NEURONUP´S NEXT STEP: STRUCTURED AND CLINICALLY VALIDATED PROGRAMS

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Abstract. *NeuronUP is a web platform (SAS) designed to be a fundamental support for professionals involved in the processes of rehabilitation and cognitive stimulation. It consists of infinite customizable materials and resources to design sessions and an User Manager Tool (being the user the patient) to save the results of each session and individual in an organized way. It´s hosted in a cloud computing system, ie a web page that professionals can access anytime, from anywhere to review the results of their patients, planning sessions, consult exercises, etc. Thanks to this, the constant generation of new material and updates of the platform are available in real time.*

Having proven the positive results of Cognitive Stimulation in the profiles NeuronUP works with, we are developing specific programs within our platform, focused on specific rehabilitation and cognitive stimulation processes. Designing and clinically validating specific programs, of which we already have the first results.

Keywords: Rehabilitation, Stimulation, Validation, Customization, Escalation, Serious Games.

1. INTRODUCTION

The goal of neuropsychological rehabilitation is to improve an individual's performance and to compensate for the impairments resulting from brain injury in order to reduce functional limitations and increase the ability of the person to perform activities of daily living (Bernabéu & Roig, 1999) with the purpose of improving quality of life (Christensen, 1988; Prigatano, 1984; Sohlberg, & Mateer, 1989).

Cognitive functions are interrelated, and interdependent on a functional and anatomical level. Functional activities involve multiple types and levels of processing. When an activity of daily living is carried out, neural combinations that recruit specific neuropsychological processes to perform it are put into play. From those motivations that initiate behavior, all the way through to visual recognition, impulse control or the development of cognitive strategies to resolve these impulses, to plan behavior or to learn. Therefore, from a professional approach, it is logical to formulate rehabilitation activities from an ecological perspective.

The goal of NeuronUP is to identify those processes in order to calibrate and design useful activities for neuropsychological rehabilitation and occupational therapy, as well

as providing a platform and flexible materials for neuropsychology professionals. NeuronUP was founded in response to several urgent questions in the field of neuropsychological rehabilitation in general, and clinical and experimental practice in particular. In line with the urgent need to carry out a more ecological neuropsychological assessment (Tirapu, 2007) that allows clinicians to assess the accurate functional condition of individuals who come for a consultation, there has emerged a school of thought that seeks to use more ecological, motivational and personalized contents in the process of cognitive stimulation and rehabilitation. Therefore, in addition to the assessed functions, an ecological approach can be applied to neuropsychological rehabilitation (Wilson; 1987, 1989).

Ecological validity refers to—Kvavilashvili & Ellis (2004)—both the representativeness of a task (the degree of correspondence in form and context in regards to a real life situation), and the generalizability of the results produced by that task. There are three different levels of generalizability:

- Level 1. Keeping the outcomes from session to session, using the same situations and materials.
- Level 2. The achieved progress has to reflect in similar tasks.
- Level 3. Transferring the skills acquired during training sessions to activities of daily living.

In NeuronUP we design materials involving activities and situations of daily living that are related not only to basic neuropsychological functions— since they are multifaceted activities—but also to variables of daily functioning (Yantz, Johnson-Greene, Higginson, & Emmerson, 2010).

2. COMPUTER-ASSISTED REHABILITATION BENEFITS

Why use a web platform of computer-assisted rehabilitation? Although it would be incorrect to conceptualize NeuronUP as solely computer-based (since many materials can be printed out), below we propose some advantages in the use of computer format (Ginarte-Arias, 2002; Lynch, 2002; Roig & Sánchez Carrión, 2005)

How have we corrected problems associated with computer-assisted neuropsychological rehabilitation?
1. We have developed a flexible system so that it is not applied in a rigid and inappropriate manner (Ginarte Arias, 2002).
2. We adapt the contents to the evolutionary moment of the persons undergoing rehabilitation (Tam & Man, 2004). Additionally, this expert system can adapt to language, educational level, or the type of brain injury of patients.

We believe that the use of cognitive rehabilitation platforms and programs cannot replace the contact, support, effort and supervision of the therapists. The programs must be continually revised and updated based on patient evolution and performance (Sánchez Carrión, Gómez Pulido, García Molina, Rodríguez Rajo, & Roig Rovira, 2011). To consider an intervention that only takes into consideration the cognitive sphere without acknowledging psychosocial, emotional and behavioral disorders is an

insufficient approach (Salas, Báez, Garreaud, & Daccarett, 2007).

Computer-Based Cognitive Rehabilitation Technologies may be used in a wide range of populations. Cole (1999) has already shown that cognitive orthoses should be highly customizable to the needs of the person. Moreover, the use of "therapist-friendly" and "user-friendly" interfaces (Cole, Ziegmann, Wu, Yonker, Gustafson & Cirwithen, 2000) should be used. These interfaces should provide a simplified file access, save and print commands for word processing to increase the ability to access, modify, and print longer, detailed amounts of information. According to Lynch (2002), these types of activities should be used to train tasks related to Activities of Daily Living, including work.

Due to heterogeneity in cognitive profiles (strengths and weaknesses), materials and guides used in computer-based technologies must be adapted in terms of complexity–number and difficulty of decision-making points-presentation of information sequentially, and others (LoPresti, Mihailidis & Kirsch, 2004). For that purpose, users must be included in the design process, according to the concept of "user sensitive inclusive design" proposed by Newell & Gregor (2000). These recommendations point to the need for a computer-based personalized cognitive training in neuropsychological rehabilitation. Peretz, Korczyn, Shatil, Aharonson, Birnboim & Giladi (2011) compared a computer-based personalized cognitive training group with a group that received a classical computer games training. Improvements in the personalized condition were significant in all the cognitive domains trained (focused attention, sustained attention, recognition, recall, visuospatial learning, visuospatial working memory, executive functions, and mental flexibility), while classical computer games group improved significantly only in four domains (focused attention, sustained attention, memory recognition and mental flexibility).

For a more extensive review, the reader can consult the following: Gillespie et al. (2012); Kueider, Parisi, Gross & Rebok (2012); Cicerone et al. (2011); Stahmer, Schreibman & Cunningham (2010); Faucounau, Wu, Boulay, De Rotrou, Rigaud (2009); Lange, Flynn & Rizzo (2009); Tang & Posner (2009); LoPresti et al. (2004), Kapur, Glisky & Wilson (2004), Bergman (2002) and Lynch (2002).

In relation to specific neuropsychological functions, a broad amount of research has been done to date. Computer-based interventions have proved effective in the rehabilitation of different domains such as attention (Borghese, Bottini & Sedda, 2013; Jiang et al., 2011; Flavia, Stampatori, Zanotti, Parrinello & Capra, 2010; Barker-Collo et al., 2009; Dye, Green & Bavelier, 2009; Green & Bavelier, 2003; Cho et al., 2002; Grealy, Johnson & Rushton, 1999; Gray, Robertson, Pentland, Anderson, 1992; Sturm & Wilkes, 1991; Niemann, Ruff & Baser, 1990; Sohlberg & Mateer, 1987), memory (Caglio et al., 2012, 2009; das Nair & Lincoln, 2012; McDonald, Haslam, Yates, Gurr, Leeder & Sayers, 2011; Bergquist et al., 2009; Gillette & DePompei, 2008; Wilson, Emslie, Quirk, Evans & Watson, 2005; Ehlhardt, Sohlberg, Glang & Albin, 2005; Glisky, Schacter & Tulving, 2004; Kapur, Glisky & Wilson, 2004; Tam & Man, 2004; Webster et al., 2001; Wilson, Emslie, Quirk & Evans, 2001; van der Broek, Downes, Johnson, Dayus & Hilton, 2000), visuospatial skills (Boot, Kramer, Simons, Fabiani & Gratton, 2008), language (Allen, Mehta, McClure & Teasell, 2012; Fink, Brecher, Sobel

& Schwartz, 2010; Lee, Fowler, Rodney, Cherney & Small, 2009; Kirsch et al., 2004b; Wertz & Katz, 2004; Katz & Wertz, 1997), social cognition (Grynszpan et al., 2010; Bernard-Opitz, Srira & Nakhoda-Sapuan, 2001), and executive functions (Nouchi et al., 2013; Johansson & Tornmalm 2012; López Martinez et al., 2011; O´Neill, Moran & Gillespie, 2010; Westerberg et al., 2007; Ehlhardt et al., 2005; Kirsch et al., 2004a; Gorman, Dayle, Hood & Rumrell, 2003).

Computer-based interventions (and micro-computing interventions) have also been applied with positive outcomes to a wide range of psychological impaired profiles such as those occurring due to TBI (Cernich et al., 2010; Gentry, Wallace, Kvarfordt & Lynch, 2008; Thornton & Carmody, 2008; Michel & Mateer, 2006), stroke (Cha & Kim, 2013; Lauterbach, Foreman & Engsberg, 2013; Akinwuntan, Wachtel & Rosen, 2012; Cameirão, Bermúdez I Badia, Duarte Oller & Verschure, 2009; Michel & Mateer, 2006; Deutsch, Merians, Adamovich, Poizner & Burdea, 2004; Teasel et al., 2003; Wood et al., 2004), dementia (Crete-Nishihata et al., 2012; Mihailidis, Fernie & Barbenel, 2010; Cipriani, Bianchetti &Trabucchi, 2006; Cohene, Baecker & Marziali, 2005; Alm et al., 2004; Hofman et al., 2003; Zanetti et al., 2000), multiple sclerosis (Flavia et al., 2010; Shatil, Metzer, Horvitz & Miller, 2010; Vogt et al., 2009; Gentry, 2008), autism spectrum disorders (Sitdhisanguan, Chotikakamthorn, Dechaboon & Out, 2012; Wainer & Ingersoll, 2011; Tanaka et al., 2010; Beaumont & Sofronoff, 2008; Sansosti & Powell-Smith, 2008; Stromer, Kimball, Kinney & Taylor, 2006; Goldsmith & LeBlanc, 2004; Silver & Oakes, 2001; Werry, Dautenhahn, Ogden & Harwin, 2001; Lane & Mistrett, 1996), ADHD (Steiner, Sheldrick, Gotthelf & Perrin, 2011; Rabiner, Murray, Skinner & Malone, 2010; Shalev, Tsal & Mevorach, 2007; Mautone, DuPaul & Jitendra, 2005; Shaw & Lewis, 2005), learning disabilities (Nisha & Kumar, 2013; Seo & Bryant, 2009 –with recommendations regarding effectiveness-; Kim, Vaughn, Klingner & Woodruff, 2006; Hasselbring & Bausch, 2005; Lee & Vail, 2005; Maccini, Gagnon & Hughes, 2002; MacArthur, Ferretti, Okolo & Cavalier, 2001; Hall, Hughes & Filbert, 2000), intellectual disabilities (Cihak, Kessler & Alberto, 2008; Mechling & Ortega-Hurndon, 2007; Ayres, Langone, Boon & Norman, 2006; Ortega- Tudela & Gómez-Ariza, 2006; Standen & Brown, 2005; Furniss et al., 1999), schizophrenia (Sablier et al., 2011; Suslow, Schonauer & Arolt, 2008 –with recommendations for future research-; Medalia, Aluma, Tryon & Merriam, 1998; Hermanutz & Gestrich, 1991), or social phobia (Neubauer, von Auer, Murray, Petermann, Helbig-Lang & Gerlach, 2013; Schmidt, Richey, Buckner & Timpano, 2009). Computer-based interventions can also be a tool for training of cognitive skills in normal aging (Kueider, Parisi, Gross & Rebok, 2012; Cassavaugh & Kramer, 2009; Basak, Boot, Voss & Kramer, 2008; Flnkel & Yesavage, 2007; Rebok, Carlson & Langbaum, 2007; Jobe et al., 2001).

In conclusion, computer-based interventions can effectively facilitate improvement in many activities that would otherwise not be possible, but future research must control relevant parameters in computer-based cognitive rehabilitation studies.

3. NEURONUP´S MISSION

NeuronUP is a game-based SAS tool for professionals involved in Neuro Rehabilitation and Cognitive Stimulation processes. We firmly believe in the role of professionals as an axis in each individual's intervention.

Therefore -the way our platform is currently designed- the professional chooses, customizes and adapts contents to create stimulation. Professional can also plan activities, tailoring them to each stage, life moment and evolution of every patient.

Short and Middle Term of NeuronUP´s work. Progresses.

Besides every customizable resource we already offer, we have been internally working for the last six months in a new Tool. It´s called "Programs" and it´s being designed to provide the professionals with a resource to develop their own Intervention Programs.

The foundation behind this new tool is to create and clinically validate structured intervention programs hand in hand with Investigation Centers, Clinical Centers and Universities we already work with. The idea is not to validate the whole NeuronUP offer in cognitive specific profiles, but to work more precisely in Intervention Programs for concrete Cognitive Functions and Profiles.
We can work with the same resources with an Alzheimer GDS2 patient with education and with a patient lacking it.

Which NeuronUP contents are better to work with a specific TEA?

This is the work we have already started and of which we have beginning first investigations on Structured and Clinically Validated Programs. We already have the first essay results:

Investigations

1. Integrated Metacognitive and Neurocognitive Training using NeuronUP in Schizophrenia: A Single-Blind Randomized Controlled Trial.

2. Prospective Observational Study to explore the effectiveness of a Cognitive Rehabilitation with technological support (NeuronUP) carried out by Multiple Sclerosis patients in a face-to-face or distance modality.

3. Non-pharmacological Treatment of Alzheimer´s Disease.

4. Clinical Trial for the study of NeuronUP´s effectiveness in a Multiple Sclerosis Population.

Two Doctoral Thesis on the development of structured programs for brain damage population are currently on progress. One at Universidad de Guadalajara and the second

at Universidad de Deusto.

This is the plan we are following to create more specific interventions using NeuronUP platform. .

5. REFERENCES

Barker-Collo, S. L., Feigin, V. L., Lawes, C. M. M., Parag, V., Senior, H., & Rodgers, A. (2009). Reducing Attention Deficits After Stroke Using Attention Process Training A Randomized Controlled Trial. Stroke, 40(10), 3293-3298. doi:10.1161/STROKEAHA.109.558239

Bergman, M. M. (2002). The benefits of a cognitive orthotic in brain injury rehabilitation. The Journal of head trauma rehabilitation, 17(5), 431- 445.

Bernabeu M., Roig T. (1999). La rehabilitación del traumatismo craneoencefálico: un enfoque rehabilitador. Barcelona. Fundació Institut Guttmann

Borghese, N. A., Bottini, G., & Sedda, A. (2013). Videogame Based Neglect Rehabilitation: A Role for Spatial Remapping and Multisensory Integration? Frontiers in Human Neuroscience, 7. doi:10.3389/fnhum.2013.00116

Cho, B.-H., Ku, J., Jang, D. P., Kim, S., Lee, Y. H., Kim, I. Y., … Kim, S. I. (2002). The Effect of Virtual Reality Cognitive Training for Attention Enhancement. CyberPsychology & Behavior, 5(2), 129-137. doi:10.1089/109493102753770516

Christensen, A.-L., & Uzzell, B. P. (2000). International Handbook of Neuropsychological Rehabilitation. Springer

Cicerone, Keith D, Langenbahn, D. M., Braden, C., Malec, J. F., Kalmar, K., Fraas, M., … Ashman, T. (2011). Evidence-based cognitive rehabilitation: updated review of the literature from 2003 through 2008. Archives of physical medicine and rehabilitation, 92(4), 519-530. doi:10.1016/j. apmr.2010.11.015

Cole, E., Ziegmann, M., Wu, Y., Yonker, V., Gustafson, C., & Cirwithen, S. (2000). Use of "therapist-friendly" tools in cognitive assistive technology and telerehabilitation. In: Proceedings of the RESNA 2000 Annual Conference: Technology for the New Millennium, June 28-July 2, 2000, Omni Rosen Hotel, Orlando, Florida (p. 31). RESNA Press

Dye, M. W. G., Green, C. S., & Bavelier, D. (2009). The development of attention skills in action video game players. Neuropsychologia, 47(8–9), 1780-1789. doi:10.1016/j.neuropsychologia.2009.02.002

Faucounau, V., Wu, Y. H., Boulay, M., De Rotrou, J., & Rigaud, A. S. (2010). Cognitive intervention programmes on patients affected by Mild Cognitive Impairment: a promising intervention tool for MCI? The journal of nutrition, health & aging, 14(1), 31-35.

Flavia, M., Stampatori, C., Zanotti, D., Parrinello, G., & Capra, R. (2010). Efficacy and specificity of intensive cognitive rehabilitation of attention and executive functions in multiple sclerosis. Journal of the Neurological Sciences, 288(1– 2), 101-105. doi:10.1016/j.jns.2009.09.024

Gillespie, A., Best, C., & O'Neill, B. (2012). Cognitive function and assistive technology for cognition: a systematic review. Journal of the International Neuropsychological Society: JINS, 18(1), 1-19. doi:10.1017/S1355617711001548

Ginarte-Arias, Y. (2002). [Cognitive rehabilitation. Theoretical and methodological aspects]. Revista de neurologia, 35(9), 870-876

Green, C. S., & Bavelier, D. (2003). Action video game modifies visual selective attention. Nature, 423(6939), 534-537. doi:10.1038/nature01647

Jiang, L., Guan, C., Zhang, H., Wang, C., & Jiang, B. (2011). Brain computer interface based 3D game for attention training and rehabilitation. En 2011 6th IEEE Conference on Industrial Electronics and Applications (ICIEA) (pp. 124- 127). Presentado en 2011 6th IEEE Conference on Industrial Electronics and Applications (ICIEA). doi:10.1109/ICIEA.2011.5975562

Kapur, N., Glisky, E. L., & Wilson, B. A. (s. f.). Technological memory aids for people with memory deficits. Neuropsychological rehabilitation, 14(1-2), 41-60.

Kueider, A. M., Parisi, J. M., Gross, A. L., & Rebok, G. W. (2012). Computerized Cognitive Training with Older Adults: A Systematic Review. PLoS ONE, 7(7). doi:10.1371/journal. pone.0040588

Kvavilashvili, L., & Ellis, J. (2004). Ecological validity and twenty years of real-life/laboratory controversy in memory research: A critical (and historical) review. History and Philosophy of Psychology , vol 6 , pp. 59-80.

LoPresti, E., Mihailidis, A., & Kirsch, N. (2004). Assistive technology for cognitive rehabilitation: State of the art. Neuropsychological Rehabilitation, 14(1-2), 5-39. doi:10.1080/09602010343000101

Lynch, B. (2002). Historical review of computer-assisted cognitive retraining. The Journal of head trauma rehabilitation, 17(5), 446-457.

Newell, A. F., & Gregor, P. (2000). "User Sensitive Inclusive Design" in search of a new paradigm. In: Proceedings on the 2000 conference on Universal Usability (CUU '00), John Thomas (Ed.). ACM, New York, NY, USA, 39-44. Association for Computing Machinery.

Peretz, C., Korczyn, A. D., Shatil, E., Aharonson, V., Birnboim, S., & Giladi, N. (2011). Computer-based, personalized cognitive training versus classical computer games: a randomized double-blind prospective trial of cognitive stimulation. Neuroepidemiology,

36(2), 91-99. doi:10.1159/000323950

Prigatano, G. P. (1999). Principles of Neuropsychological Rehabilitation. Oxford University Press Inc.

Salas, C., Báez, M. T., Garreaud, A. M., & Daccarett, C. (2007). Experiences and challenges in cognitive rehabilitation: towards a model of contextualized intervention? Rev. chil. neuropsicol. (Impr.), 2(1), 21-30

Sánchez-Carrión, R., Gómez Pulido, A., GarcíaMolina, A., Rodríguez Rajo, P., & Roig Rovira, T. (2011) Tecnologías aplicadas a la rehabilitación neuropsicológica. In: Bruna, O., Roig, T., Puyuelo, M., Junqué, C. & Ruano, A. (Eds.) Rehabilitación neuropsicológica. Intervención y práctica clínica (pp. 131-140). Barcelona: Masson

Sohlberg, M., & Mateer, C. A. (1989). Introduction to Cognitive Rehabilitation. Guilford Publications.

Stahmer, A. C., Schreibman, L., & Cunningham, A. B. (2011). Toward a technology of treatment individualization for young children with autism spectrum disorders. Brain research, 1380, 229- 239. doi:10.1016/j.brainres.2010.09.043

Tam, S.-F., & Man, W.-K. (2004). Evaluating computer-assisted memory retraining programmes for people with post-head injury amnesia. Brain injury: [BI], 18(5), 461-470. doi:10.1 080/02699050310001646099

Tang, Y.-Y., & Posner, M. I. (2009). Attention training and attention state training. Trends in cognitive sciences, 13(5), 222-227. doi:10.1016/j. tics.2009.01.009

Tirapu Ustárroz, J., García Molina , A. & Roig Rovira, T. (2007). Validez ecológica en la exploración de las funciones ejecutivas. Anales de Psicología, 23(2) 289-299.

Wilson, B. (1987). Single-Case Experimental Designs in Neuropsychological Rehabilitation. Journal of Clinical and Experimental Neuropsychology, 9(5), 527-544. doi:10.1080/01688638708410767

Wilson, B. (1989). Models of cognitive rehabilitation. En R. L. Wood & P. Eames (Eds.), Models of brain injury rehabilitation (pp. 117-141). Baltimore, MD, US: Johns Hopkins University Press.

Yantz, C. L., Johnson-Greene, D., Higginson, C., & Emmerson, L. (2010). Functional cooking skills and neuropsychological functioning in patients with stroke: an ecological validity study. Neuropsychological rehabilitation, 20(5), 725-738. doi:10.1080/09602011003765690

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