Specificity?" using the negativity bias task (NBT) developed by Gazzo Castañeda et al. (2016), taking inspiration from a previous work of Hilton et al. (1990). This project's aim is to perform an intercultural evaluation of the evolutionary hypothesis of the tendency to amplify negative happenings with respect to positive ones in the decisional process and emotional evaluation of the situations. In a first place, we are going to reproduce the same NBT on a Chilean sample, in order to get a comparable view of negativity bias in both "Occidentalized" American culture and European ones. Later, we will test the negativity bias also in aboriginal cultures (i.e., Collas, in the North of Chile).

Emotions, cognition, and individualism/collectivism

The "Reading the Mind in the Eyes" test (Eyes test, or RMET; Baron-Cohen et al. 1997) has been developed as a performance-based measure. It is an advanced Theory of Mind (ToM or "cognitive empathy": Baron-Cohen 1995) task involving mental state attribution and complex facial emotion recognition from photographs where only the eye region of the face is available. The RMET test has been evaluated in more than 250 studies since its development, showing a good reliability as a measure. Currently, we are involved in an international collaboration with Dr. Thomas Hünefeldt (Sapienza University, Rome) aimed to investigate the in-group advantages and differences for advanced emotion recognition in youngsters(14–19 years old), which plays an important role in the development of the personality of adolescents. The idea is to administer the RMET and the Auckland Individualism and Collectivism Scale to investigate possible cultural differences in the development of these traits, according to the collective/individualistic orientation of the culture.

Global/local influence on visual processing of emotion-based stimuli

In our laboratory, we replicated an experiment conducted by a PhD student of La Sapienza, University of Rome, Skaisté Gabriele Kerusauskaite ("Emotion recognition after global/local processing in a psychological refractory period paradigm"), who kindly shared it with our laboratory for this purpose. We developed it as a part of the "Basic Investigation Course" for undergraduate students, letting them get into how to develop and design an experimental paradigm and at the same time use this instance to collect data for the experiment. This study aimed to investigate how the "psychological refractory period" (Pashler 1994) in the presentation of global/local stimuli influences the recognition of emotion in human faces (sad or happy).

There is evidence that emotions play an important role in perception (Srinivasan and Hanif 2010), and it has been shown that are related to attention and affective-based visual perception (Srinivasan and Gupta 2010). Also, Srivastava and Srinivasan (2008b) found better identification of happy faces rather than sad faces following a neutral first target identification using an attentional dwell-time paradigm. The study of the PhD student Kerusauskaite has been developed based on the paradigm and evidence obtained by Srinivasan and Hanif (2010), who show that global processing facilitates identification of happy faces and local processing facilitates identification of sad faces. Our intention is to evaluate whether there may be cultural differences in this regard.

Applied research

Neuropsychological effects of exposure to organophosphate pesticides

This is one of the main current lines of research, with around 8 years of development, and have emerged fundamentally based on the necessity of study the health effects of direct and indirect exposure to pesticides of the regional population, considering that Maule region have a 33% of rural population with many farms and agriculture as the most important regional economic activity. Our specific interest has been about the neurotoxic effects of organophosphate (OP) pesticides, which are the most sold in the country. OP pesticides are a group of chemical compounds used for the control and elimination of insects in agriculture, but also for residential and industrial applications (Muñoz-Quezada et al. 2013). OP pesticides act as acetylcholinesterase (AChE) inhibitors, preventing the breakdown of the neurotransmitter acetylcholine, increasing both its concentration and duration of action in the body. The neurologic effects of OP exposure, even at low levels, may be detrimental during development because neurotransmitters, including acetylcholine, are essential in the cellular and architectural development of the brain (Barr et al. 2006). Excessive exposure in humans results in over excitation of muscarinic and nicotinic receptors of the nervous system, inducing an over-accumulation of this neurotransmitter in the cholinergic synapses due to phosphorylation of the active cholinesterase molecule site. In one of the studies made by our laboratory members (Muñoz et al. 2011) involving a sample of school children, an inverse association was found between exposure above the limit of detection for the dimethyltiophosphate (DMTP) urine metabolites, which are biomarkers of OP pesticides residues, and the performance on Processing speed factor of intelligence. Also we made an analytic cross-sectional study involving a sample of agricultural workers exposed and non-exposed to pesticides. We applied a battery of four neuropsychological tests and a measure for detection of peripheral polyneuropathy through pallesthetic threshold assessment by on–off method. The results showed that on the Wechsler adult intelligence scale (WAIS-IV), exposed agricultural workers exhibited poorer performance than non-agricultural workers in verbal comprehension, processing speed, in the full-scale IQ, and in measures of discrimination sensitivity, adjusted by years of schooling and/or age (Muñoz-Quezada et al. 2016a, b, 2017). Also we found a positive association between the presence of peripheral polyneuropathy and chronic occupational exposure to OP, adjusting for age and sex (Grillo et al. 2018).

Currently, we have two ongoing research projects in this field. One of them is a research grant of Dr. Muñoz-Quezada which received funds from the National Fund for the Scientific Development (FONDECYT) to study the effects of an educational intervention in rural school communities on their risk perception and exposure to pesticides. The second study corresponds to a research grant of Dr. Lucero with funds of the superintendency of social security (SUSESO) of the Chilean Government to validate a test battery for the monitoring of cognitive effects on occupational exposure to AChE inhibitors pesticides in agricultural workers.

Biometrics for identity recognition

This collaborative project aims to use EEG data for personal identification (biometrics for identity recognition). Identity recognition can be performed considering different biometrics approaches, some more conventional (physical characteristics of a person such as fingerprints: Rathod et al. 2015; iris: Wildes 1997; writing: Aubin and Mora 2017; face recognition: Kong et al. 2005) and others that have been recently explored as a "new" approach to biometrics, the cognitive ones. The cognitive approach intends to identify biometric features in the cerebral activity (Campisi and La Rocca 2014). In cognitive psychology, EEG signal has been

recently proposed as a new approach to biometric recognition by using different sources: baseline EEG registration with closed eyes (Campisi et al. 2011), visual perceptual potential (Palaniappan and Mandic 2007), and even asking subjects to imagine to read (Marcel and Millán 2007) or talk (Brigham and Kumar 2010). Our laboratory, together with the Technological Research on Pattern Recognition Lab (www.litrp.cl) headed by Dr. Marco Mora, is exploring tactile stimuli potential as a way to recognize identity patterns in sensorial ERP amplitude and timing, because of its simplicity to evoke and automaticity of reaction potential. The outcomes of this collaboration will also reflect a deeper study for the improvement of classical biometrical methodology for the pattern recognition (i.e., introducing new approaches such as deep learning, extreme learning machines, new features). The research team of Dr. Mora recently received a grant from the fund for the promotion and scientific technological development of Chile to elaborate a mobile device for person recognition through fingerprints. Based on this effort, they have planned to expand this first effort to explore in the next future the use of brain waves for biometrics.

Adaptation and standardization of the Chilean version of the Wechsler Intelligence Scale for children—5th edition

In collaboration with the Center of Inclusive Technologies (Centro de Tecnología de la Inclusión [CEDETI]) of the Pontifical Catholic University of Chile, we have contributed with data collection of a sample of children from Talca, Maule region. This effort is part of the work for the Chilean adaptation of the fifth edition of the Wechsler Scale of Intelligence for children. The last and only version of this scale that has been adapted to Chilean population corresponds to the third edition (WISC-III), which was published more than 10 years ago (Ramírez and Rosas 2007a, b). The publishing final version of the Chilean WISC-V is expected by the ending months of 2018.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Human and animal rights The manuscript has not been published previously (partly or in full). All procedures performed in studies involving human participants mentioned here were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the studies mentioned in this paper.

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