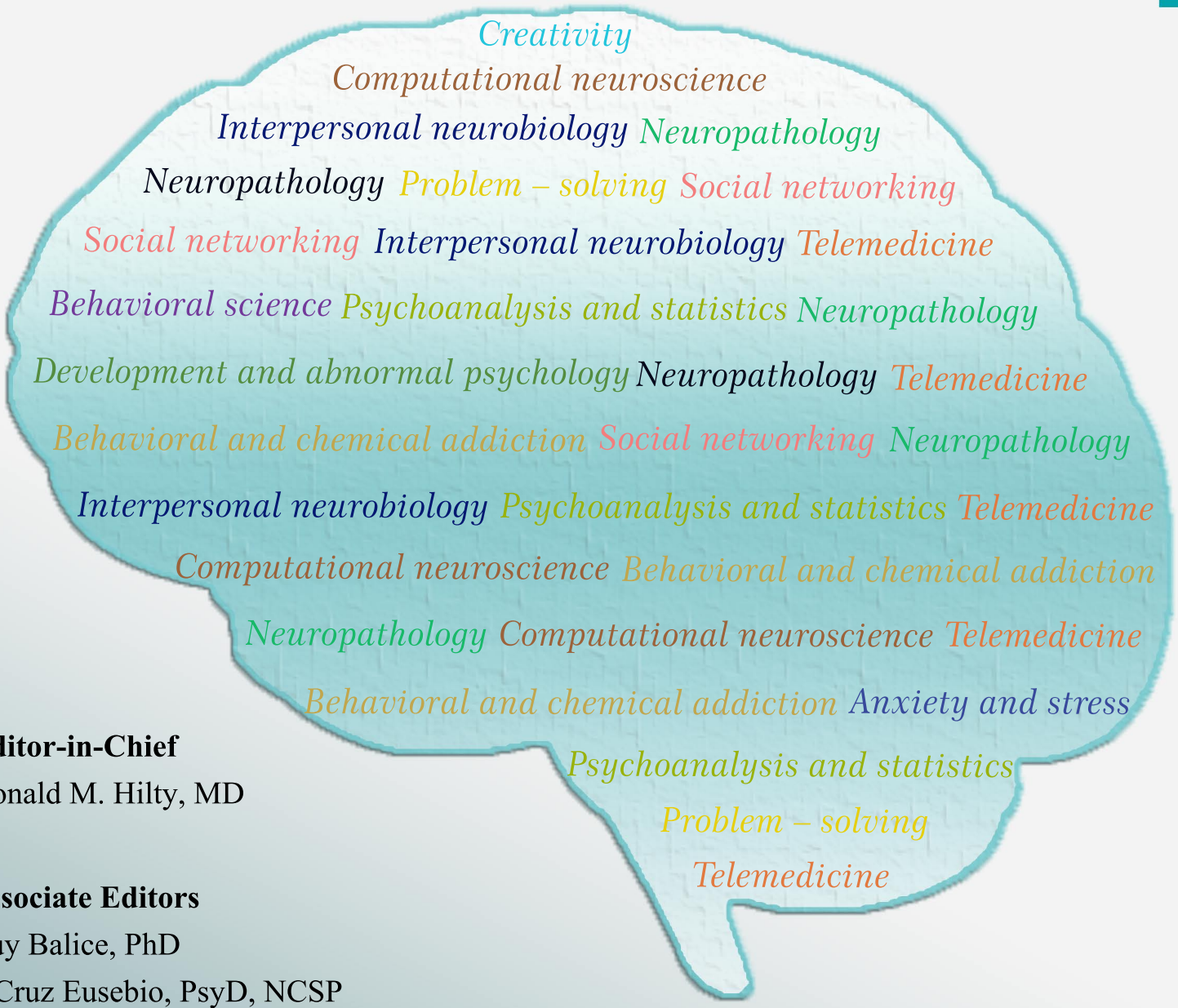
Openventio PUBLISHERS

ISSN 2380-727X

PSYCHOLOGY AND COGNITIVE SCIENCES

Open Journal

| February 2017 | Volume 3 | Issue 1 |



PSYCHOLOGY AND COGNITIVE SCIENCES

Openventio PUBLISHERS

ISSN 2380-727X

Open Journal

TABLE OF CONTENTS

PSYCHOLOGY AND COGNITIVE SCIENCES

Openventio PUBLISHERS

ISSN 2380-727X

Open Journal

http://dx.doi.org/10.17140/PCSOJ-3-e004

Editorial

***Corresponding author**
Lawrence M. Aleamoni, PhD
Professor Emeritus
Department of Disability and Psychoeducational Studies
University of Arizona
Tucson, AZ 85721, USA
Tel. (520) 297-5110; (520) 665-9988
Fax: (520) 297-9427
E-mail: aleamonl@email.arizona.edu

Volume 3 : Issue 1
Article Ref. #: 1000PCSOJ3e004

Article History
Received: September 8th, 2016
Accepted: September 8th, 2016
Published: September 20th, 2016

Citation
Aleamoni LM. Who are better at evaluating faculty teaching peers or students? *Psychol Cogn Sci Open J*. 2016; 3(1): e1. doi: 10.17140/PCSOJ-3-e004

Who are Better at Evaluating Faculty Teaching Peers or Students?

Lawrence M. Aleamoni, PhD*

Department of Disability and Psychoeducational Studies, University of Arizona, Tucson, AZ 85721, USA

In any Comprehensive Faculty Evaluation System it is important to define the broad range of roles that faculty must play in order to be successful. It is also important to identify the sources of information necessary to evaluate faculty performance in their various roles.

One of the roles that are always present in any comprehensive faculty evaluation system is that of Teaching. There are a plethora of articles and books on the most appropriate sources for evaluating this role such as Dean, Department Head, Peers, Students, Self, etc. Of these sources, students have received the greatest amount of attention over the past 50 or more years. For many of those concerned with the use of student ratings of faculty teaching, peer evaluation has been presented as the antidote. This typically manifests itself in the form of peers conducting classroom visitations and observations. When peers conduct classroom visitations and observations they typically represent a very limited sample of class meetings and are conducted without the benefit of a reliable and valid observational checklist. In addition, peers tend to judge the observed faculty member's performance against their own personal standards, which may or may not be appropriate. Therefore, typical peer evaluation of classroom teaching, tends to yield unreliable and invalid data upon which to judge a particular faculty member's teaching performance.

Students, on the other hand, are daily observers and participants in the faculty member's classroom. They are able to engage the faculty member in discussion and verify the veracity of the information being presented in the classroom. They are able to attest to the ability of the faculty member to motivate and lead or direct their learning. Therefore, when students are provided with professionally constructed, appropriately administered and correctly interpreted student rating forms, they are an excellent source of reliable and valid measures of the quality of classroom teaching. Over 90 years of studies on student ratings emphasize that the students are the best source of information on the design, delivery and implementation of classroom teaching.

PSYCHOLOGY AND COGNITIVE SCIENCES

Openventio PUBLISHERS

ISSN 2380-727X

Open Journal

http://dx.doi.org/10.17140/PCSOJ-3-118

Mini Review

***Corresponding author**
Sabine Huemer, PhD
Visiting Assistant Professor
Department of Psychology
Loyola Marymount University
1 LMU Drive, Los Angeles
CA 90045, USA
E-mail: shuemer@lmu.edu;
Sabine.Huemer@lmu.edu

Volume 3 : Issue 1
Article Ref. #: 1000PCSOJ3118

Article History
Received: October 30th, 2016
Accepted: December 5th, 2016
Published: December 6th, 2016

Citation
Huemer S. Memory in autism: A case of remembering *versus* knowing. *Psychol Cogn Sci Open J.* 2016; 3(1): 1-5. doi: 10.17140/PCSOJ-3-118

Memory in Autism: A Case of Remembering *Versus* Knowing

Sabine Huemer, PhD*

Department of Psychology, Loyola Marymount University, 1 LMU Drive, Los Angeles, CA 90045, USA

According to the *Diagnostic and Statistical Manual Fifth Edition*, the DSM-5,[1] autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by persistent social communication deficits and repetitive patterns of behavior including intense preoccupations and inflexible adherence to routines. ASD may occur with or without accompanying intellectual impairment and the severity of the disorder may fluctuate over time. Previously, an ASD diagnosis based on the *Diagnostic and Statistical Manual Fourth Edition* (DSM-IV) fell into one of 5 subtypes, most prominently, Asperger's syndrome and autism, diagnoses that indicated a generally higher (Asperger's) or lower level of functioning (autism). This brief report attempts to review literature on memory in ASD with a special focus on the discrepancy between an intact, at times, even extraordinary memory for large amounts of factual information and an often impaired memory for autobiographical information. A look at memory patterns in ASD may be helpful in understanding learning differences and aid in the customization of targeted intervention strategies.

Tulving[2,3] divides human memory into 2 distinct systems that are open to conscious awareness: The semantic system stores timeless facts available mostly upon cued recall recognition, while the episodic system relies on an individual's ability to put stored memories into a spatio-temporal and self-referential context upon free recall.[4] The Remember/Know (R/K) procedure[3] is used in recognition tasks to study both memory systems. Participants are asked to study a list of words, and then have to respond whether they remember the episode of having seen the word (R), or if they merely know (K) the word without the recollection of the specific episode.

Early observational studies found that individuals with classic autism and Asperger's often possess extraordinary rote memory skills and are able to memorize large amount of factual information.[5,6] Experimental studies on memory in ASD reveal a pattern of unimpaired memory span alongside impaired free recall.[7,8] When asked to recall a sequence of dot locations in order, Bowler et al[9] revealed impairments in non-verbal short-term serial order memory in adults with ASD as compared to typical individuals. Together with parallel findings using verbal material,[10] these results indicate that order processing appears to be a cross-domain deficit in ASD.

Free recall and the ability of *mental time travel*[2] have been related to the comprehension of *a temporally extended self*,[11,12] the understanding that the "I" we experience now is the same as the "I" from memories past, and *episodic future thinking*,[13] the ability to project oneself into plausible future situations. Zelazo et al[14,15] have shown that children with ASD have problems with this type of episodic remembering in tasks involving 'if-then' rules.[15,16] Later studies revealed the neural correlates of R/K discrepancies in ASD: episodic recognition involving the recollection of contextual information (R), which is impaired in ASD, shows to be mediated by hippocampal processes while familiarity based recognition (K), which is intact in ASD, is mediated by perirhinal processes.[17-19]

Free recall and episodic memory impairments have been associated with deficits in

ISSN 2380-727X
http://dx.doi.org/10.17140/PCSOJ-3-118

theory of mind (ToM),[20] the understanding of others beliefs and perspectives, an ability that has shown to be delayed or impaired in ASD.[21,22] In order to have episodic memories, a person needs to be able to form a *metarepresentation* of an episode, i.e. they must be able to understand their own memory of an event as a representation of the actual event.[23] These *metarepresentations* help a person to hold a true and false understanding of an event which is necessary in false-belief tasks testing ToM. Based on problems with ToM in ASD and the association of ToM with episodic memory deficits, Bowler, Gardiner and Grice[24] predicted and found that participants with Asperger's had lower R scores on recognition tasks using the standard R/K procedure. However, both control group and Asperger individuals yielded more R responses of high-frequency than low-frequency words. Both groups also show reduced R but not K responses when attention during the encoding phase was divided.[25] This qualitative, but not quantitative, similarity between groups indicates that individuals with Asperger's can reconstitute some of the spatio-temporal and self-referential context needed in episodic memory tasks.

Lind et al[26] examined 20 high functioning elementary school children with ASD and compared them to 20 neurotypical controls to probe the possibility of interdependent atypical cognitive development and behavior on series of tasks. The ASD group exhibited impairments in spatial navigation, episodic memory, episodic future thinking, and central coherence but not ToM and relational memory as compared to controls. ToM was tested on a version of the "animations" task[27] which is sensitive to ToM impairments in high-functioning individuals with ASD contrary to the more traditional "false belief tasks".[23] Interestingly, spatial navigation as tested on the computer-simulated "memory island" task was significantly negatively correlated to repetitive behaviors in the ASD group.

In a recent functional magnetic resonance imaging or functional MRI (fMRI) study in which participants listened to four categories of names including their own first names, (Huemer S et al unpublished data, 2016) found that individuals with ASD with high verbal ability, just like neurotypical controls, activated right hippocampal processes when hearing their own first name, while individuals with ASD with low verbal ability scores activated left thalamic processes associated with the memorization of new events.[28] Since perirhinal areas receive afferents from the nucleus reuniens of the thalamus, these findings indicate that individuals with ASD who have lower verbal ability "know" their name like a recently learned fact whereas individuals with ASD with high verbal ability, who often find themselves on the higher functioning end of the autism spectrum, like neurotypical controls recollect contextual autobiographical information when processing their own name.

When looking for the causes of the uneven memory profile in ASD, the work of Hermelin and O'Connor[7] and ensuing supporting studies[24,29] indicate that individuals with ASD fail to encode word sequences in a meaningful way (*deep encoding*) as opposed to neurotypical controls who use semantic and syntactical strategies to aid recall. In *deep encoding,* we draw from semantic aspects of material to be remembered, for example, considering category membership of words, which typically leads to enhanced memory as opposed to shallower levels of encoding that involve the processing of non-semantic features, for example, counting the number of syllables.[30] A lack of encoding strategies will also lead to problems in remembering more complex materials. Happé[31] found that individuals with ASD performed significantly worse on memory tasks with more complexity, both visual and auditory, when compared to neurotypical controls due to a lack of strategy and task organization.

The use of strategy in memory tasks was further examined using the *relational and individual item paradigm*[32] that tests free recall on items related to each other in category (*relational processing*) as opposed to items with semantic information that specific only to the item itself (*item specific processing*). Gaigg et al[33] showed that participants with ASD recalled overall fewer categories and less items in smaller but not larger categories, and they were less likely than typical participants to cluster items into their respective categories during recall. As opposed to these selective differences in relational processing in ASD, no significant differences between groups were found in the item-related processing portion of the study. As opposed to the original Hunt and Seca[32] paradigm, Gaigg et al[33] presented participants with a baseline and an orienting task which provided more practice and helped the ASD group overcome difficulties in the orienting task by deploying their relational memory processes effectively, which indicates that relational processing strategies are available to individuals with ASD but their deployment needs to be aided. These findings further substantiate the *Task Support Hypothesis*[34] which states that the memory difficulties of individuals with ASD can be attenuated when the procedure includes meaningful cues to the remembered material at recall.

Solomon et al[35] used the Relational and Item Specific Encoding (RISE) task to compare 22 adolescents with ASD to 26 well-matched neurotypical control subjects. As opposed to predictions, the ASD group did more poorly thank controls on recognition for objects that had been encoded in the item-specific condition but showed no difference for objects that had been encoded relationally. The study also found that the ASD group relied relatively less on familiarity during item recognition following relational encoding than controls did. The ASD group exhibited weaker cognitive control related to strategic memory processes that produced less overall learning. Performance on item and associative recognition improved with age in the ASD group while performance in the control group was a product of strategic learning processes. While these results may contradict the general consensus of impaired relational memory processes and intact item-specific memory in ASD, Solomon et al's[35] findings may be largely influenced by the stimulus characteristics of the RISE task where item-specific encoding relies on judgments related to abstract features and relational encoding can be aided

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-118

with strong visuo-spatial ability. Abstraction is shown to be difficult for individuals with ASD[36] while visuo-spatial abilities are considered strong.[37]

Neuroscientific evidence supports the theory of relational memory processes.[38] The hippocampus has been identified as the site of domain-general relational memory processes where individual features of an episode are integrated and organized.[19,39,40] Morphological abnormalities of the hippocampus are relatively well documented in ASD.[41,42] Areas outside the hippocampus, such as perirhinal, entorhinal and parahippocampal areas are found to mediate more domain-specific item and contextual processes.[43,44]

In summary, episodic remembering requires a person to put memories into a spatio-temporal and self-referential context, and relies on free recalls, which are areas of weakness in ASD. Anatomical and functional differences in hippocampal areas in ASD may be associated with these deficits. Environmental task support may help with the processing of relational and more complex information related to spontaneous recall. Item characteristics may play a role in some of the prior findings that contradicted general consensus findings. Age may be another factor in putting these findings into perspective since ASD studies have focused on younger age groups whereas episodic memory is known to develop considerably through adolescence and maturation does not occur until young adulthood.[45] Further, studies are needed to establish a more complete profile of memory processing in ASD including intellectually lower-functioning individuals and adults with ASD.

REFERENCES

1. American Psychiatric Association, APD. *Diagnostic and Statistical Manual of Mental Disorders*. 5th ed. Arlington, VA, USA: American Psychiatric Association; 2013.

2. Tulving E. *Elements of Episodic Memory*. Oxford: Oxford University Press; 1983.

3. Tulving E. Memory and consciousness. *Canadian Psychology.* 1985; 26: 1-12.

4. Tulving E. Episodic Memory: From mind to brain. *Annual Review of Psychology.* 2002; 53: 1-25. Web site. http://www.annualreviews.org/doi/pdf/10.1146/annurev.psych.53.100901.135114. Accessed October 29, 2016.

5. Kanner L. Autistic disturbances of affective contact. *Nervous Child*. 1943; 2: 217-250. Web site. https://simonsfoundation.s3.amazonaws.com/share/071207-leo-kanner-autistic-affective-contact.pdf. Accessed October 29, 2016.

6. Wing L. Asperger's syndrome: A clinical account. *Psychological Medicine.* 1981; 11: 115-129. doi: 10.1017/S0033291700053332

7. Hermelin B, O'Connor N. *Psychological Experiments With Autistic Children*. Oxford, UK: Pergamon Press; 1970.

8. Minshew N, Goldstein G. The pattern of intact and impaired memory functions in autism. *J Child Psychol Psychiatry*. 2001; 42: 1095-1101. doi: 10.1111/1469-7610.00808

9. Bowler DM, Poirier M, Martin JS, Gaigg SB. Nonverbal short-term serial order memory in autism spectrum disorder. *J Abnorm Psychol.* 2016; 125(7): 886-893. doi: 10.1037/abn0000203

10. Poirier M, Martin JS, Gaigg SB, Bowler DM. Short-term memory in autism spectrum disorder. *J Abnorm Psychol.* 2011; 120: 247-252. doi: 10.1037/a0022298

11. Neisser U. Two perceptually given aspects of the self and their development. *Developmental Review.* 1991; 11: 197-209. doi: 10.1016/0273-2297(91)90009-D

12. Povinelli DJ, Landau KR, Perilloux HK. Self-recognition in children using delayed versus live feedback: Evidence of a developmental asynchronicity. *Child Development.* 1996; 67: 1540-1554. doi: 10.1111/j.1467-8624.1996.tb01813.x

13. Lind SE, Bowler DM. Episodic memory and episodic future thinking in adults with autism. *J Abnorm Psychol*. 2010; 119(4): 896-905. doi: 10.1037/a0020631

14. Zelazo PD, Burack JA, Benedetto E, Frye D. Theory of mind and rule use in individuals with Down syndrome: A test of the uniqueness and specificity claims. *J Child Psychol Psychiatry.* 1996; 37: 479-484. doi: 10.1111/j.1469-7610.1996.tb01429.x

15. Zelazo PD, Frye D. Cognitive complexity and control II: The development of executive control in childhood. *Curr Dir Psychol Sci*. 1998; 47: 121-126. Web site. https://www.jstor.org/stable/20182520?seq=1#page_scan_tab_contents. Accessed October 29, 2016.

16. Zelazo PD, Burack JA, Boseovski J, Jacques S, Frye D. A cognitive complexity and control framework for the study of autism. In: Burack JA, Charman T, Yirmiya N, Zelazo PR, eds. *The Development of Autism: Perspectives from Theory and Research*. Mahwah, NJ, USA: Lawrence Erlbaum Associates; 2001: 195-217.

17. Brown MW, Aggleton JP. Recognition memory: What are the roles of perirhinal cortex and hippocampus? *Nat Rev Neurosci.* 2001; 2: 51-61. doi: 10.1038/35049064

18. Davachi L, Mitchell JP, Wagner AD. Multiple routes to memory: Distinct medial temporal lobe processes build item and source memories. *Proceedings of the National Academy of Science USA*. 2003; 100(4): 2157-2162. doi: 10.1073/pnas.0337195100

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-118

19. Holdstock JS, Mayes AR, Gong QY, Roberts N, Kapur N. Item recognition is less impaired than recall and associative recognition in a patient with selective hippocampal damage. *Hippocampus*. 2004; 15: 203-215. doi: 10.1002/hipo.20046

20. Perner J. Experiential awareness and children's episodic memory. In: Schneider W, Weinert FE, eds. *Interactions among Aptitudes, Strategies and Knowledge in Cognitive Performance.* New York: Springer; 1990.

21. Baron-Cohen S, Leslie A, Frith U. Does the autistic child have a 'theory of mind'? *Cognition*. 1985; 21: 37-46. Web site. http://autismtruths.org/pdf/3.%20Does%20the%20autistic%20child%20have%20a%20theory%20of%20mind_SBC.pdf. Accessed October 29, 2016.

22. Fletcher PC, Happé F, Frith U, et al. Other minds in the brain: A functional imaging study of 'theory of mind' in story comprehension. *Cognition.* 1995; 57: 109-128. Web site. https://pdfs.semanticscholar.org/8c9f/6785efcb75e18af9ca9a7fe479decff-1b5a1.pdf. Accessed October 29, 2016.

23. Perner J, Ruffman T. Episodic memory and autonoetic consciousness: Developmental evidence and a theory of childhood amnesia. *J Exp Child Psychol*. 1995; 59: 516-548. Web site. http://eric.ed.gov/?id=EJ507168. Accessed October 29, 2016.

24. Bowler DM, Gardiner JM, Grice S. Episodic memory and remembering in adults with Asperger's syndrome. *J Autism Dev Disord*. 2000; 30: 295. doi: 10.1023/A:1005575216176

25. Bowler DM, Gardiner JM, Gaigg SB. Factors affecting conscious awareness in the recollective experience of adults with Asperger's syndrome. *Conscious Cogn*. 2007; 16: 124-143. doi: 10.1016/j.concog.2005.12.001

26. Lind SE, Bowler DM, Raber J. Spatial navigation, episodic memory, episodic future thinking, and theory of mind in children with autism spectrum disorder: Evidence for impairments in mental simulation? *Front Psychol.* 2014; 5(1411): 1-20. doi: 10.3389/fpsyg.2014.01411

27. Abell F, Happe F, Frith U. Do triangles play tricks? Attribution of mental states to animated shapes in normal and abnormal development. *Cogn Dev*. 2000; 15: 1-16. doi: 10.1016/S0885-2014(00)00014-9

28. Winocour G. The hippocampus and thalamus: Their roles in short- and long-term memory and the effects of interference. *Behavioral Brain Research*. 1985; 16: 135-152.

29. Tager-Flusberg H. Semantic processing in the free recall of autistic children. *Br J Dev Psychol.* 1991; 9: 417-430. doi: 10.1111/j.2044-835X.1991.tb00886.x

30. Craik FIM, Lockhart RS. Levels of processing: A framework for memory research. *J Verbal Learning Verbal Behav*. 1972; 11(6): 671-684. doi: 10.1016/S0022-5371(72)80001-X

31. Happé F. The role of age and verbal ability in theory of mind task performance of subjects with autism. *Child Development*. 1995; 66: 843-855.

32. Hunt RR, Seta CE. Category size effects in recall: The roles of relational and individual item information. *Journal of Experimental Psychology: Learning, Memory and Cognition*. 1984; 10: 454-464. Web site. http://psycnet.apa.org/index.cfm?fa=buy.optionToBuy&id=1985-11356-001. Accessed October 29, 2016.

33. Gaigg SB, Gardiner JM, Bowler DM. Free recall in autism spectrum disorder: The role of relational and item-specific encoding. *Neuropsychologia*. 2008; 46(4): 983-992. doi: 10.1016/j.neuropsychologia.2007.11.011

34. Bowler DM, Matthews NJ, Gardiner JM. Asperger's syndrome and memory: Similarity to autism but not amnesia. *Neuropsychologia*. 1997; 35: 65-70.

35. Solomon M, McCauley JB, Iosif A, Carter CC, Ragland JD. Cognitive control and episodic memory in adolescents with autism spectrum disorder. *Neuropsychologia.* 2016; 89: 31-41. doi: 10.1016/j.neuropsychologia.2016.05.013

36. Solomon M, Frank MJ, Smith AC, Ly S, Carter CS. Transitive inference in adults with autism spectrum disorders. *Cog Affect Behav Neurosci*. 2011; 11(3): 437-449. doi: 10.3758/s13415-011-0040-3

37. Joseph RM, Steele SD, Meyer E, Tager-Flusberg H. Self-ordered pointing in children with autism: Failure to use verbal mediation in the service of working memory? *Neuropsychologia.* 2005; 43(10): 1400-1411. doi: 10.1016/j.neuropsychologia.2005.01.010

38. Nicolson R, DeVito, TJ, Vidal CN, Sui Y, Hayashi KM. Detection and mapping of hippocampal abnormalities in autism. *Neuroimaging*. 2006; 148(1): 11-21. doi: 10.1016/j.pscychresns.2006.02.005

39. Eichenbaum H. Hippocampus: Cognitive processes and neural representations that underlie declarative memory. *Neuron*. 2004; 44: 109-120. doi: 10.1016/j.neuron.2004.08.028

40. Squire LR. Memory and the hippocampus: A synthesis from findings with rats, monkeys and humans. *Psychological Review.* 1992; 99: 195-231. doi: 10.1037/0033-295X.99.2.195

41. Groen W, Teluji M, Buitelaar J, Tendolka I. Amygdala and hippocampus enlargement during adolescence in autism. *J Am Acad Child Adolesc Psychiatry.* 2010; 49(6): 552-560. doi: 10.1016/j.jaac.2009.12.023

ISSN 2380-727X
http://dx.doi.org/10.17140/PCSOJ-3-118

42. Nicolson R, DeVito TJ, Vidal CN, Sui Y, Hayashi KM. Detection and mapping of hippocampal abnormalities in autism. *Neuroimaging*. 2006; 148: 11-21.

43. Davachi L. Item, context and relational episodic encoding in humans. *Curr Opin Neurobiol.* 2006; 16: 693-700.

44. Mayes A, Montaldi D, Migo E. Associative memory and the medial temporal lobes. *Trends Cogn Sci*. 2007; 11(3): 126-135. doi: 10.1016/j.tics.2006.12.003

45. Ghetti S, Bunge SA. Neural changes underlying the development of episodic memory during middle childhood. *Dev Cog Neurosci*. 2012; 2(4): 381-395. doi: 10.1016/j.dcn.2012.05.002

PSYCHOLOGY AND COGNITIVE SCIENCES

Openventio PUBLISHERS

ISSN 2380-727X

Open Journal

http://dx.doi.org/10.17140/PCSOJ-3-119

Research

*Corresponding author
Beverly M. Ochieng, PhD
Great Lakes University of Kisumu
P.O Box 2224-40100
Kisumu, Kenya
E-mail: beverly_ochieng@yahoo.com

Volume 3 : Issue 1
Article Ref. #: 1000PCSOJ3119

Article History
Received: September 30th, 2016
Accepted: December 6th, 2016
Published: December 7th, 2016

Citation
Ochieng BM, Duma S, Ochieng JN, Kaseje DCO. Development and testing a volunteer screening tool for assessing community health volunteers' motives at recruitment and placement in Western Kenya. *Psychol Cogn Sci Open J*. 2016; 3(1): 6-16. doi: 10.17140/PCSOJ-3-119

Development and Testing a Volunteer Screening Tool for Assessing Community Health Volunteers' Motives at Recruitment and Placement in Western Kenya

Beverly M. Ochieng, PhD[1*]; Sinegugu Duma, PhD[2]; Jackline N. Ochieng, MSc[1]; Dan C. O. Kaseje, PhD[1]

[1]*Great Lakes University of Kisumu, P.O Box 2224-40100, Kisumu, Kenya*
[2]*University of Cape Town, P.O. Box Private Bag, Cape Town, South Africa*

ABSTRACT

Introduction: In times of inadequate resources and rising public demand, social service organizations rely on volunteers to meet needs. In the current human resource for health crisis in Africa there is urgent need for community health volunteers (CHVs). Studies have highlighted problems of high attrition rates leading to high replacement training costs among CHVs. There is need for careful selection of volunteers that can serve long-term, once trained. This study was done to develop a volunteer assessment framework for recruitment of CHVs. The framework is based on identification intrinsic motives for volunteering that have been shown to be associated with long volunteer service.
Methods: The assessment tool was developed by searching literature for theory based constructs and assessment items associated with volunteering. These constructs and items were synthesized into a proposed assessment framework. The framework was subjected to face content and construct validation in West Kenyan context in phase 1 of the study. The validated framework was tested for ability to differentiate between long serving volunteers and non-volunteers matched by gender, age and residence. The 2 groups were presented with test items and asked to record their agreement on a scale of 1 to 5 on the reasons why people volunteer.
Results: From literature we identified functional, role identity, and social exchange as theories underpinning volunteering. From these theories we identified 8 constructs to include in a proposed volunteer assessment framework. We tested the framework and although all the eight constructs satisfied internal consistency test only 5: altruism, materialism, social adjustment, esteem enhancement and career development were statistically significantly more associated with either volunteers or non-volunteers. Therefore, only these were included on the final volunteer assessment framework, for identification of long serving volunteers in the local context.
Conclusion: We propose a volunteer assessment tool with the 5 constructs and 25 assessment items for identification and recruitment of CHVs, with motives consistent with long-term volunteer service. The final framework consists of altruistic (altruism, social adjustment, esteem enhancement) or egoistic (material gain and career development) constructs with 25 assessment statements. The frame work would able to identify individuals with altruistic motives to include and those with egoistic tendencies to exclude during a volunteer recruitment exercise.

KEYWORDS: Community; Health volunteer; Assessment; Motives; Assessment; Motives; Constructs.

ABBREVIATIONS: CHV: Community Health Volunteers; VAF: Volunteer Assessment Framework; FGD: Focus Group Discussion.

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-119

INTRODUCTION

Volunteerism has existed for centuries and in all cultures based on the notion of solidarity and reciprocity where people live.[1] Volunteering is characterized by acts undertaken freely for reasons other than financial gain, for the benefit of others.[2] When the State cannot reach every individual and household with essential care it must rely on volunteers to complement its efforts.[3] Community health volunteers (CHV) is such an approach, built on the local strengths, tradition and experience which has become a major service delivery strategy in Kenya.[4,5]

Yet more recently, a major debate has existed as to whether people in poor settings can be expected to volunteer, particularly in delivering health services at the community level. Researchers in this field have highlighted problems such as high attrition rate and high cost of training as reasons against CHVs yet studies show their effectiveness in addressing human resource crisis,[6] and have been shown to be cost-effective.[7]

This paper presents the development and testing of a theory based framework for identifying volunteers likely to serve for long as community health volunteers, based their motives for volunteering. Using this framework to assess volunteers at recruitment would improve retention after training and thus reduce costs by minimizing replacement. This would improve the cost-efficiency of community volunteer programs. The paper focuses on the development and testing of a volunteer assessment framework (VAF) for Western Kenya.

Study Objectives

1. To develop a volunteer assessment framework from theories in literature.
2. To test the validity and reliability of the proposed volunteer assessment framework for CHVs in the local context.

METHODS

Development of the Volunteer Assessment Framework

We reviewed literature to identify theories on volunteerism relevant to CHVs, intrinsic and extrinsic factors that have been shown to influence volunteer retention and performance. We searched for the volunteer assessment items that have been used in the field of volunteerism research in order to develop an assessment framework. The search was limited to published literature in English globally scope and unlimited time period. The keywords used in the search included theories, volunteer, motives.

The search engine used was mainly Google and data bases included MEDLINE, CINAHL, Cochrane, PSYCNET, HINARI, EMBASE, POPLINE information was extracted using theories, motives and assessment items as themes. Constructs and items to measure them were identified as described by researchers.[8-10] This process yielded an emerging framework to be tested in the local setting.

Face and content validity was undertaken in a population of 300 respondents as described Netemeyer,[11] and Hogan and Greenfield.[12] This was done in Kisumu district, a population similar to the study population, using self-administered questionnaires. In addition the researcher conducted a focus group discussion (FGD) and key informant interviews with local community resource people to ensure that constructs and assessment items were suited to the local socio-cultural context. From the pretest new suggestions were incorporated in the draft framework. Further, a panel of content experts reviewed the proposed assessment items to verify that they were appropriate indicators of respective constructs, as described by Schultz and Whitney[13] to refine the tool.

The resulting draft Volunteer Assessment Framework consisted of 8 constructs with a total of 84 assessment items. It was translated into local languages (Kiswahili and Luo) by 2 pairs of the respective language experts and back translated to English by independent language experts to confirm the accuracy of the local language versions of the framework. The final draft from the face and content validity data was pretested a population similar to the study population to ensure that constructs and assessment items were suited to the local socio-cultural context. The framework was transformed into structured questionnaires administered to 150 volunteers and 150 non-volunteers matched by sex, age and residence. The respondents were to express their agreement with assessment statements based on Likert scale, to determine suitability the constructs and assessment items as expressed in the local language, in terms of the questions and meanings conveyed to suit the local setting in which the tool would be used.

Testing of the Volunteer Assessment Framework

The testing of the framework was carried out in Nyakach, Rarieda and Butere Sub-Counties in Western Kenya. The study population consisted of all community health volunteers listed by the Sub Counties of study and their next door neighbors. All 530 CHVs who had been active as volunteers for 5 or more years were enrolled in the study. A similar number of neighbors that were non-volunteers were also recruited into the study as comparison group, matched by gender, residence and age, making the sample population 1060.

The proposed VAF was tested in 2 steps. First, construct validity was assessed using Cronbach's alpha index,[14] to establish the reliability of the internal consistency of the framework. The responses on volunteers' motives were thus validated by correlations with construct measures, in the local context. The internal consistency test was thus undertaken using the Cronbach's alpha coefficient test, as described by Polit and Beck.[15]

To identify constructs and items that were more associ-

ISSN 2380-727X
http://dx.doi.org/10.17140/PCSOJ-3-119

ated with CHVs than non-CHVs the framework was assessed to identify constructs and assessment items demonstrating the responses among volunteers that were significantly different from non-volunteers. This was done by presenting the descriptions of the 8 volunteer motives contained in the tool being tested, to the 1062 respondents, half of whom were non-CHVs, by self administered structured statements. The assessment items explored responses to statements designed to assess motives for volunteering, under the 8 constructs. The participants were to express the degree to which they agreed or disagreed with the assessment items as stated, concerning reasons why people volunteer, based on a Likert scale of 1 to 5.

We used cluster analysis to determine association between the constructs and assessment items statistically significantly more with volunteers than with non-volunteers. We clustered the responses into agree (4, 5), undecided (3) and disagree (1, 2) and cross tabulated against the proportions among volunteers and non-volunteers. We compared the proportions in the different clusters for each of the constructs and assessment items. The significance of difference in proportions between the 2 groups was assessed by a chi-square statistic (χ^2), degrees of freedom (df) and significance values (p). This was used to examine the relationship between constructs and assessment items and volunteer status. The constructs and assessment items that showed statistically different scores between volunteers and non-volunteers, were considered suitable for inclusion in the final volunteer assessment framework. A p value<0.05 was considered statistically significant.

We obtained ethical approval from the Great Lakes University of Kisumu ethical review board.

Findings

From literature: Motivation has been examined from psychosocial,[16] need-based,[17] intrinsic factors,[18] social identity,[19] value-based,[20] and self concept-based.[21] Key concepts described by other researchers include concepts from the social exchange,[22] functional approach[23] and role identity[24] theories. Applying the theories to better understand why volunteering is good for everyone.[25] People continue to volunteer to the extent that their experiences fulfill their relevant motives.[26,27]

Social exchange theory was developed by Kohlberg.[22,28,29] It underpins the motive of material gain, such as remuneration, as a basis for volunteering, people volunteer according to perceived reward, balancing contributions and rewards. Similar motives have been described as extrinsic motivation.[30,31]

Functional theory: Clary and Snyder[32] defined functional analysis as being "concerned with the reasons and purposes that underlie and generate psychological phenomena served by people's beliefs and their actions". The main premise is that while different people can perform the same actions, the actions serve different psychological functions for different individuals.[31,33,34] Clary and Snyder[32] found that individuals who reported greater satisfaction also expressed stronger intentions to continue volunteering. Indeed, satisfaction was shown to correlate with time spent volunteering and longevity of service.[35] Material motives include rewards such as strengthening one's résumé, and developing one's career, Morrow-Howell and Mui.[36]

Role identity theory: Role identity theory, developed from social psychology, which states that individuals classify themselves and others according to their social roles. Individuals adopt multiple roles which have associated behavioral expectations.[37] These roles impact on their role identity suggesting psycho-social benefits from volunteer activities.[38] According to this perspective roles are stable across time and situations[39] and individuals will seek to reinforce their role perceptions, motivated by factors such as self-esteem and efficacy.[40,41] A key dimension of role identity is role enhancement,[42] benefits of accumulation of social roles. Roles have a buffering effect contributing to the need to be productive and maintain meaning throughout life.[43] These benefits are considered important by those who choose to volunteer.[44,45] Volunteering becomes, not so much what one does, but who one is Van Dyne and Farmer.[26] Finkelstein[46] stresses that role identity dictates how others perceive you and is important throughout life Stryker.[37] Warburton[47] suggests that volunteering in health may provide a key role for those affected by the erosion of traditional family and cultural values in the African context.

Social motives refer to individual satisfactions with rewards of interpersonal interactions Morrow-Howell and Mui.[36] They identified three major categories of volunteer motivations: (1) Altruistic (2) Material and (3) Social. Altruistic motives pertain to intangible rewards that are intrinsic to the volunteering act itself, namely satisfactions resulting from feeling that one has helped someone else. A study by Anderson and Moore[49] provided empirical evidence for altruistic motives for volunteering. They seek to translate their deeply held values into actions[50] similar to the need for esteem.[17]

In a research program on AIDS volunteers, Omoto and Snyder[35] found that 5 specific motives for volunteer work could be consistently identified: (1) values, and (2) community concern, which are altruistic. Community concern reflects people's sense of obligation to their community, Omoto[51], Penner[52]; (3) understanding, (4) esteem enhancement, which are social and (5) personal development which is materialistic. Understanding reflects the fact that volunteering may serve to satisfy a person's intellectual curiosity about other people, a social construct. Esteem enhancement encompasses motivations dealing with finding ways to cope with guilt over being more fortunate than others which is social. Finally, personal development focuses on personal growth, considered materialistic. Similarly, Clary[10] identified 5 factors relating to intention to volunteer[10]: (1) value expression, (2) knowledge, (3) social adjustment, (4) ego protection, and (5) utilitarian concern which correspond to Omoto and Snyder's.[35] Clary's[8] 6 motivations, which they claim to be of generic relevance to volunteerism, (1) values, (2) understanding,

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-119

(3) social, (4) protective (5) enhancement and (6) career development. Ochieng[53] added spirituality as an important construct in Kenya's local setting, along with material gain and community concern highlighted in her study.[53]

The following 8 motive constructs were identified from literature: for use in proposed volunteer assessment framework (Table 1).

1. Altruistic: Motives have intangible rewards, intrinsic to the volunteering act itself, namely satisfactions resulted from feeling that one has helped someone else. They are based on underlying beliefs held that one should make humanitarian contributions to society.[35,54] Anderson and Moore[49] suggested measurement items as: the person tends to think about the welfare of other people, feels empathy for them, and acts to benefit them, looks for opportunity to express their humanitarian concerns.
2. Community Concern: This reflects people's sense of obligation to their community as described by Omoto and Snyder.[35]
3. Spirituality: Mentioned by Ochieng[53] in her study among volunteers in Kenya.
4. Social adjustment: Social motives refer to individual satisfactions with rewards of interpersonal interactions, group identification, and networking.[10,36] Participating in activities viewed favorably by important others and group.
5. Esteem enhancement: Are positive strivings of the ego and self-confidence.[10] Helping is a means of maintaining positive feelings about themselves.[55,56]
6. Development of understanding: Opportunity to learn, and satisfy intellectual curiosity.[10,35,54]
7. Material gain: Material motives, according to Morrow-Howell and Mui[36] are concerned with extrinsic tangible rewards.
8. Career enhancement: Volunteerism enhances one's career Beale,[57] "stepping stones" to employment by learning skills,[35] improves labor market value,[58] self-development experience for youth.[59]

Testing of the Framework

All the motive constructs in the proposed Volunteer Assessment Framework satisfied internal consistency test, described by Polit and Beck,[15] scoring greater than Cronbach alpha 0.8 (Table 2).

Theories	Motives	Assessment items
Functional theory/ Role identity	Altruistic	Feeling to help others, Belief in helping others, Thinks about the welfare of others, Feeling empathy for others, acting to benefit others Express humanitarian concern, Feeling to translate deeply held values to action
Functional theory	Community Concern	Sense of obligation to community, contributing to society
	Spirituality	
Role identity	Social adjustment	Normative social pressure, getting along with others, Need to respond to group demand, Emotional gratification, desire to interact with others, build relationship with others, Activities viewed favorably by others, meeting expectations of others, self concept, Considers volunteering as a leisure activity, Satisfies the expectations of others
Role identity	Esteem enhancement	Enhance self confidence, to feel good about one-self, Self improvement, self acceptance, Brings meaning and purpose to life, Contributes to well-being, Valuable to self
Role identity theory	Development of understanding	Satisfies intellectual curiosity about other people and their problems, Educational experience, Chance to gain new experience, Opportunity to challenge self, test existing skills
Functional theory	Career development	Learning job related skills, Offers employment opportunity, Maintain employment skills, Opportunity to make friends and learn from them new skills, Learn more about area of interest, Increase job prospects, Career path, Stepping stone to job
Social exchange theory	Material gain	Benefit in kind or cash, Benefit from materials, Frequent rewards, Benefits add wealth

Table 1: Assessment items by motives and theories.

Constructs (Volunteer Motives)	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
Altruistic	0.84	0.84	12
Development of Understanding	0.85	0.85	10
Community Concern	0.91	0.92	20
Esteem Enhancement	0.87	0.87	10
Social Adjustment	0.91	0.91	13
Material Gain	0.90	0.90	5
Career Development	0.86	0.86	11
Spirituality	0.80	0.80	5

Table 2: Conbach's Coefficient alpha values by motive constructs.

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-119

For altruistic values all the assessment scale items were significantly associated with long serving volunteers than with non-volunteers, (Table 3A). For community concern and spirituality there was no statistically significant difference of scores between volunteers and non-volunteers. For social adjustment all the assessment scale items were significantly more associated with long serving volunteers than with the non-volunteers (Table 3B). For esteem enhancement all the assessment scale items were significantly more associated with long serving volunteers than with non-volunteers (Table 3C).

Development of understanding did not seem to resonate consistently with respondents in our study. The test item "to satisfy curiosity was more associated with volunteers, while the rest either demonstrated no difference between volunteers and controls such as "gain experience" or were associated more with controls (Table 3D) and may not be suitable for the framework.

For materialistic constructs, all the assessment scale items were significantly associated more with non-volunteers than with volunteers (Table 3E). Similarly all assessment items under career development motives were significantly associated with non-volunteers than with volunteers (Table 3F).

DISCUSSION

All 8 constructs can be used in the local setting since the internal consistency of the proposed framework all the constructs in the tool were above 0.8 by Cronbach's alpha coefficient test as described by Polit & Beck.[15] The framework was adequately valid in the local context.

Altruistic constructs had strong association with volunteers. Altruistic values have been recognized by other studies that had described individuals who volunteer in order to express

Altruistic value assessment items	Respondents	Disagree n (%)	Undecided n (%)	Agree n (%)	*p* value
It creates a better society	CHVs	12 (1.2)	9 (0.9)	509 (48.1)	0.00
	Non-CHVs	15 (1.5)	32 (3.0)	483 (45.6)	
Of values and belief in making things better for others.	CHVs	23 (2.1)	18 (1.7)	489 (46.1)	0.00
	Non-CHVs	47 (4.4)	35 (3.3)	448 (42.3)	
It translates deep held values into actions.	CHVs	28 (2.6)	30 (2.8)	472 (44.6)	0.01
	Non-CHVs	52 (4.9)	50 (4.7)	428 (40.4)	
They think about the welfare of other people	CHVs	18 (1.7)	41 (3.9)	471 (40.3)	0.00
	Non-CHVs	56 (5.3)	36 (3.2)	438 (41.3)	
They feel empathy for others	CHVs	24 (2.3)	23 (2.2)	483 (45.5)	0.00
	Non-CHVs	52 (4.9)	35 (3.3)	443 (41.8)	
They benefit others	CHVs	38 (3.5)	13 (1.3)	479 (45.2)	0.00
	Non-CHVs	85 (8.0)	23 (2.1)	422 (34.5)	
Intention to contribute positively to society	CHVs	18 (1.7)	23 (2.2)	489 (46.1)	0.05
	Non-CHVs	38 (3.6)	35 (3.3)	457 (43.1)	
They consider themselves to be people who get involved	CHVs	47 (4.5)	37 (3.4)	446 (42.1)	0.00
	Non-CHVs	125 (11.8)	47 (4.4)	358 (33.8)	

Table 3A: Proportion of respondents agreeing with altruistic values by volunteer status.

Social adjustment		Agree	Undecided	Disagree	*p* value
It is an opportunity for relationships	CHVs	84 (7.9)	24 (2.3)	422 (39.8)	0.00
	Non-CHVs	105 (9.9)	32 (3.0)	393 (37.1)	
People at job/school/church/group would approve of their volunteering	CHVs	169 (15.9)	41 (3.9)	320 (30.2)	0.04
	Non-CHVs	129 (12.2)	42 (3.9)	359 (33.9)	
People who are close to them would support them to volunteer	CHVs	188 (17.8)	39 (3.6)	303 (28.6)	0.04
	Non-CHVs	139 (13.1)	38 (3.6)	353 (33.3)	
Their family members would encourage them to volunteer	CHVs	207 (19.5)	47 (4.5)	276 (26.1)	0.00
	Non-CHVs	155 (14.6)	55 (5.2)	320 (30.2)	
Of reciprocal interactions in community	CHVs	242 (22.8)	43 (4.0)	245 (23.1)	0.00
	Non-CHVs	169 (16.0)	44 (4.1)	317 (29.9)	

Table 3B: Proportion of respondents agreeing with social adjustment values by volunteer status.

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-119

Esteem enhancement		Agree n (%)	Undecided n (%)	Disagree n (%)	*p* value
They want to instill pride in themselves	CHVs	309 (29.1)	28 (2.7)	193 (18.3)	0.00
	Non-CHVs	236 (22.3)	53 (5.0)	241 (18.3)	
They want to instill self-esteem in themselves	CHVs	255 (24.1)	46 (4.3)	229 (21.6)	0.00
	Non-CHVs	197 (18.6)	40 (3.7)	293 (27.6)	
No matter how bad they have been feeling, volunteering helps them to forget about it	CHVs	214 (20.2)	54 (5.1)	262 (24.7)	0.00
	Non-CHVs	182 (17.2)	42 (3.9)	306 (28.9)	
They enjoy being part of activities in the community	CHVs	141 (13.3)	45 (4.2)	344 (32.5)	0.02
	Non-CHVs	94 (8.9)	46 (4.3)	390 (36.8)	
They enjoy doing the activity	CHVs	139 (13.1)	42 (3.9)	349 (32.9)	0.02
	Non-CHVs	126 (11.9)	44 (4.1)	360 (33.9)	
It makes them feel good about themselves	CHVs	231 (21.8)	28 (2.7)	271 (25.6)	0.01
	Non-CHVs	176 (16.6)	45 (4.2)	309 (29.2)	
Community Concern	CHVs	154 (14.5)	26 (2.5)	350 (33.1)	0.03
	Non-CHVs	144 (13.6)	34 (3.2)	352 (33.2)	
It makes them feel important	CHVs	282 (26.6)	25 (2.4)	223 (21)	0.00
	Non-CHVs	225 (21.2)	51 (4.8)	254 (23.9)	
It makes them feel appreciated	CHVs	249 (23.5)	48 (4.6)	233 (22)	0.00
	Non-CHVs	226 (21.3)	49 (4.6)	255 (24.1)	
It makes them feel recognized	CHVs	253 (23.9)	41 (3.9)	236 (22.3)	0.00
	Non-CHVs	197 (18.6)	47 (4.4)	304 (27)	

Table 3C: Proportion of respondents agreeing with esteem enhancement values by volunteer status.

Development of understanding		Disagree n (%)	Undecided n (%)	Agree n (%)	*p* value
It satisfies their curiosity about other people and the problems that they face	CHVs	69 (6.5)	31 (2.9)	430 (40.6)	0.03
	Non-CHVs	94 (8.9)	30 (2.8)	406 (38.3)	
Of personal growth	CHVs	180 (17)	55 (5.2)	295 (27.9)	0.00
	Non-CHVs	144 (13.6)	36 (3.3)	350 (33.1)	
Of the opportunity to make friends	CHVs	183 (17.3)	47 (4.4)	300 (28.3)	0.00
	Non-CHVs	145 (13.7)	32 (8.9)	353 (33.3)	
Of the chance to gain new experience	CHVs	83 (7.9)	28 (2.7)	419 (39.5)	0.02
	Non-CHVs	69 (6.5)	46 (4.3)	415 (39.2)	
Of opportunity to challenge themselves	CHVs	194 (18.3)	60 (5.7)	276 (26.0)	0.00
	Non-CHVs	145 (13.6)	54 (5.1)	331 (31.3)	
Volunteerism allows them to test their existing skills and abilities	CHVs	123 (11.7)	42 (4.0)	366 (34.4)	0.03
	Non-CHVs	108 (10.2)	61 (3.9)	381 (35.9)	

Table 3D: Proportion of respondents agreeing with development of understanding values by volunteer status.

Material gain	Respondents	Disagree n (%)	Undecided n (%)	Agree n (%)	*p* value
They benefit at times in terms of cash or kind	CHVs	331 (31.3)	36 (3.4)	163 (15.4)	0.00
	Non-CHVs	226 (21.4)	43 (4.0)	261 (24.6)	
Sometimes they are paid	CHVs	314 (29.6)	51 (4.8)	165 (15.6)	0.00
	Non-CHVs	226 (21.4)	33 (3.1)	271 (25.5)	
At times they are given materials that have remained after volunteering	CHVs	290 (27.4)	45 (4.3)	195 (18.4)	0.00
	Non-CHVs	207 (19.5)	45 (4.2)	278 (26.2)	
Sometimes they are rewarded and they feel good	CHVs	274 (25.8)	46 (4.4)	210 (19.9)	0.00
	Non-CHVs	200 (18.8)	37 (3.5)	293 (27.6)	
Volunteer benefits add to their wealth	CHVs	245 (23.1)	35 (3.3)	250 (23.6)	0.00
	Non-CHVs	193 (18.2)	34 (3.2)	303 (28.6)	

Table 3E: Proportion of respondents agreeing with material gain values by volunteer status.

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-119

Career development		Disagree n (%)	Undecided n (%)	Agree n (%)	*p* value
They want to learn job-related skills	CHVs	100 (9.5)	33 (3.1)	397 (37.5)	0.01
	Non-CHVs	87 (8.2)	29 (2.8)	414 (39.1)	
It will help them get an opportunity at a place where they would like to work	CHVs	80 (7.6)	53 (5.0)	397 (37.5)	0.00
	Non-CHVs	83 (7.9)	27 (2.6)	420 (39.6)	
It can help them get a job	CHVs	100 (9.5)	33 (3.1)	397 (37.5)	0.01
	Non-CHVs	87 (8.2)	29 (2.8)	414 (39.1)	

Table 3F: Proportion of respondents agreeing with career development values by volunteer status.

firmly held beliefs of the importance for one to help others.[50,60] Under this construct strong personal values underpin the motive for volunteering. This finding is consistent with research undertaken on volunteer motivation by Penner[61] suggesting this construct to be among the most powerful predictors of long-term volunteerism such as is required for CHVs (Table 4).

Social adjustment describes individuals who volunteer to build social networks and enjoy interactions. In our study, this construct was associated with volunteers. The statements that volunteers identified more with as compared to non-volunteers were approval by peers, friends, and family and expecting reciprocity from other members of the community which are culturally supportable.[53] Volunteering was seen as useful not only intrinsically, but in the eyes of others.[46]

Esteem enhancement encompasses motivations with positive strivings of the ego.[8] Carlson et al[55] working on mood of helping others suggested that people use helping as a means of enhancing positive feelings about themselves. This phenomenon is explained by Cheng et al[62] suggesting that undertaking generative acts is becoming increasingly challenging for older people in the technical age, when older people have less and less to teach the younger generation. For this reason older people may take up volunteerism to maintain positive relationships with offspring.[63]

Egoistic constructs, material gain, had strong associa-

Complete the following sentences about the reason people volunteer and indicate the degree of your agreement with each one.
People volunteer because:

1. Altruistic value (core)	Strongly Agree	Agree	Undecided	Disagree	Strongly disagree
It creates a better society					
It translates deep held values into actions					
They think about the welfare of other people					
They feel empathy for others					
They consider themselves to be people who get involved					
2. Social adjustment					
It is an opportunity for relationships					
People at job/school/church/group would approve of their volunteering					
People close to them would support them to volunteer					
Their family members would encourage them to volunteer					
Of reciprocal interactions in community					
3. Esteem enhancement					
They want to instill pride in themselves					
No matter how bad they have been feeling, volunteering helps them to forget about it					
They enjoy being part of activities in the community					
It makes them feel good about themselves					
It makes them feel important					
It makes them feel appreciated					
It makes them feel recognized					
4. Material Gain					
They benefit at times in terms of cash or kind					
Sometimes they are paid					
At times they are given materials that have remained after volunteering					
Sometimes they are rewarded and they feel good					
Volunteer benefits add to their wealth					
5. Career Development					
They want to learn job-related skills					
It will help them get an opportunity at a place where they would like to work					
It can help them get a job					

Table 4: The resulting Final Volunteer Assessment Framework (VAF)

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-119

tion with non-volunteers. Hence, a tool with egoistic constructs can be used to identify people who are unsuitable for being long serving volunteers, as required for CHVs. Our finding is consistent with many other social theories underlying reasons for people to take action because they weigh investment against benefits, such as social cognitive theory by Bandura,[48] or those perceiving volunteering as a productive activity.[25] All the assessment items were strongly associated with non-volunteers than volunteers. Career development was also associated with non-volunteers. Gidron[59] suggested that the rewards for volunteering were either personal or indirectly economic such as gaining work experience. All the assessment scale items under career development motives were significantly associated with controls.
The remaining 2 constructs, community concern and spirituality, did not demonstrate adequate difference in association with either volunteers or non-volunteers and may not be useful in the framework in the local context. Community concern and spirituality may be rooted on theories that are beyond psychosocial in the disciplines of social anthropology and theology that were not adequately explored in this study, and therefore an area for further investigation. Some studies point out that volunteerism is associated with social philanthropy that are associated religious values as sources of motivation.[64,65]

CONCLUSION

This study provided valuable information about the actual motivations and their relative importance to identify volunteers likely to serve long as needed in community based health care. Of the 8 constructs considered 5 with 25 test items were useful in identifying volunteers, positively or negatively. Development of understanding had inconsistent association with volunteers and non-volunteers. Spirituality and community concern did not differentiate between volunteers and non-volunteers and therefore unsuitable for the framework being tested. Researchers in this field have described the importance of these differences to managers involved in the recruitment, placement and retention of volunteers within their organization, but have not clearly demonstrated the differences and hence the contribution of this study. This framework will be instrumental in the recruitment of appropriately motivated volunteers for long-term assignments, and hence improve the retention rate among volunteers, by excluding those that are unsuitable. Taking the 2 tests together, using both altruistic and egoistic constructs one can identify volunteers to include as well exclude people who cannot serve long-term as volunteers required of community health volunteers. This will improve the cost-efficiency CHV programs. By understanding the motivations of their volunteers through the framework, a manager of volunteers can identify and select volunteers that are likely to serve long-term based on their motivation. The final framework has 5 constructs and 20-30 assessment items.

ACKNOWLEDGEMENT

This work was carried out with support from the Great Lakes Univesrsity of Kisumu and Teseadale Corti research Programme, a research funding partnership composed of the Canadian Institutes of Health Research, Foreign Affairs, Trade and Development Canada, and the International Development Research Centre. This work was carried out with the aid of a grant from the International Development Research Centre (IDRC), Ottawa, Canada, and with the financial support of the Government of Canada provided through Foreign Affairs, Trade and Development Canada (DFATD).

CONSENT FROM PARTICIPANTS

All participants were briefed on the purpose of the research and they were given free will to choose whether to participate in the research.
The Principle Investigator seek consent from all participants. The information provided by the participants was kept private and confidential.
The study results was shared will all interested participants.

COMPETING INTERESTS

The authors declare no competing interests in the research study.

REFERENCES

1. Ellis SJ. Research on volunteerism: What needs to be done. *J Volunt Action Res*. 1985; 14(2-3): 11-14. doi: 10.1177/089976408501400204

2. Dekker P, Halman L. *The Values of Volunteering: Cross-Cultural Perspectives*. New York, NY, USA: Kluwer Academic/Plenum Publishers; 2003.

3. Smith DJ. Making a difference: Can governments influence volunteering. *Voluntary Action*. 1998; 1(1): 7-20. Web site. http://www.ivr.org.uk/component/ivr/making-a-difference. Accessed September 29, 2016.

4. Ministry of Health. Health Sector Strategic Plan III, Government of Kenya-Health Sector Reform Secretariat. *Reversing the Trends: The National Health Sector Strategic Plan (NHSSP II) 2005-2010*. 2005.

5. Henderson KA. Motivations and perceptions of volunteerism and a leisure activity. *Journal of Leisure Research*. 1981; 13: 208-218. Web site. http://eric.ed.gov/?id=EJ255790. Accessed 2016.

6. Haines A, Sanders D, Lehmann U, et al. Achieving child survival goals: Potential contribution of community health workers. *Lancet*. 2007; 369: 2121-2131. doi: 10.1016/S0140-6736(07)60325-0

7. Hongoro C, McPake B. How to bridge the gap in human re-

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-119

sources for health. *Lancet.* 2004; 364: 1451-1456. doi: 10.1016/S0140-6736(04)17229-2

8. Clary EG, Snyder M, Ridge RD, et al. Understanding and assessing the motivations of volunteers: A functional approach. *J Pers Soc Psychol.* 1998; 74(6): 1516-1530. doi: 10.1037/0022-3514.74.6.1516

9. Clary EG, Snyder M. Motivations for volunteering and giving: A functional approach. In: CH Hamilton, WF Ilchman (Eds). *New Directions for Philanthropic Fundraising*. San Francisco, CA, USA: Jossey-Bass; 1995: 111-123.

10. Clary EG, Snyder M, Ridge RD, Miene PK, Haugen JA. Matching messages to motives in persuasion: A functional approach to promoting volunteerism. *J Appl Soc Psychol.* 1994; 24(13): 1129-1149. doi: 10.1111/j.1559-1816.1994.tb01548.x

11. Netemeyer RG, Bearden WO, Sharma S. *Scaling Procedures: Issues and Applications*. USA: Sage Publications, Inc.; 2003.

12. Hogan NS, Greenfield DB, Schmidt LA. Development and validation of the Hogan grief reaction checklist. *Death Studies*. 2001; 25(1): 1-32.

13. Schultz KS, Whitney DJ. *Measurement Theory in Action*. Thousand Oaks, CA, USA: Sage; 2005.

14. Cronbach LJ, Meehl PE. Construct validity in psychological tests. *Psychol Bull*. 1955; 52: 281-302. Web site. http://psychclassics.yorku.ca/Cronbach/construct.htm. Accessed September 29, 2016.

15. Polit DF, Beck CT. *Nursing Research: Principles and Methods*. Philadelphia, PA, USA: Lippincott Willaims and Wilkins; 2004.

16. Jung Carl G. *Psychological Types.* Princeton, NJ, USA: Princeton University Press; 1971: 333.

17. Maslow AH. *Motivation and Personality.* New York, NY, USA: Harper; 1954.

18. Katz D. The functional approach to the study of attitudes. *Public Opin Q.* 1960; 106-204. Web site. https://www.jstor.org/stable/2746402?seq=1#page_scan_tab_contents. Accessed September 29, 2016.

19. Ashforth BE, Mael F. Social identity theory and the organization. *Acad Manage Rev.* 1989; 14(1): 20-39. Web site. https://www.jstor.org/stable/258189?seq=1#page_scan_tab_contents. Accessed September 29, 2016.

20. Etzioni A. *Complex Organizations: A Sociological Reader.* New York, NY, USA: Holt, Rinehart, & Winston; 1961.

21. Sullivan JJ. Self theories and employee motivation. *Journal of Management*. 1989; 15: 345-363.

22. Howarth E. Personality characteristics of volunteers. *Psychological Reports.* 1976; 38: 855-858. doi: 10.2466/pr0.1976.38.3.855

23. Clary EG, Snyder M. A functional analysis of altruism and prosocial behavior: The case of volunteerism. *Review of Personality and Social Psychology.* 1991; 12: 119-148. Web site. http://psycnet.apa.org/psycinfo/1991-97117-005. Accessed September 29, 2016.

24. Finkelstein MA, Penner LA. Predicting organizational citizenship behavior: Integrating the functional and role identity approaches. *Soc Behav Pers*. 2004; 32: 383-398. doi: 10.2224/sbp.2004.32.4.383

25. Warburton J, McLaughlin D. Doing it from your heart: The role of older women as informal volunteers. *J Women Aging.* 2006, 18: 55-72.

26. Van Dyne L, Farmer SM. It's who I am: Role identity and organizational citizenship behavior of volunteers. In: Turnipseed DL, ed. *A Handbook on Organizational Citizenship Behavior: A Review of 'Good Soldier' Activity in Organizations*. Hauppage, NY, USA: Nova Science Publishing; 2005: 181-207.

27. Houle BJ, Sagarin BJ, Kaplan MF. A functional approach to volunteerism: Do volunteer motives predict task preference? *Basic Appl Soc Psych.* 2005; 27: 337-344. doi: 10.1207/s15324834basp2704_6

28. Fitch RT. Characteristics and motivations of college students volunteering for community service. *Journal of College Student Personnel.* 1987; 28: 424-431. Web site. http://psycnet.apa.org/psycinfo/1988-34194-001. Accessed September 29, 2016.

29. Fisher RJ, David A. The effects of recognition and group need on volunteerism: A social norm perspective. *Journal of Consumer Research*. 1998; 262-275. Web site. http://www.jstor.org/stable/10.1086/209538?seq=1#page_scan_tab_contents. Accessed September 29, 2016.

30. Bandura A. *Social Foundations of Thought and Action: A Social Cognitive Theory.* Englewood Cliffs, NJ, USA: Prentice-Hall; 1986.

31. Stukas AA, Daly M, Cowling MJ. Volunteerism and social capital: A functional approach. *Australian Journal on Volunteering.* 2005; 10(2). Web site. https://search.informit.com.au/documentSummary;dn=032774803656339;res=ielhss. Accessed September 29, 2016.

32. Clary EG, Snyder M. The motivations to volunteer: Theoretical and practical considerations. *Curr Dir Psychol Sci*. 1999;

ISSN 2380-727X
http://dx.doi.org/10.17140/PCSOJ-3-119

8: 156-159. doi: 10.1111/1467-8721.00037

33. Snyder M, Clary EG, Stukas AA. The functional approach to volunteerism. In: Maio G, Olson J, eds. *Why We Evaluate: Functions of Attitudes.* Mahwah, NJ, USA: Lawrence Erlbaum; 2000.

34. Snyder, M, Omoto AM. Who helps and why? The psychology of AIDS volunteerism. In: Spacapan S, Oskamp S, eds. *Helping and Being Helped: Naturalistic Studies*. Thousand Oaks, CA, USA: Sage Publications; 1992: 213-239.

35. Omoto AM, Snyder M. Sustained helping without obligation: Motivation, longevity of service, and perceived attitude change among AIDS volunteers. *J Pers Soc Psychol*. 1995; 68(4): 671-686.

36. Morrow-Howell N, Mui AC. Elderly volunteers: Reasons for initiating and terminating service. *J Gerontol Soc Work.* 1989; 13(3/4): 21-34. doi: 10.1300/J083V13N03_03

37. Stryker S. *Symbolic Interaction: A Social Structural Version.* Menlo Park, CA: Benjamin Cummings; 1980.

38. Gubrium J, Wallace J. Who theorizes age? *Ageing Soc.* 1990; 18: 131-149. doi: 10.1017/S0144686X00008047

39. Stryker S, Burke P. The past, present and future of an identity theory. *Soc Psychol Quart.* 2000; 63: 284-297. Web site. https://www.jstor.org/stable/2695840?seq=1#page_scan_tab_contents. Accessed September 29, 2016.

40. Stets J, Burke P. Identity theory and social identity theory. *Soc Psychol Quart.* 2000; 63: 224-237. Web site. http://wat2146.ucr.edu/papers/00a.pdf. Accessed September 29, 2016.

41. Stryker S, Statham A. Symbolic Interaction and role theory. In: Lindzet G, Aronson E, eds. *Handbook of Social Psychology*. New York, NY, USA: Random House; 1985.

42. Moen P, Robison, J, Dempster-McClain D. Caregiving and women's well-being: A life-course approach. *J Health Soc Behav.* 1995; 36: 259-273. Web site. http://www.jstor.org/stable/2137342?seq=1#page_scan_tab_contents. Accessed September 29, 2016.

43. Greenfield E, Marks N. *Volunteering Protects Older Adults at Risk for Loss of Purpose in Life*. Madison, WI, USA: University of Wisconsin-Madison; 2010.

44. MacNeela P. The give and take of volunteering: Motives, benefits, and personal connections among Irish volunteers. *Voluntas.* 2008; 19: 125-139. doi: 10.1007/s11266-008-9058-8

45. Finkelstein MA, Penner LA, Brannick MT. Motive, role identity, and prosocial personality as predictors of volunteer activity. *Soc Behav Pers.* 2005; 33: 403-418. doi: 10.2224/sbp.2005.33.4.403

46. Finkelstein M. Intrinsic *vs.* extrinsic motivational orientations and the volunteer process. *Pers Indiv Differ.* 2009; 46: 653-658. Web site. http://scholarcommons.usf.edu/psy_facpub/770/. Accessed September 29, 2016.

47. Warburton JR, Chambers B. Older Indigenous Australians: their integral role in community and culture. *Australas J Ageing.* 2007; 26: 3-7. doi: 10.1111/j.1741-6612.2007.00213.x

48. Bandura A. Moral disengagement in the perpetration of inhumanities. *Pers Soc Psychol Rev.* 1999; 3: 193-209. doi: 10.1207/s15327957pspr0303_3

49. Anderson JC, Moore LF. The motivation to volunteer. *J Volunt Action Res.* 1978; 7: 120-129. doi: 10.1177/089976407800700312

50. Piliavin JA, Charng H-W. Altruism: A review of recent theory and research. *Annu Rev Sociol.* 1990; 16: 27-65. Web site. https://www.jstor.org/stable/2083262?seq=1#page_scan_tab_contents. Accessed September 29, 2016.

51. Omoto AM, Snyder M. Considerations of community: The context and process of volunteerism. *Am Behav Sci.* 2002; 45(5): 846-867. doi: 10.1177/0002764202045005007

52. Penner LA, Finkelstein MA. Dispositional and structural determinants of volunteerism. *Journal of Personality & Social Psychology*. 1998; 74: 525-537.

53. Ochieng BM**,** Kasej DCO, Wafula CO. The contributions of community based volunteers efforts towards Millennium Development Goals' in Nyando District, Kenyan. *Journal of Developing Countries Studies.* 2012; 2(5): 36-43. Web site. http://www.iiste.org/Journals/index.php/DCS/article/viewFile/1918/1898. Accessed September 29, 2016.

54. Finkelstein MA. Volunteer satisfaction and volunteer action: A functional approach. *Soc Behav Pers.* 2008; 36: 9-18. Web site. http://scholarcommons.usf.edu/psy_facpub/768/. Accessed September 29, 2016.

55. Carlson M, Charlin V, Miller N. Positive mood and helping behavior: A test of six hypotheses. *J Pers Soc Psychol.*1988; 55: 211-229.

56. Carmines EG, Zeller RA. Reliability and Validity Assessment. Thousand Oaks, CA, USA: Sage; 1979.

57. Beale AV. Exploring careers through volunteerism. *The School Counselor.* 1984; 32. 68-71. Web site. http://www.jstor.org/stable/23900068?seq=1#page_scan_tab_contents. Accessed September 29, 2016.

58. Becker GS. *Human Capital: A Theoretical and Empirical*

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-119

Analysis, With Special Reference to Education. New York, NY, USA: Columbia University Press; 1964.

59. Gidron B. Volunteer work and its rewards. *Volunt Adm.* 1978; 11: 18-32.

60. Clary EG, Snyder M, Ridge R. Volunteers motivations: A functional strategy for the recruitment, placement, and retention of volunteers. *Nonprofit Manag Leadersh.* 1992; 2: 333-350. doi: 10.1002/nml.4130020403

61. Penner LA. Dispositional and organizational influences on sustained volunteerism: An interactionist perspective. *J Soc Issues*. 2002; 58: 447-467. doi: 10.1111/1540-4560.00270

62. Cheng YY, Chan MM, Kwong J, et al. The good old days and a better tomorrow: Historical representations and future imaginations of China during the 2008 Olympic games. *Asian J Soc Psychol*. 2010; 13: 118-127. doi: 10.1111/j.1467-839X.2010.01307.x

63. Cheng YY, Chen X, Chiu CY. Cultural identity and preference for local *vs*. foreign cultures. Paper presented at the Guanghua School of Management, Peking University, Beijing China. 2009.

64. Kironde S, Banjunirwe F. Lay workers in directly observed treatment (DOT) programmes for tuberculosis in high burden settings: Should they be paid? A review of behavioral perspectives. *African Health Science.* 2002; 2(2): 73-78. Web site. http://www.ajol.info/index.php/ahs/article/view/6798/0. Accessed September 29, 2016.

65. Kaseke E, Dhemba J. Five-country study on service and volunteering in Southern Africa. *Zimbabwe Country Report.* 2006.

PSYCHOLOGY AND COGNITIVE SCIENCES

Openventio PUBLISHERS

ISSN 2380-727X

Open Journal

http://dx.doi.org/10.17140/PCSOJ-3-120

Research

*Corresponding author
Paul H. Falcone, MS
MusclePharm Sports Science Institute
4721 Ironton St., Building A
Denver, CO 80239, USA
Tel. (303) 396-6105
Fax: (800) 490-7165
E-mail: paul@musclepharm.com

Volume 3 : Issue 1
Article Ref. #: 1000PCSOJ3120

Article History
Received: November 30th, 2016
Accepted: January 11th, 2017
Published: January 11th, 2017

Citation
Falcone PH, Tai C-Y, Carson LR, et al. The effect of mild dehydration induced by heat and exercise on cognitive functiona. *Psychol Cogn Sci Open J.* 2017; 3(1): 17-23. doi: 10.17140/PCSOJ-3-120

The Effect of Mild Dehydration Induced by Heat and Exercise on Cognitive Function

Paul H. Falcone, MS[1*]; Chih-Yin Tai, EdD[1]; Laura R. Carson, BS[1]; Jesse A. Gwinn, BA[1]; Tyler R. Mccann, BA[1]; Nick J. Loveridge, BA[1]; Jordan R. Moon, PhD[2]

[1]MusclePharm Sports Science Institute, 4721 Ironton St., Building A, Denver, CO 80239, USA
[2]American Public University System, School of Health Sciences, Charles Town, WV, USA

ABSTRACT

Background: Past studies have demonstrated cognitive impairment after dehydration, though results are not always consistent. Methodological differences may account for these discrepancies. Therefore, the purpose of the present study was to determine the effects of mild dehydration on various domains of cognitive function.
Methods: Twenty-seven men (n=14; 26.9±4.6 years; 176.3±6.6 cm; 79.1±9.0 kg) and women (n=13; 27.3±4.3 years; 171.0±6.5 cm; 66.5±4.5 kg) participated in the study. Subjects were dehydrated to approximately 2% body mass loss *via* treadmill running and sauna. Measurements were collected prior to and after dehydration. Cognitive function tests included: Finger tapping, symbol digit coding, Stroop, and shifting attention tests.
Results: Reaction time during the shifting attention test was significantly lower from pre-testing to post-testing (PRE: 882.67±126.59 ms; POST: 830.00±105.83 ms; p=0.0012). The Stroop reaction time was significantly lower from pre-testing to post-testing (PRE: 712.56±97.52 ms; POST: 671.63±97.21 ms; p=0.02). No significant changes were observed in any other measurements.
Conclusion: Dehydration may enhance cognitive functioning in the areas of Stroop reaction time and reaction time during the shifting attention test.

KEYWORDS: Reaction time; Executive function; Heat stress; Thermoregulatory; Amino acid.

INTRODUCTION

Water is an essential nutrient for many bodily systems and functions, such as regulation of body temperature, lubrication of joints, and optimal cardiovascular function.[1] Hydration is especially important in sports and physical activity, due to prodigious perspiration. However, dehydration is a common problem since many athletic individuals do not hydrate properly. Evidence supports the idea that dehydration leads to decrements in physical performance.[2-4] Regarding cognitive function, many researchers contend that dehydration leads to reduced cognitive function,[5-10] though the evidence is equivocal.[11-14]

One possible reason for the mixed results in the literature is that the methods for testing cognitive function are inconsistent among studies. Because there are many cognitive domains that contribute to cognitive function, some studies focused on specific domains. In many of the studies on athletic populations such as golfers,[10] soccer players,[15] and jockeys,[16] the testing methods were sport-specific to determine the effects of dehydration on the cognitive aspect of their specific sport. Task-specific outcomes are also seen among cognitive tests in military personnel.[9,13] While sport-specific testing methods may be ideal for elite athletes, they may not serve recreational or amateur athletes who lack the necessary level of expertise.

Conversely, many studies that tested a wider range of domains chose cognitive tests that may not be ideal for athletic individuals. Though reaction time has been included in many studies to date, researchers often focused on short- and long-term memory[5,6] or employed tests

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-120

that may not translate well to sport, such as perceptive discrimination *via* visual determination of line length.[7] More recently, studies have tested areas such as executive function[11] and sustained attention,[17,18] but a paucity of data exists in areas such as motor speed and psychomotor speed, which are essential for athletes and athletic individuals. More research needs to be conducted to establish a set of cognitive tests and/or cognitive domains that accurately measure the cognitive functions necessary for athletic performance.

Another reason for the mixed results in the literature is the variety of methods employed to achieve dehydration. Common interventions include: Water deprivation,[10,19] passive heat stress,[7,11,16] exercise,[11,14,20] combined exercise and heat,[5,6,12] and comparison of dehydration methods.[7,8] Since dehydration can result from various and multiple insults, various dehydration methods must be tested and should reflect the population being studied. In a sport context, most dehydration occurs during exercise in a hot environment; therefore, both exercise and heat should be employed to elicit dehydration to measure cognitive function in athletes of all levels.

Therefore, the purpose of the present study was to determine the effects of mild dehydration in recreational athletes elicited by a dehydration protocol employing both exercise and heat on various domains of cognitive function. Cognitive domains were chosen to be sport-specific and include: Psychomotor speed, reaction time, cognitive flexibility, processing speed, executive function, and motor speed. Our hypothesis was that mild dehydration would cause a decrement in cognitive function in all tests.

METHODS

Subjects

Twenty-seven men (n=14; age: 26.9±4.6 years; height: 176.3±6.6 cm; weight: 79.1±9.0 kg) and women (n=13; age: 27.3±4.3 years; height: 171.0±6.5 cm; weight: 66.5±4.5 kg) participated in the study. All individuals were recreationally trained, defined as exercising two or more times per week for at least one year, as assessed by an exercise status questionnaire. Subjects were free of cardiovascular disease, diabetes, or any other diseases that would exclude them from participation in the study, as assessed by a health history questionnaire. No medications or supplements that could interfere with the study had been consumed for at least one month prior to testing. All protocols for this study were approved by an Institutional Review Board and written informed consent was provided by the subjects prior to testing.

Experimental Design

Subjects arrived to the laboratory in the morning in a euhydrated state after an overnight fast. Subjects were also required to abstain from exercise for 24 hours prior to testing so that fatigue was not a factor. A urine sample was provided and measured for urine specific gravity *via* refractometry (Atago, Inc., Tokyo, Japan) to ensure hydration status. If the USG value was above 1.025, the subject was considered dehydrated and given 500 ml of water to drink in accordance with ACSM guidelines prior to testing to achieve euhydration at baseline. Urine color, body temperature and skin temperature were measured, followed by cognitive function testing. After baseline testing, subjects performed the dehydration protocol. Subsequently, all tests were repeated.

Dehydration

A combination of active dehydration *via* treadmill running and passive dehydration *via* sauna was employed to achieve dehydration. After baseline testing, subjects were required to run on a treadmill (Woodway, Inc., Waukesha, WI, USA) for 30 minutes at 80% maximum heart rate (206.9-(0.67*Age)).[21] Afterward, subjects sat in a sauna at 70 °C for 15 minute intervals until 2% body weight loss was attained, which is the value that performance decrements begin to occur.[22] Nude, dry body weight was measured between sauna intervals *via* calibrated scale to ensure that the body weight loss was as close to 2% as possible. When 2% body weight loss was achieved, subjects showered and dried their bodies completely. Nude, dry body weight was measured again and this weight was used as the post-dehydration body weight in the present study.

Measurements

All measurements were taken prior to and immediately following the dehydration protocol. After USG was measured, urine color was measured using a color chart developed by Armstrong and colleagues and validated in young athletes.[23,24] Body temperature *via* digital thermometer (American Diagnostic Corporation, Hauppauge, NY, USA) and skin temperature *via* forehead infrared thermometer (Telatemp Corp., Anaheim, CA, USA) were measured, immediately followed by cognitive function testing. Subjects sat at a computer and performed a variety of cognitive function tests (CNS Vital Signs Inc., Morrisville, NC, USA), including: Finger tapping test, symbol digit coding, Stroop test, and shifting attention test. The CNS Vital Signs test battery was chosen for its high reliability,[25] lack of a learning effect,[25] and the application of its tests to sports performance. The finger tapping test requires subjects to tap the space bar with their right hand as many times as they can in ten seconds. The test is repeated with the left hand, and two trials are performed with each hand. The symbol digit coding test involves a serial presentation of symbols and empty boxes below, along with a legend at the top that designates a number to correspond with each possible symbol. Subjects must enter the number that corresponds with the highlighted symbol. The stroop test consists of three parts. In the first part, the words RED, YELLOW, BLUE and GREEN appear at random on the screen and the subject responds as quickly as possible by hitting the space bar (simple reaction time). In the second part, the words RED, YELLOW, BLUE and GREEN appear in color on the screen randomly and the subject responds

ISSN 2380-727X
http://dx.doi.org/10.17140/PCSOJ-3-120

only when the color matches the word (complex reaction time). In the third part, the words RED, YELLOW, BLUE and GREEN appear in color on the screen randomly and the subject responds only when the color does not match the word (Stroop reaction time). The shifting attention test involves three geometric figures on a screen – one on the top and two on the bottom. The top figure is either a square or a circle. The bottom figures are a square and a circle. The figures are either red or blue (color is randomized). Subjects must match one of the bottom figures with the top figure *via* arrow keys. The rules of matching are changed randomly (either by color or by shape). Each test started with a practice test to ensure familiarization with the test protocol. The testing room was free of distraction and extraneous noise. A total of 11 outcome variables were collected from each subject, which were then used to calculate 6 cognitive domains (Figure 1).

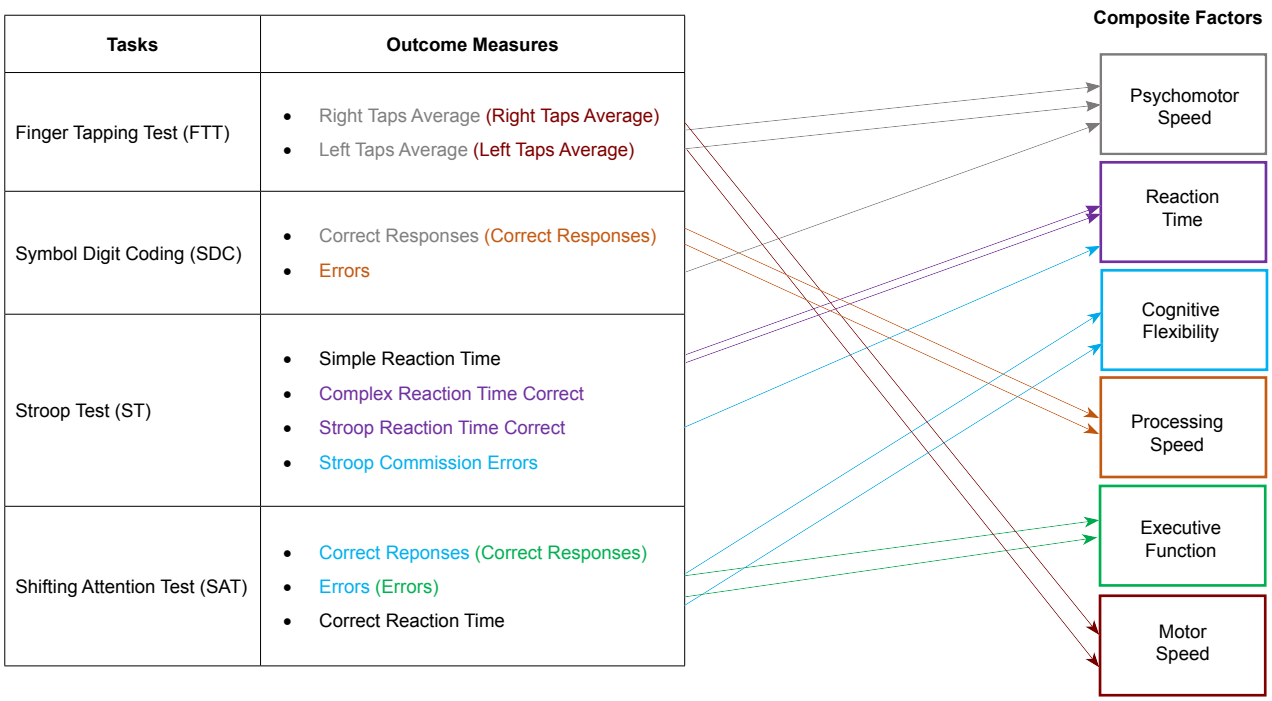
Statistics

All data were analyzed using SPSS software (Version 20.00, SPSS Inc., Chicago, IL, USA). Dependent *t*-tests were used to calculate time differences between pre- and post-dehydration cognitive function. Since multiple pairwise tests were being performed on the same set of data, a Bonferroni correction was used to adjust the *p* value. Therefore, significance was set at $p \leq 0.0029$.

RESULTS

Mild dehydration was achieved in all subjects (weight lost: 1.51±0.27 kg; percent dehydration: 2.11±0.32%). Significant differences were observed for urine specific gravity values (PRE: 1.008±0.008; POST: 1.015±0.009; p=0.00006) and for urine color (PRE: 3.22±1.27; POST: 4.17±1.30; p=0.018). No significant differences were observed for body temperature (PRE: 36.29±0.21 °C; POST: 36.29±0.19 °C; p>0.05) or for skin temperature (PRE: 34.28±0.60 °C; POST: 34.08±1.30 °C; p>0.05). All results for cognitive domains and specific test results can be found in Table 1. Significant differences were not demonstrated in any of the six cognitive domains measured: psychomotor speed (PRE: 203.74±23.50; POST: 207.48±27.29; p>0.05); reaction time (PRE: 658.48±63.38ms; POST: 645.67±95.85ms; p>0.05); cognitive flexibility (PRE: 53.22±8.82; POST: 53.93±7.82; p>0.05); processing speed (PRE: 83.11±14.20; POST: 86.04±17.17; p>0.05); executive functioning (PRE: 54.93±8.32; POST: 55.74±7.09; p>0.05); motor speed (PRE: 119.33±13.50; POST: 119.56±16.26; p>0.05). Regarding specific tests, two measurements demonstrated a significant difference from pre to post at $p \leq 0.05$, and one measurement demonstrated a significant difference according to the Bonferroni correction ($p \leq 0.0029$). The reaction time during the shifting attention test was significantly lower at post-testing, compared to pretesting (PRE: 882.67±126.59ms; POST: 830.00±105.83 ms; p=0.0012).The Stroop reaction time during the Stroop test was significantly lower at post-testing, compared to pretesting (PRE: 712.56±97.52 ms; POST: 671.63±97.21 ms; p=0.02), but was not significant when the Bonferroni correction was applied. No significant changes were observed in any other measurements during specific tests.

Figure 1: Cognitive Function Domains Diagram. The Computerized Cognitive Function Test Battery (CNS Vital Signs, Morrisville, NC, USA) is Summarized, Indicating How Tests are Separated into Specific Outcomes, and which Outcomes Contribute to each Cognitive Domain. Colors Correspond with Arrows and Outlines of Cognitive Domains, and Repeated Outcomes Indicate that they Correspond with more than One Domain.



Openventio PUBLISHERS

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-120

Table 1: Summary Data for Cognitive Function Domains and Specific Test Results before and after Dehydration.

		Mean	SD	Mean Difference	*p* Value	Effect Size (d)
Psychomotor speed	Pre	203.74	23.50	3.74	0.16	0.14
	Post	207.48	27.29			
Reaction time†	Pre	658.48	63.38	-12.81	0.33	0.24
	Post	645.67	95.85			
Cognitive flexibility	Pre	53.22	8.82	0.70	0.49	0.36
	Post	53.93	7.82			
Processing speed	Pre	83.11	14.20	2.93	0.13	0.54
	Post	86.04	17.17			
Executive functioning	Pre	54.93	8.32	0.81	0.45	0.47
	Post	55.74	7.09			
Motor speed	Pre	119.33	13.50	0.22	0.89	0.04
	Post	119.56	16.26			
Finger tapping test: right taps average	Pre	62.63	7.60	-0.48	0.63	0.22
	Post	62.15	10.38			
Finger tapping test: left taps average	Pre	56.33	7.18	1.04	0.27	0.72
	Post	57.37	7.11			
Symbol digit coding: correct	Pre	84.41	14.69	2.52	0.19	0.44
	Post	86.93	17.58			
Symbol digit coding: errors†	Pre	1.30	1.81	0.22	0.54	2.59
	Post	1.52	1.31			
Stroop: simple reaction time†	Pre	345.93	41.87	-6.70	0.45	0.25
	Post	339.22	49.02			
Stroop: complex reaction time†	Pre	604.78	69.24	14.52	0.46	0.22
	Post	619.30	123.46			
Stroop: Stroop reaction time†	Pre	712.56	97.52	-40.93	0.02*	0.55
	Post	671.63	97.21			
Stroop: commission errors†	Pre	1.67	1.57	0.15	0.75	0.99
	Post	1.81	2.48			
Shifting attention test: correct	Pre	57.74	6.65	1.48	0.07	1.29
	Post	59.22	5.77			
Shifting attention test: errors†	Pre	2.81	2.56	0.67	0.08	3.75
	Post	3.48	2.05			
Shifting attention test: reaction time†	Pre	882.67	126.59	-52.67	0.00121**	0.53
	Post	830.00	105.83			

*indicates post significantly different from pre at $p \leq 0.05$. **indicates post significantly different from pre at $p \leq 0.0029$. †indicates tests in which a lower score is better.

DISCUSSION

In contrast to our hypothesis, the main findings of the present study indicated that Stroop reaction time during the Stroop test and reaction time during the shifting attention test were enhanced by a sport-specific dehydration protocol employing both heat and exercise, and reaction time during the shifting attention test was significantly different even after the Bonferroni correction was applied. Previous studies have generally found that dehydration caused a decrement in cognitive function[5-10] or that no significant changes occurred.[13-15,18,19,26] However, three studies did demonstrate cognitive improvement after dehydration.[11-13] It is possible that the differences among cognitive function assessment tools and domains contributed to the discrepancy in findings. For example, Tomporowski and associates[11] employed a category-switching task developed by Kramer[27] that is very similar to the shifting attention test in the present study. Reaction times were faster after exercise in the Tomporowski study, regardless of whether subjects were 3% dehydrated or if fluid replacement kept them hydrated, which supports the faster reaction times during the shifting attention test in the present study. Also, errors significantly increased after exercise during the category-switching task when the response required the subject to switch categories, i.e. when the task became more complex, as opposed to a non-switching response.[11] Similarly, there was a trend observed for errors (p=0.08) on the shifting attention test

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-120

in the present study. Therefore, consistency in testing methods is essential in order to compare results among studies.

In other studies that tested for reaction time, results were either positive or not significant. Leibowitz et al[12] induced either 2.5% or 5% dehydration using exercise performed in a heat chamber, which improved reaction time in response to peripheral stimuli but no change in response to central stimuli. In a marksmanship test in volunteer soldiers, response time between target presentation and firing of the rifle improved after exercise with no effect from 2.6% dehydration.[13] Cullen et al[16] observed no effect of 4% dehydration on choice reaction time in jockeys, which was supported in other studies employing water deprivation to achieve 1.5% and unreported dehydration, respectively.[10,19] Though the literature is not conclusive, it is interesting to note that most of the studies that demonstrated cognitive decrements did not test for reaction time.[5,6,9,10] In the study by Cian and associates where cognitive decrements were observed after 2.7% dehydration and choice reaction time was measured, cognitive function worsened in perceptual discrimination and short-term and long-term memory, but no changes were observed in choice reaction time.[7] Therefore, it seems plausible that choice reaction time is a cognitive domain that is insensitive to dehydration or is improved in some cases of exercise-induced dehydration.

Since there are a variety of cognitive domains that contribute to cognitive function, it is important to test domains that are specific to the population and the outcomes of interest. In healthy, active individuals, there are many possible outcomes of interest, such as quality of life, decreased risk for chronic disease, and improvements in work output, school performance, and sports performance. Cognitive domains such as short- and long-term memory may be more applicable to quality of life and school performance, whereas choice reaction time and motor skills may be more applicable to sports performance. The domains chosen for the present study were derived from previous studies in athletes to translate to sports performance. Bandelow et al[15] tested soccer players on the same motor skills test (finger tapping test) and with a choice reaction time test that tested the same cognitive domain as the complex reaction time section of the Stroop test.[15] Triathletes were tested for simple and choice reaction time, which are tested in the Stroop test.[28] Track and field athletes were tested on a variety of executive and non-executive tasks to determine the effects of exercise on executive function, which was tested *via* the shifting attention test in the present study.[29]

Interestingly, Stroop reaction time was the only reaction time test measured by the Stroop test that demonstrated improvements, though it is the most complex. Stroop reaction time measures the responses in the third part of the Stroop test, where a response must be given when the color of the word does not match the word written. This was a novel finding since it suggested that the subjects' ability to respond to rapidly changing and increasingly complex sets of directions was improved, and other researchers have suggested that an attenuation of exercise-induced cognitive benefits occurs as complexity increases, because more errors were made in tasks that required subjects to shift decision-making rules.[11] This was not the case in the present study, in which the most robust effect was observed from the shifting attention test, which was significant even after the Bonferroni correction was applied.

Another area of discrepancy in the literature is the method of dehydration. Various methods of dehydration are employed in studies, and dehydration methods should reflect how dehydration occurs in specific populations. For example, fluid deprivation is probably the most common method by which dehydration occurs in everyday life. In most athletic situations involving dehydration, both heat and exercise play a role. In military, tactical and sport contexts, intense exercise is often performed in hot, humid conditions. Therefore, dehydration protocols may be more applicable to sport when heat and exercise are both employed, even though studies have not demonstrated significant differences between deprivation methods.[7,8] Since exercise was employed as a method of dehydration in the present study, the cognitive improvements may have been caused by the exercise and not the dehydration. Multiple studies have demonstrated improved cognitive function after exercise.[9,20,30-32] For example, Nanda et al[30] elicited improvements in memory, reasoning, and planning after 30 minutes of cycling at 70% of heart rate reserve.[30] Hillman and associates found that amplitude of event-related brain potential increased after 30 minutes of treadmill running,[20] which involved a similar exercise bout as employed by the present study. One possible mechanism is that exercise increases blood flow to the brain, which has been linked to improvements in cognitive function.[33] The exercise-induced dehydration may have elicited positive cholinergic effects, as demonstrated in an animal study by Fordyce et al.[34] Though exercise may be contributing to the cognitive benefits, it is important to note that not all exercise-induced dehydration studies demonstrated improvements.[5,33]

There are limitations regarding interpretation of the findings of the present study. First, the combination of exercise and heat stress in the dehydration protocol limits the ability to determine whether exercise or dehydration is causing the improvements, though employing both dehydration methods was important to apply the dehydration to sport contexts. Second, our null results and trends may be non-significant due to small data set size. Third, the subjects were athletic, active individuals, but were not collegiate or professional athletes. Therefore, it is difficult to determine whether the findings would apply to highly athletic men and women. Future studies investigating dehydration and cognitive function need to enlist elite athletes in various sports to support the use of sport-specific cognitive testing methods and dehydration protocols.

CONCLUSION

In summary, mild dehydration caused by both exercise and heat

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-120

exposure enhanced Stroop reaction time during the Stroop test. Second, reaction time during the shifting attention test was significantly different after dehydration, even after the Bonferroni correction was applied. These findings have military, tactical, and sport applications, in which athletes and athletic individuals are often performing at various levels of dehydration caused by both heat and exercise, and require optimal cognitive functioning in multiple, specific areas. Also, weight-class athletes may employ both exercise and sauna to achieve weight loss, which may induce quicker reaction times when the dehydration is mild. More research is needed to elucidate the precise areas of cognitive function that improve or decline as a result of mild dehydration, and whether elite athletes will demonstrate the same improvements as athletic individuals.

ACKNOWLEDGEMENTS

We would like to thank MusclePharm Inc., for funding for this study. Citation of commercial organizations or products does not constitute endorsement by the authors.

CONFLICTS OF INTEREST

The authors declared that they have no conflicts of interest.

REFERENCES

1. Hellwig JP, Otten JJ, Meyers LD. *Dietary Reference Intakes: The Essential Guide to Nutrient Requirements*. Washington DC, USA; National Academies Press; 2006.

2. Institute of Medicine of the National Academies. *Electrolytes, and Water, DRI. Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate*. Wshington DC, USA: National Academy Press; 2005.

3. American College of Sports Medicine, Sawka MN, Burke LM, et al. Exercise and fluid replacement. *Med Sci Sports Exerc*. 2007; 39(2): 377-390. doi: 10.1249/mss.0b013e31802ca597

4. Judelson DA, Maresh CM, Farrell MJ, et al. Effect of hydration state on strength, power, and resistance exercise performance. *Med Sci Sports Exerc*. 2007; 39(10): 1817-1824. doi: 10.1249/mss.0b013e3180de5f22

5. Gopinathan PM, Pichan G, Sharma VM. Role of dehydration in heat stress-induced variations in mental performance. *Arch Environ Health*. 1988; 43(1): 15-17. doi: 10.1080/00039896.1988.9934367

6. Sharma VM, Sridharan K, Pichan G, Panwar MR. Influence of heat-stress induced dehydration on mental functions. *Ergonomics*. 1986; 29(6): 791-799. doi: 10.1080/00140138608968315

7. Cian C, Barraud PA, Melin B, Raphel C. Effects of fluid ingestion on cognitive function after heat stress or exercise-induced dehydration. *Int J Psychophysiol*. 2001; 42(3): 243-251.

8. Cian C, Koulmann N, Barraud PA, Raphel C, Jimenez C, Melin B. Influences of variations in body hydration on cognitive function: Effect of hyperhydration, heat stress, and exercise-induced dehydration. *J Psychophysiol*. 2000; 14(1): 29-36. doi: 10.1027//0269-8803.14.1.29

9. Lindseth PD, Lindseth GN, Petros TV, Jensen WC, Caspers J. Effects of hydration on cognitive function of pilots. *Mil Med*. 2013; 178(7): 792-798. doi: 10.7205/MILMED-D-13-00013

10. Smith MF, Newell AJ, Baker MR. Effect of acute mild dehydration on cognitive-motor performance in golf. *J Strength Cond Res*. 2012; 26(11): 3075-3080. doi: 10.1519/JSC.0b013e318245bea7

11. Tomporowski PD, Beasman K, Ganio MS, Cureton K. Effects of dehydration and fluid ingestion on cognition. *Int J Sports Med*. 2007; 28(10): 891-896. doi: 10.1055/s-2007-965004

12. Leibowitz HW, Abernethy CN, Buskirk ER, Bar-or O, Hennessy RT. The effect of heat stress on reaction time to centrally and peripherally presented stimuli. *Hum Factors*. 1972; 14(2): 155-160. Web site. http://journals.sagepub.com/doi/abs/10.1177/001872087201400205. Accessed November 29, 2016.

13. Adam GE, Carter R 3rd, Cheuvront SN, et al. Hydration effects on cognitive performance during military tasks in temperate and cold environments. *Physiol Behav*. 2008; 93(4-5): 748-756. doi: 10.1016/j.physbeh.2007.11.028

14. Armstrong LE, Ganio MS, Casa DJ, et al. Mild dehydration affects mood in healthy young women. *J Nutr*. 2012; 142(2): 382-388. doi: 10.3945/jn.111.142000

15. Bandelow S, Maughan R, Shirreffs S, et al. The effects of exercise, heat, cooling and rehydration strategies on cognitive function in football players. *Scand J Med Sci Sports*. 2010; 20(Suppl 3): 148-160. doi: 10.1111/j.1600-0838.2010.01220.x

16. Cullen S, Dolan E, McGoldrick A, et al. The impact of making-weight on cognitive performance in apprentice jockeys. *J Sports Sci*. 2015; 33(15): 1589-1595. doi: 10.1080/02640414.2014.1002104

17. Ganio MS, Armstrong LE, Casa DJ, et al. Mild dehydration impairs cognitive performance and mood of men. *Br J Nutr*. 2011; 106(10): 1535-1543. doi: 10.1017/S0007114511002005

18. Ely BR, Sollanek KJ, Cheuvront SN, Lieberman HR, Kenefick RW. Hypohydration and acute thermal stress affect mood state but not cognition or dynamic postural balance. *Eur J Appl Physiol*. 2013; 113(4): 1027-1034. doi: 10.1007/s00421-012-2506-6

19. Neave N, Scholey AB, Emmett JR, Moss M, Kennedy DO, Wesnes KA. Water ingestion improves subjective alertness, but has no effect on cognitive performance in dehydrated healthy

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-120

young volunteers. *Appetite*. 2001; 37(3): 255-256. doi: 10.1006/appe.2001.0429

20. Hillman CH, Snook EM, Jerome GJ. Acute cardiovascular exercise and executive control function. *Int J Psychophysiol*. 2003; 48(3): 307-314. doi: 10.1016/S0167-8760(03)00080-1

21. Jackson AS. Estimating maximum heart rate from age: Is it a linear relationship? *Med Sci Sports Exerc*. 2007; 39(5): 821. doi: 10.1249/mss.0b013e318054d3ca

22. Sawka MN, Cheuvront SN, Kenefick RW. Hypohydration and human performance: Impact of environment and physiological mechanisms. *Sports Med*. 2015; 45(Suppl 1): S51-S60. doi: 10.1007/s40279-015-0395-7

23. Armstrong LE, Soto JA, Hacker FT Jr, Casa DJ, Kavouras SA, Maresh CM. Urinary indices during dehydration, exercise, and rehydration. *Int J Sport Nutr*. 1998; 8(4): 345-355. Web site. https://www.infona.pl/resource/bwmeta1.element.elsevier-edd78b3e-3323-3fbb-8d6e-050dae3adc03. Accessed November 29, 2016.

24. Armstrong LE, Maresh CM, Castellani JW, et al. Urinary indices of hydration status. *Int J Sport Nutr*. 1994; 4(3): 265-279.

25. Gualtieri CT, Johnson LG. Reliability and validity of a computerized neurocognitive test battery, CNS Vital Signs. *Arch Clin Neuropsychol*. 2006; 21(7): 623-643. doi: 10.1016/j.acn.2006.05.007

26. Szinnai G, Schachinger H, Arnaud MJ, Linder L, Keller U. Effect of water deprivation on cognitive-motor performance in healthy men and women. *Am J Physiol Regul Integr Comp Physiol*. 2005; 289(1): R275-R280. doi: 10.1152/ajpregu.00501.2004

27. Rogers WA, Fisk AD. *Human Factors Interventions for the Health Care of Older Adults*. CRC Press; 2001.

28. Collardeau M, Brisswalter J, Vercruyssen F, Audiffren M, Goubault C. Single and choice reaction time during prolonged exercise in trained subjects: Influence of carbohydrate availability. *Eur J Appl Physiol*. 2001; 86(2): 150-156. doi: 10.1007/s004210100513

29. Luft CD, Takase E, Darby D. Heart rate variability and cognitive function: Effects of physical effort. *Biol Psychol*. 2009; 82(2): 164-168. doi: 10.1016/j.biopsycho.2009.07.007

30. Nanda B, Balde J, Manjunatha S. The acute effects of a single bout of moderate-intensity aerobic exercise on cognitive functions in healthy adult males. *J Clin Diagn Res*. 2013; 7(9): 1883-1885. doi: 10.7860/JCDR/2013/5855.3341

31. Liu YF, Chen HI, Wu CL, et al. Differential effects of treadmill running and wheel running on spatial or aversive learning and memory: Roles of amygdalar brain-derived neurotrophic factor and synaptotagmin I. *J Physiol*. 2009; 587 (Pt 13): 3221-3231. doi: 10.1113/jphysiol.2009.173088

32. Lin TW, Chen SJ, Huang TY, et al. Different types of exercise induce differential effects on neuronal adaptations and memory performance. *Neurobiol Learn Mem*. 2012; 97(1): 140-147. doi: 10.1016/j.nlm.2011.10.006

33. Critchley HD, Corfield DR, Chandler MP, Mathias CJ, Dolan RJ. Cerebral correlates of autonomic cardiovascular arousal: A functional neuroimaging investigation in humans. *J Physiol*. 2000; 523(Pt 1): 259-270. doi: 10.1111/j.1469-7793.2000.t01-1-00259.x

34. Fordyce DE, Farrar RP. Enhancement of spatial learning in F344 rats by physical activity and related learning-associated alterations in hippocampal and cortical cholinergic functioning. *Behav Brain Res*. 1991; 46(2): 123-133. doi: 10.1016/S0166-4328(05)80105-6

PSYCHOLOGY AND COGNITIVE SCIENCES

Openventio PUBLISHERS

ISSN 2380-727X

Open Journal

http://dx.doi.org/10.17140/PCSOJ-3-121

Research

*Corresponding author
Enrico Bignetti, MD
Professor of Clinical Biochemistry and Molecular Biology
Department of Veterinary Sciences
University of Parma
Via del Taglio 10
Parma 43126, Italy
Tel. +39 0521 032710
E-mail: Enrico.bignetti@unipr.it; biriko@icloud.com

Volume 3 : Issue 1
Article Ref. #: 1000PCSOJ3121

Article History
Received: December 24th, 2016
Accepted: February 2nd, 2017
Published: February 3rd, 2017

Citation
Bignetti E, Martuzzi F, Tartabini A. A psychophysical approach to test: "The bignetti model". *Psychol Cogn Sci Open J*. 2017; 3(1): 24-35. doi: 10.17140/PCSOJ-3-121

A Psychophysical Approach to Test: "The Bignetti Model"

Enrico Bignetti, MD[1*]; Francesca Martuzzi, MD[2]; Angelo Tartabini, MD[3]

[1]Department of Veterinary Sciences, University of Parma, Via del Taglio 10, Parma 43126, Italy
[2]Department of Food Science, University of Parma, Via del Taglio 10, Parma 43126, Italy
[3]Department of Neurosciences, University of Parma, Via del Taglio 10, Parma 43126, Italy

ABSTRACT

The cognitive "Bignetti Model" (TBM) thoroughly discussed elsewhere, shares a strong analogy with "Learning Through Experience" (LTE) and Bayesian Learning Process (BLP). Here, TBM's theory is challenged by means of a psychophysical press/no-press decision task (DT). Participants must press a computer key in response to sweet food image (SWEET) or refrain from doing it with a salted food image (SALTED) (24 trials each, mixed at random in a 48-trial DT). Reaction times (RT) plotted as a function of trials decrease exponentially according to a well-known "intertrial priming" effect. When 1 SWEET is repeated 24 times per DT, RTs tend to a minimal value that corresponds to the fastest, instinctive RT the participant can exhibit when engaged in a traffic light-based task. Interestingly, the more we change SWEET images, the greater are the final RTs in a DT (this disturbance is not seen by changing SALTED images). It is proposed that the increase of motivational incentives along the task may foster the learning process. In the presence of SWEET distractors this process is impaired due to a short-term memory mismatch between increasing targets of similar semantics. These results are compatible both with the current literature and TBM.

KEYWORDS: The Bignetti Model (TBM); Learning Through Experience (LTE); "Press-no-press" task; Distractors; Non-competitive inhibition.

ABBREVIATIONS: TBM: The Bignetti Model; FW: Free-Will; LTE: Learning Through Experience; BLP: Bayesian Learning Process; RT: Reaction Time; SRT: Simple Reaction Time; M&M: Michaelis and Menten Enzyme Kinetics.

INTRODUCTION

"The Bignetti Model" (TBM)

"The Bignetti Model" (TBM) is a comprehensive approach that considers cognition as a pure neurobiological process (see Appendix). In TBM, Self and Free Will (FW) are self-feeding illusions of the mind with a functional role in cognition.[1-7]

In the past, the discussion on TBM has been conducted on a purely theoretical basis; now, the theory needs to be validated applying a suitable experimental approach. The main TBM's feature that must be challenged is: individual reactions to "repetitive" stimuli should become increasingly efficient, due to an ongoing learning process. On the other hand, if different stimuli are introduced in the previous sequence, just as distractors of the ongoing learning process, action-decision making should be slowed down.

Psychophysical methods mostly investigate the reaction time (RT) of a subject exposed to a well-known physical signal. RT is considered a basic measure of mental processing speed. With the advent of experimental psychology in the 19th century, Ebbinghaus[8] estab-

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-121

lished that the learning process occurring in a problem-solving paradigm undoubtedly works alongside with experience. Since Ebbinghaus,[8] problem solving has been evaluated using the "learning curves", psychophysical methods still remain valuable tools to investigate a learning process in a subject exposed to a specific experience.

According to both TBM features and hints from psychophysical bibliography, a "press/no-press" visual test was set up. If preliminary results reveal the presence of an experience-dependent learning process, compatible with TBM, this makes reasonable to address a bottom-up investigation to neural correlates. It is a matter of fact that the neuronal correlates of the learning curve remain undefined so further investigations with electrophysiology or imaging techniques are needed.[9-17]

METHODS

Food Items and "Press-No-Press" Decision-Tasks (DT)

The decision task (DT) was carried out by means of a dedicated software running on a normal desk-computer, developed by M2 Scientific Computing srl The original software was home-made modified in order to fit the data in accordance to enzyme kinetic equations.[7]

The general scheme of DT is reported in Figure 1. It is devised to carry out 48 sequential trials per DT; at each session, a black and white (b/w) drawing of sweet food image (SWEET) or salted food image (SALTED) is projected onto the computer screen for 40 milliseconds (msec). Subjects must press the space bar as soon as possible in response to SWEET; otherwise, they must refrain from pressing the bar. In a one second time lapse, the machine can acquire the RT given. Then, it appears the instruction to press in 4 seconds the bar again in case the participant thinks he has made a mistake (in either direction). Afterwards, a new trial begins.

DTs of increasing complexity are composed as it follows:

- DT-1: 1 SWEET and 1 SALTED are presented 24 times each;
- DT-2: 8 different SWEET and 8 different SALTED, repeated 3 times each, are presented;
- DT-3: 24 different SWEET and 24 different SALTED are presented 24 times each.

The 48 sessions are randomly mixed. The three paradigms correspond to three-levels of complexity increased by reducing the recurrence of identical images and adding novel ones.

To understand whether the presence of sessions with SALTED may cause a cross-interference with RTs recorded, preliminary control tests were carried out:

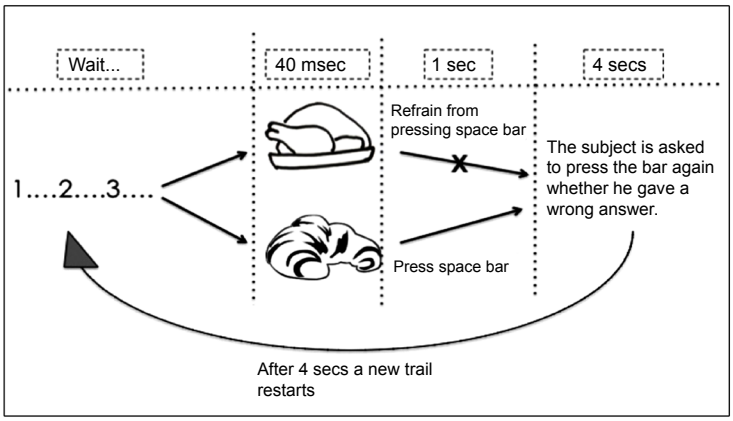
- DT-1c: only one single SWEET is repeated for 24 sessions; whereas, the 24 SALTED images are all different (shown).
- A series of DTs with paradigms specular to those descripted above: i.e., "press" action response to SALTED instead of SWEET; the results did not show any significant difference (not shown).

Participants: Selection and Test Directions

It is clear from the literature that the most critical parameter to keep under control in DT's subjects is age homogeinity[11-15]; to this aim, University students (n=110) in age from 19 to 21 years of both sexes (at this age, the performance is gender independent) have been selected.

The subjects were chosen among compulsory attendance students with an optimum didactic career: this, as a principle, can exclude the use of drugs or other addictions, condition which was not possible to investigate. Then, the subjects are

Figure 1. Sequence and Timing of Events Describing the Paradigm of "Press-No-Press" Decision-task (DT). The Basic Paradigm is Made of 48 Trials: 24 with b/w Sweet Food Images of and 24 with b/w Salted Food Images. Trials are Presented in Random Sequence. Complex Paradigms are Obtained by Changing Images Trial after Trial.



ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-121

evenly distributed in three DTs and engaged in the 48 sessions per task only once. The authors do not direct the participants in the test; the instructions on how to proceed are given only by the software.

Food B/W Images and Mental Processes Associated

During each trial, a single b/w image of SWEET or SALTED is presented to the subject for about 40 msec. The subject should decide to press or refrain from pressing the bar key of the computer on perception of SWEET or SALTED, respectively.

A subject should decide a response provided, by control experiments, that: 1) The items are clearly visualized on the screen; 2) The images are already well encoded in the subject's long-term memory and 3) The subject's age is conducive to easy recall. The following prerequisites were chosen:

- B&W drawings of traditional Italian foods that are unequivocally considered SWEET or SALTED are used as visual stimuli. In order to choose these drawings, control subjects (i.e., students different from DT's subjects) are engaged in a recognition panel to select a series of food images popular and well coded in long-term memory.
- The reason why SWEET and SALTED images are used is that: 1) The gustatory sensation of a food is easily evoked by its image;[18] 2) Sweet, salty and sour are our predominant gustatory perceptions, having the lowest thresholds;[19,20] however, sour foods have been removed from the series of cues, being untypical in Italian cuisine; 3) Among visual, gustatory or olfactory stimuli, the visual paradigm is the most robust and the simplest method of stimulation.[17]
- B&W drawings with neat contours and few or no shading can facilitate immediate recognition, by means of a mental process named "continuity".[21] Time needed to identify each stimulus on the computer screen, has been estimated to be less than 40 msec by means of control experiments carried out with different subjects.
- The real scope of DTs is being withheld to participants to avoid self-conditioning prejudices. Moreover, the instructions they read before starting the test are given to focus their interest on reaction times with no importance to food. Now-a-days, the relationship between food, diet and health is a major topic of the media.[22,23] Obviously, such scope is totally out of the interests of this work.

Traffic-Lighter Control Test (R&G-Dt)

At the end of DT sessions, the software visualizes a new instruction inviting every participant to be engaged in the press/no-press traffic-lighter test, also named the "red & green decisional task" (R&G-DT). This test starts with a stable red spot on the screen; then, after a waiting time that varies randomly from 1 to 6 seconds, the spot turns to green in few msec. With the green light, participants must press the enter key, the fastest as possible for several repetitive sessions. By means of R&G-DT "simple" reaction times (SRT), subjects' fastest, instinctive reflex is measured. Then, the authors feel authorized to consider participants' RT as instinctual and automatic when they tend to SRTs.

This task has been introduced, primarily, as an easy method to calibrate the overall system. Moreover, a comparison between SRT and DTs', RT might reveal interesting differences between instinctive reflexes and voluntary reactions.

Michaelis-&-Menten's (M&M) Enzyme Kinetic Equations as a Tool for Interpreting Dts' Data

In analogy with many biological systems (e.g., TBM), reactions between enzymes (E_t) and substrates (S) exhibit a probabilistic behaviour *per se*; although, they can be deterministically predicted by M&M's kinetic equations,[24,25] when the reactions are carried out in "steady-state" conditions (i.e. [S] variable, $[E_t]$ constant and $[S]>>[E_t]$).[5,6] The general M&M's kinetic equation (Figure 2, top, left) is:

$$V_i = [S]\, V_{Max}/(K_M+[S])[E_t].$$

According to this equation:

- The rate V_i hyperbolically tends to V_{max} for $[S]\rightarrow\infty$ (Figure 2, top right).
- V_i trend corresponds to the "probability" of substrate-dependent enzyme saturation and reaction (varying from 0% to 100%).
- "M&M constant" K_M indicates the concentration [S] at which $V_i=V_{max}/2$ (50% of "probability).
- The presence of inhibitors in enzyme kinetics can be evidenced by re-plotting the hyperbolic M&M's curves according to a "double-reciprocal" function (Figure 2, below left). "Non-competitive" inhibition is a specific case in which V_{max} decreases, whereas, K_M remains constant as the inhibitor concentration is increased (Figure 2, below right).

The curves of DT-1, DT-2 and DT-3 are analysed by means of enzyme kinetic equations, provided some assumptions are adopted: $[E_t]$ stands for the participant, [S] for the number of trials *N*, V_i for RTs and [I] for the number of SWEET images that play the role of distractors in DT-2 and DT-3, i.e., 8 and 24 respectively.

RESULTS

Examples of Individual Performances

Figure 3 reports RTs of two individuals engaged in DT-1 and DT-1c. The trials per task are 48 but RTs in response to SWEET stimuli are ≤24 points on each curve (the errors are excluded). Moreover, the total errors made by every participant are very few (≤3%); they are calculated by summing both incorrect responses to SALTED and the correct responses to SWEET but

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-121

Figure 2: By Using the General "Michaelis&Menten"' Assumptions (top-left), a Hyperbolic Curve of Enzyme Initial Velocity (V_i) as a Function of Substrate Concentration ([S]) can be Obtained (top-right). In the Presence of "Non-competitive" Inhibitors, Non-productive Ternary Complexes are Formed (below-left) thus Subtracting the Enzyme from the Active Stream. By Plotting $1/V_i$ as a Function of 1/[S] One May Envisage a "Non-competitive" Inhibition Type (below-right).

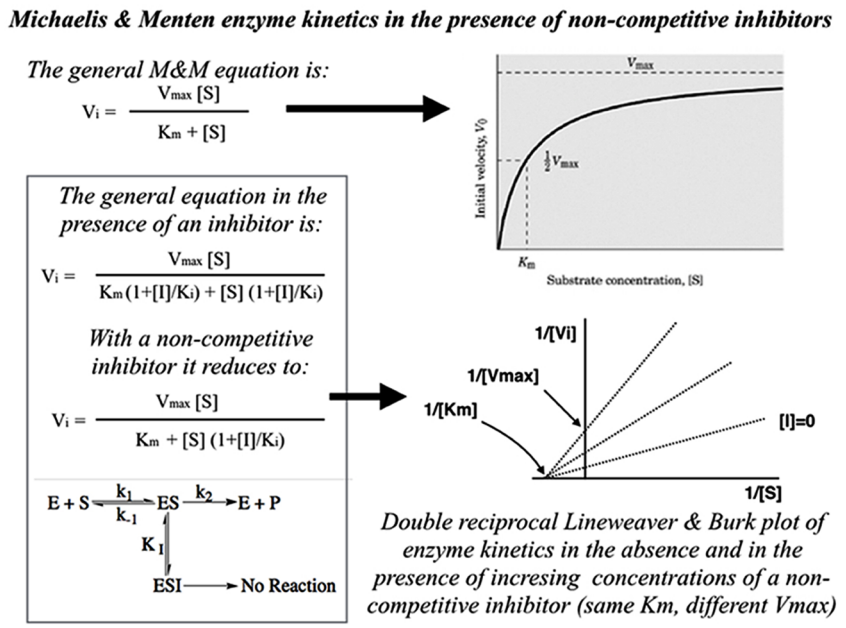
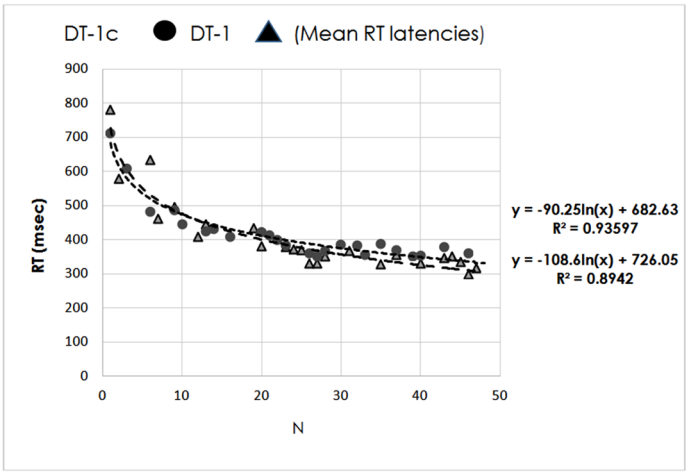


Figure 3. RTs of Two Individuals Engaged in DT-1 and DT-1c, Respectively.



shortly afterwards annulled by the participants. These errors are randomly distributed along the tasks, thus suggesting that there isn't a significant correlation with food categories, individual food images, participants' gender or task difficulty.

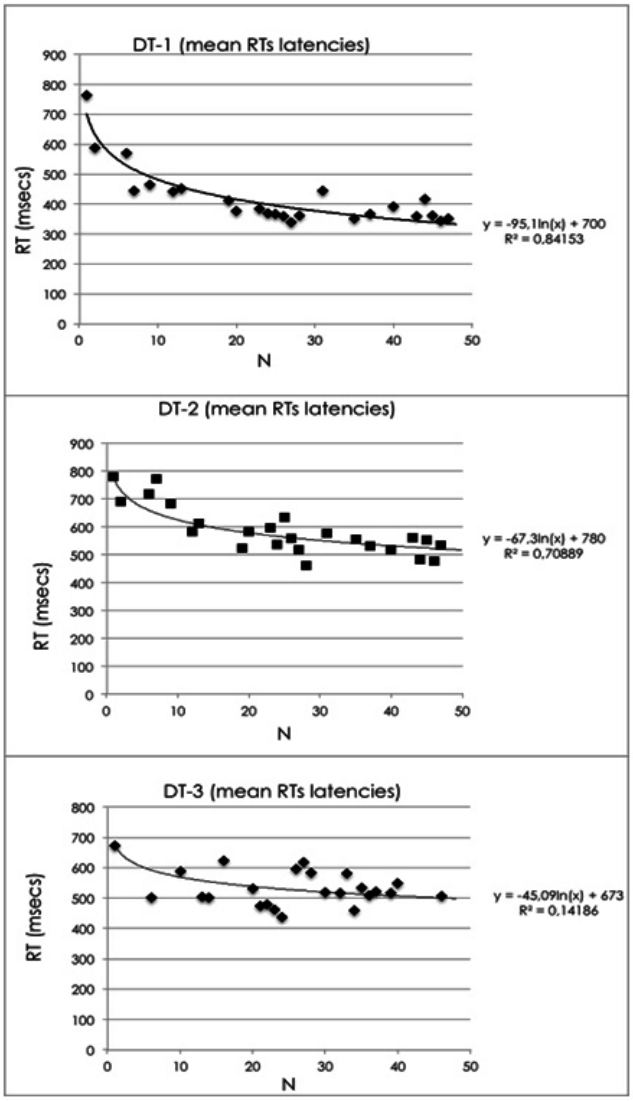
Grouping and Averaging Individual RTs

According to DT, participants' RTs are grouped, averaged and then plotted as a function of *N* (the trial number) (Figure 4). Data best fitting exhibits an exponential decay in all cases that; however, worsen progressively from DT-1 to DT-3. Only DT-1 and DT-1c curves are super imposable. The others initiate with almost the identical RTs as in DT-1/DT-1c but end at different RT limits (for $N \rightarrow \infty$). DT-1 and DT-1c clearly tend to very low values, quite close to SRT; while, DT-2 and DT-3 curves progressively tend to larger RT final values.

Moreover, the variability of standard deviations (SD) along the 24 SWEET trials per DT are calculated; then, these data, plotted as a function of *N* for the three DTs, can be linearly interpolated by best-fitting equations: SD=-2.3N+184 (r^2=0.7), SD=-2N+150 (r^2=0.5) and SD=-2N+200 (r^2=0.4), respectively for DTs-1/DT-1c, DT-2 and DT-3. By comparing these equations, one can see that SD almost coincide, though, r^2 signifi-

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-121

Figure 4: From top Below, the Three Panels Provide the Mean RT Values as a Function of *N* (trials) of Subjects Engaged in DT-1, DT-2 and DT-3, Respectively. From top Below, DTs' Complexity is Increasing and, Correspondingly, Subjects' Performance is Worsening (i.e. the limit of RT Curves Tends Progressively to a Higher Value for $N \rightarrow \infty$ and R^2 of the Best-fitting is Worsening).

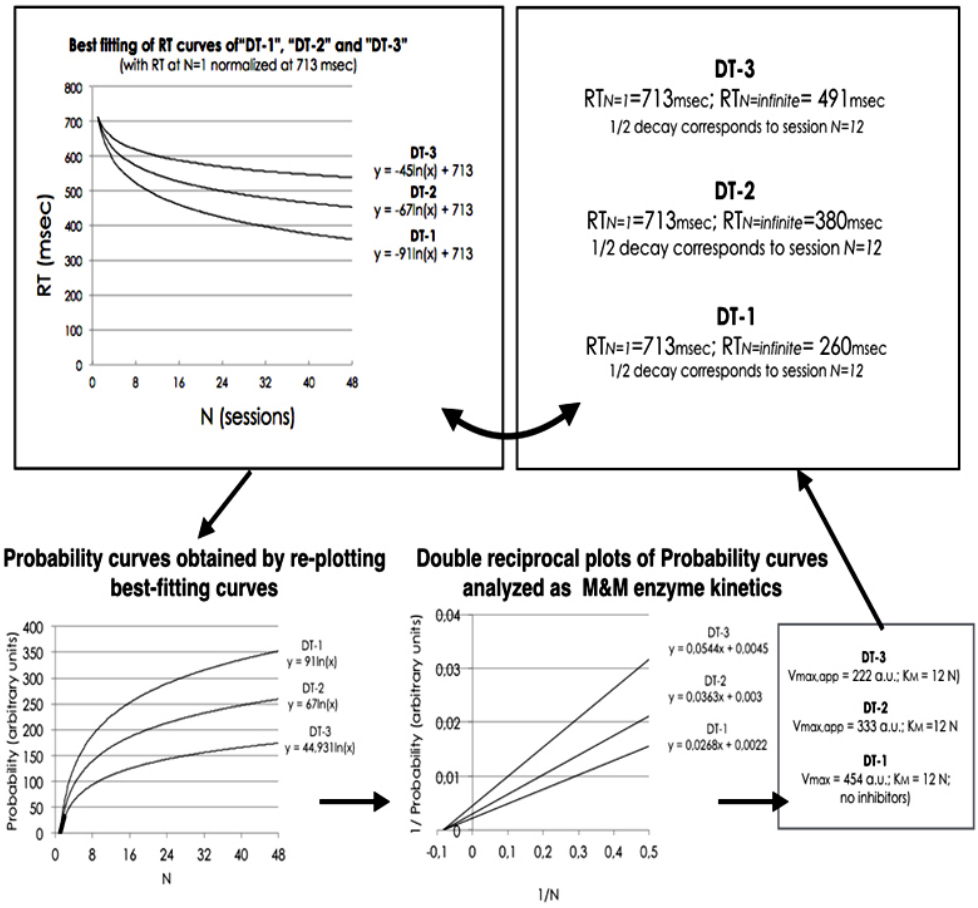


cantly worsen from DTs 1/1c to DT-3. As expected on the basis of TBM, SD reduction along the tasks suggests that repetitive sessions may cause a beneficial effect on mechanism known as "Learning Through Experience" (LTE) (see below); though, r^2 worsening is indicative of a decrease of subjects' self-confidence in tasks with increasing difficulty. The reason why the control task DT-1c gives identical results to DT-1 means that SALTED do not play any cross disturbing effect, this result is very intriguing and will be extensively discussed below.

DTs' data have been also analysed with a multifactor mixed Anova test. By posing RT and SRT latencies (msec) as dependent variables, one can assess significant differences among DTs, intra-task sessions and inter-task subjects ($p<0.001$). Moreover, least square values of RT latencies slightly ameliorate as a function of *N* in all DTs, in accordance with SD trends. To this regard, the positive trends of both indices reveal the increase of subjects' accuracy around the mean RT latency. This accuracy has nothing to do with an increase of precision in stimulus identification, since the errors (≤3%) are very few and randomly distributed across the tasks; rather, it might be indicative of the raise of confidence in the protocol of the task. However, the question now is: "Why the acquisition of this confidence along DT-2 and -3 is different than DT-1 (and its control DT-1c)"?

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-121

Figure 5: Top-left: Best-fitting Curves of Mean RTs. Data are Superposed by Normalizing RTs at *N*=1. Top-right: RTs at *N*=1, at *N*→∞ and at Trial *N*=12. Below-left: The Curves Shown at Top-left are Reversed Upwards to Obtain LTE "Probability" Curves. Below-middle and Right: "Double Reciprocal" Plot of 1/Probability as a Function of 1/*N*; in Analogy with Enzyme Kinetics, it can be Inferred that K_M=12 (Intercept on X-axis) and that there are Increasing Concentrations of a "Non-competitive" Inhibitor (Intercept on Y-axis), Respectively in DT-2 and DT-3.



DT's Curves Reveal A Different Skill Acquisition Along The Task

The best-fitting curves of DT-1,-2 and-3 in Figure 4 intuitively remind the authors of a learning trend that shows the improvement of individual performance with experience (DT-1c data are super imposable to DT-1, not shown). To understand why the three paradigms show different performances, the best-fitting curves are overlapped on the same graph and compared (Figure 5) (N.B. according to an admissible assumption, their starting RT latencies are all normalized at 713±58 msec).

TBM predicts a cognitive behaviour compatible with a BLP.[6] In other words, the model foresees that the information accumulated by previous experience can be used to upgrade the efficacy of the following action. By repetition, learning is progressively enriched in a trend described by a hyperbolic LTE curve.[26] This curve represents the increase of the learning "Probability" ranging between 0% and 100% with maximal experience. So that, the three DTs' curves exhibit an exponential decrease of RT latencies in function of trials, thus indicating the occurrence of maximal LTE "Probability". So that, LTE "Probability" curves are obtained by reversing upward DTs' curves (Figure 5). By observing the new plot, the three curves do not tend to the same limit so that we may infer that maximal LTE "Probability" is progressively reduced in DTs of higher complexity. To this regard, the possibility that the subjects might progressively suffer from increasing mental tiredness along tasks of higher complexity is a very weak explanation since subjects' mistakes are very low and equally distributed in all DTs.

Then, the question remaining is which kind of LTE impairment might be responsible for such a difference in learning processes. According to the "subtractive/additive" methods discussed in the "Introduction", we may suppose that, most of RT latencies at the beginning of the tasks are time spent to choose between "press" and "no-press" protocols. In accordance with TBM, unconscious mind (UM) should carefully analyse both protocols, thus doubling the time needed to take a decision. Conversely, when the task is at the end, i.e. LTE is close to a maximum value, most probably both item recognition ability and press/no-press paradigm confidence are at a maximum; then, RT

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-121

latencies are practically reduced to the mechanical pressing of computer key, i.e., an unavoidable time-consuming process that cannot be reduced below its physiological threshold. Evidently, in DT-2 and DT-3, the subjects' performance as for the action decision-making is impaired due to the presence of distracting images. Below, we'll try to provide an explanation for this effect.

SRT Measured by Means of R&G-DT

By means of "R&G-DT" the mean SRT latency exhibited by all participants is 280 msec (±30). This performance is quite close to the SRT value of 247.6 msec (±18.5) that has been measured by means of a visual task with 120 medical students.[27]

Quantitative Analysis of LTE Curves by Adopting Enzyme Kinetic Equations

The three LTE "probability" curves reported in Figure 5 can be analysed by means of M&M's general equation, provided the assumptions made above (see methods). All kinetic parameters calculated by these means are summarized in Table 1.

Two question are now arising: "Which kind and of which strength is the inhibition exerted by SWEET distractors? In order to answer the first questions, the three curves in Figure 5 are re-plotted according to the "double reciprocal" function (Figure 5). The straight lines share the same intercept on X-axis ($1/K_M$) but have intercepts on Y-axis ($1/V_{max}$) progressively increasing from DT-1 to DT-3. By comparing this result with the example reported in Figure 2, one can conclude that SWEET distractors exert an inhibition of "non-competitive" type.

As far as it regards the second question, the strength of an inhibitor inversely depends on K_i. In order to estimate it, a "double reciprocal" plot of the "non-competitive" inhibition equation is carried out; moreover, at a very large amount of [S] (i.e., at the end of DTs, with *N*=48), the [S] term can be removed so that the final, simplified form of the equation becomes:

$$1/V_{app,max} = (1+ [I]/K_i)/ V_{max}$$

To solve the equation, one can assume that total SWEET distractors [I] encountered by participants in DT-1, DT-2 and DT-3, are 0, 8 and 24, respectively; then, $1/V_{app,\ max}$ is plotted as a function of [I]. As expected, one gets a very straight line (see Figure 6) with the slope $1/V_{max}K_i$; so that, both $V_{app,\ max}$ from the intercept on Y-axis (at [I]=0) and K_i=18 from the slope can be calculated (Table 1 for a complete list of kinetic parameters). By knowing that participants at the end of DT-2 and DT-3, have met 8 and 24 inhibitors, respectively, $V_{app,max}$ calculated on the basis of the preceding equation, is: 0.69×353 msec=244 msec in DT-2 and 0.42×353 msec=148 msec in DT-3, respectively. These values are quite close to experimentally estimated LTE "Probability" values: 259 msec, and 174 msec (Table 1).

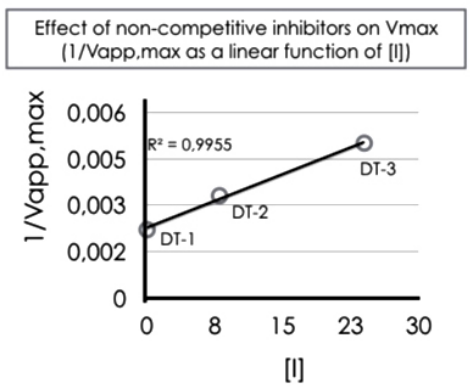
DISCUSSION

Intertrial Priming Effects

Studies regarding go/no-go tasks show that when the targets of successive trials have a feature in common, RTs are shorter. This effect is interpreted as the result of "intertrial priming effect". However, the nature of the representation underlying this effect and how priming is affected by the task remain obscure. Different authors have devised their own experiments in search of a better model describing this effect and trying to explain its mechanism.[28-31] In general, the effects of priming or distracting were consolidated observations.

From these experiments, it can be inferred that repetition of the same protocol and the lack of any warning or reprimand

Figure 6: Distractor Effect Due to SWEET Items (I) on LTE Probability (V_i). If the Inhibitor is of the "Non-competitive" Type, A Straight Line can be Obtained by Plotting $1/V_{app,max}$ as a Function of SWEET Distractors [I] (i.e. 0, 8 and 24, Respectively for DT-1, DT-2 and DT-3). Half $V_{app,max}$ is Obtained when Subject has Met 18 Distractors (K_i=18) During the Task.



ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-121

Table 1: Comparison between Starting and Ending RT Latencies Obtained by Means of Best-fitting Curves of Mean Experimental Data and Data Re-elaborated by Means of LTE "Probability".
Kinetic Parameters Characterizing the "Pressing" Activity by Assuming Enzyme Kinetic Equations in the Absence (DT-1) and in the Presence of Non-competitive Inhibitors (DT-2 and DT-3). Last Column Reports Simple Reaction Times (SRT) Calculated at $N \rightarrow \infty$. In DT-1, $V_{app,max}=V_{max}$ and SRT_{app}=SRT.

	Best-fitting of RTs have been normalized at *N*=1		Probability (LTE)		M&M enzyme kinetic parameters				
	RT latency *(N=1)*	RT latency *(N=48)*	Trial *(N=1)*	Trial (N=48)	$V_{app,max}$ *(N→∞)*	K_M	*Sweet distractors (inhibitors)*		$SRT_{app}= (RT_{N=1})-V_{app,max}$
	msec	msec	msec	msec	msec	*N*	[I]	K_i	msec
DT-1	713	360	0	353	454	12	0	0	260
DT-2	713	453	0	259	333	12	8	18	380
DT-3	713	538	0	174	222	12	24	18	491

until the end of the task, might trigger participants' confidence in the task and an increase in self-esteem at a conscious level. The paradigm of present study does not manifest any form of reward or punishment during the task. However, the lack of any warnings might be interpreted as praise by the subject. These perceptions improve participants' performance. The increasing satisfaction of the conscious inner witness in seeing that any decision (presumed free by the agent) ends the action correctly is perceived as "Reward". This inference can be drawn in accord with TBM and the illuminating papers of Tolman on "cathexis".[5,32-34] According to TBM, FW is an illusion, necessary to self-attribute the sense of responsibility (SoR) of "so-called" voluntary actions; with SoR, obviously, reward or punishment are consequent, depending on the outcome of the action. Therefore, a motivational mechanism of learning is switched on.

Impairment of Priming Effect

In the presence of SWEET distractors, the priming effect is impaired, as if the subject could not acquire any useful experience from the past and any new trial were always the first. Interestingly, subject's ability in item (SWEET or SALTED) identification is not altered (errors ≤3%). In summary, distraction mechanism is not a question of long-term memory failure; it might rather depend on short-term memory mismatch, caused by the presence of stimuli belonging to the same semantic category though different.

Saliency and the Priming Effect

The term Saliency means a key attentional mechanism facilitating discrimination of various items and learning.[35,36] Saliency might play a primary role in the first mental process of the participant engaged in DTs, i.e. the attentional selection and categorization of the stimulus as soon as it appears. This role might be progressively impaired due to the increase of the disturbing effect from DT-1 to DT-3. Conversely, the involvement of Saliency in processes like press/no-press decision, recognition of the correct computer key and finger motion is improbable. Moreover, the participants considered the task as a sort of game, in which they felt motivated to demonstrate how fast their reflexes are; in this context, what mostly contributes to LTE curve trends is learning the way to speed up the performance, trial after trial; to this aim, Saliency alone cannot pursue such motivational mechanism.

Some Aspects of LTE Curves Unveiled by a Mathematical Analysis

Only the kinetic analysis of the collected data may reveal quantitative implications that, otherwise, might pass unnoticed. It has been shown above that LTE curves in DT-1, DT-2 and DT-3 progressively decrease their final RT values (at N=48) from 353 msec to less than half (174 msec) due to the presence of increasing amounts of SWEET distractors (Table 1).

The intriguing question now arising is: "Why is K_M the same for the three tasks, although distractors are changing so much"? Or, in other words: "Is there any mechanistic relationship between K_M and K_i"? In order to answer to these questions, at first one should consider the meaning of K_M=12, i.e. 50% of LTE "$probability_{max}$" is achieved at the 12th trial; this is a feature common to all DTs, whichever distractors are present or not. According to enzyme kinetics' metaphor, the presence of "non-competitive" inhibitors should not affect K_M. Indeed, the reasons can be understood by looking at the reaction scheme in Figure 2. Enzyme-substrate complexes split into two possible pathways: some are proportionally subtracted by "non-competitive" inhibitors, whereas the rest (not locked by the inhibitor), regularly undergoes the priming mechanism that exhibits half "facilitating" effect at the 12th trial. At second, the meaning of K_i should be more deeply investigated. According to enzyme kinetics, K_i corresponds to the inhibitor's amount capable of locking half

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-121

enzyme, therefore halving V_{max}; this constant can been calculated only at reaction conditions with very large [S]. As far as it regards DTs, K_i=18 would mean that 50% of the LTE "probability$_{max}$" is impaired by 18 distractors when N=48; as a matter of fact, only DT- 3 participants can meet 18 different SWEET distractors right at the 18th trial; conversely, DT-2 participants will never meet more than 8 distractors in the whole test so that impairment is largely reduced. In conclusion, the inhibitory effect in DT-2 and DT-3 can significantly emerge quite after the 12th trial. This conclusion is in accordance with the results that Greyer et al[37] has obtained in cross-trial priming experiments; also in their paradigm, the "inhibitory" effect, in contrast to the "facilitating" effect, emerged only after extended practice.

To this regard, it should be mentioned that SALTED stimuli as well as B&W images of completely different semantic categories (like faces, cars etc. substituted for SALTED images) are not perceived as distractors (not shown).

CONCLUSION

When the trials of a "press/no-press" task are repeated with identical stimuli (as in DT-1 and DT-1c), a learning curve possibly correlated both with faster and faster object recognition and with a progressive amelioration of procedural skill, can be observed. Moreover, distractors that are introduced in the repetitive sequence (as in DT-2 and DT-3), seem to impair the learning process; possibly, action-decision making is apparently slowed down. The "priming effect" observed in repetitive trials and the negative effect on it, in the presence of "distractors", is well known in classic "press/no-press" ("go/no-go") decisional tasks and is in accordance with TBM's expectations.

An even more interesting result is the quantitative estimate of the two effects that can be calculated by using "Michaelis-Menten" (M&M) enzyme kinetic equations. These equations have been derived to deterministically predict probabilistic enzyme reactions (in "steady-state" conditions), so that the metaphoric analogy with TBM in which action-decision mechanism is based on a probabilistic-deterministic model, is striking.

Data analysis carried out by means of M&M's enzyme kinetic equations, leads the authors to conclude that: 1) The priming effect is preserved also in DT-2 and DT-3, although with a different percent of probability which varies according to the number of SWEET distractors and a specific K_i; 2) The priming effect occurs at earlier trials than the distractor-induced inhibition; 3) Distractors exhibit an inhibition of the "non-competitive" type, a result that favours the hypothesis of the addition of mental loops that delay the regular pathway to priming without excluding it.

In conclusion, the main concern of this work is to validate the theory of TBM by experimental means. The results of press/no-press DTs are compatible either with TBM or with the current literature's observations. This psychophysical approach here reported can be considered as a first necessary step along TBM validation, to be continued from a bottom-up perspective towards imaging techniques.

ACKNOWLEDGMENT

We are indebted to Dr. Alberto Sabbioni for the helpful statistical analysis of the data and his stimulating discussions.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

REFERENCES

1. Bignetti E. Dissacrazione della coscienza [in Italian]. Il Valico eds. Firenze; 2001.

2. Bignetti E. Consciousness can learn but cannot decide. *Annali Facoltà Med Vet.* University of Parma. 2004; 24: 31-52.

3. Bignetti E. Free will is the illusionary by-product of self-perception. 2010: *Proceedings of "The 4th International Nonlinear Science Conference"*. Palermo, Italy; The Soc. for Chaos Theory in Psychology and Life Science.

4. Bignetti E. Ego and free will: A virtual binomial apt for cognition. 2013: *Proceedings of "Neuroplasticity and cognitive modifiability"*. Jerusalem, Israel; *Medimond, eds*.

5. Bignetti E. The functional role of free-will illusion in cognition: "The Bignetti Model". *Cognitive Systems Research.* 2014; 31-32: 45-60. doi: 10.1016/j.cogsys.2014.04.001

6. Bignetti E. From brain to mind: A plain route from neurobiology to psychology. *Psychol Cogn Sci Open J.* 2015; 1: 15-25. doi: 10.17140/PCSOJ-1-103

7. Bignetti E, Ghirri A. Mind and Free Will. *Annali Facoltà Med Vet. University of Parma.* 2010; 30: 33-42.

8. Ebbinghaus H. Memory: A Contribution to Experimental Psychology. *Ann Neurosci*. 2013; 20(4): 155-156. Web site. http://nwkpsych.rutgers.edu/~jose/courses/578_mem_learn/2012/readings/Ebbinghaus_1885.pdf. Accessed December 23, 2016.

9. Schopus A, Vogels R, Qian N, Orban G. Practising orientation identification improves orientation coding in V1 neurons. *Nature.* 2001; 412(6846): 549-553. doi: 10.1038/35087601

10. Orban GA, VanEssen D, Vanduffe W. Comparative mapping of higher visual areas in monkeys and humans. *Trends Cogn Sci*. 2004; 8(7): 315-324. doi: 10.1016/j.tics.2004.05.009

11. Woods DL, Wyma JM, Yund EW, Herron TJ, Reed B. Factors influencing the latency of simple reaction time. *Front Hum*

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-121

Neurosci. 2015; 9: 129-131. doi: 10.3389/fnhum.2015.00131

12. Howland J, Rohsenow DJ, Arnedt JT, et al. The acute effects of caffeinated versus non-caffeinated alcoholic beverage on driving performance and attention/reaction time. *Addiction*. 2011; 106(2): 335-341. doi: 10.1111/j.1360-0443.2010.03219.x

13. Anitei M, Schuhfried G, Chraif M. The influence of energy drinks and caffeine on time reaction and cognitive processes in young Romanian students. *Procedia-Social Behavioral Sciences*. 2011; 30: 662-670.

14. Reed TE. Causes and intraindividual variability in reaction times: A neurophysiologically oriented review and a new suggestion. *Personality And Individual Differences*. 1998; 25(5): 991-998. doi: 10.1016/S0191-8869(98)00123-8

15. Szyfman A, Wanner G, Spencer L. The relationship between cellular phone use, performance, and reaction time among college students: Implications for cellular phone use while driving. *American J Health Education*. 2003; 34(2): 81-83. doi: 10.1080/19325037.2003.10603533

16. Dykiert D, Der G, Star JM, Deary IJ. Sex differences in reaction time mean and intraindividual variability across the life span. *Dev Psychol*. 2012; 48(5): 1262-1276. doi: 10.1037/a0027550

17. Huerta CI, Sarkar PR, Duong TQ, Laird AR, Fox PT. Neural bases of food perception: Coordinate-based meta-analyses of neuroimaging studies in multiple modalities. *Obesity*. 2014; 22(6): 1439-1446. doi: 10.1002/oby.20659

18. Ohia K, Toepel U, LeCoutre J, Hudry J. Visual-Gustatory Interaction: Orbitofrontal and Insular Cortices Mediate the Effect of High-Calorie Visual Food Cues on Taste Pleasantness. *Plos One*. 2012; 7(3): e32434. doi: 10.1371/journal.pone.0032434

19. Science Buddies Staff. Sensory Science: Testing taste thresholds. *Scientific American*, Nature America Inc; 2013.

20. Hale J. The Development of Food Preferences. *Psych Central*. Web site. http://psychcentral.com/lib/the-development-of-food-preferences/. Accessed December 23, 2016.

21. Spivey M. *The continuity of mind*. NY, USA: Oxford University Press; 2007.

22. Giusti A, Bignetti E, Cannella C. Exploring new frontiers in total food quality definition and assessment: from chemical to neurochemical properties. *Food Bioprocess Technol*. 2008; 1: 130-142. doi: 10.1007/s11947-007-0043-9

23. Teslovich T, Friedl EK, Kostro K, et al. Probing behavioural responses to food: Development of a food-specific go/no-go task. *Psychiatry Res*. 2014; 219(1): 166-170. doi: 10.1016/j.psychres.2014.04.053

24. Segel IH. Enzyme Kinetics. Hoboken, NJ, USA: *John Wiley and Sons*; 1975.

25. Johnson KA, Goody RS. The original michaelis constant: Translation of the 1913 michaelis-menten paper. *Biochemistry*. 2011; 50(39): 8264-8282. doi: 10.1021/bi201284u

26. Schultz W. Neuronal rewards and decisions signals: from theories to data. *Physiol Rev*. 2015; 95(2): 853-951. doi: 10.1152/jn.00458.2005

27. Jain A, Bansai R, Kumar A, Singh KD. A comparative study of visual and auditory reaction times on the basis of gender and physical activity levels of medical first year students. *Int J Appl Basic Med Res*. 2015; 5(2): 124-127. doi: 10.4103/2229-516X.157168

28. Maljkovic V, Nakayama K. Priming of pop-up: I, Role of features. *Mem Cognit*. 1994; 22(6): 657-672. Web site. http://vpl.uchicago.edu/pdfs/MemCog94.pdf. Accessed December 23, 2016.

29. Maljkovic V, Nakayama K. Priming of pop-up: II, the role of position. *Perception Psychophysics*. 1996; 58(7): 977-991. Web site. http://vpl.uchicago.edu/pdfs/PercPsychophys96.pdf. Accessed December 23, 2016.

30. Maljkovic V, Nakayama K. Priming of pop-up: III, a short-term implicit memory system beneficial for rapid target selection. *Visual Cognition*. 2000; 7(5): 571-595. Web site. https://ai2-s2-pdfs.s3.amazonaws.com/d790/a921290119a8e47f2f5f-474c4810f4cd24f3.pdf. Accessed December 23, 2016.

31. Huang L, Holcombe AO, Pashler H. Repetition priming in visual search: episodic retrieval, not feature priming. *Memory Cognition*. 2004; 32(1): 12-20. doi: 10.3758/BF03195816

32. Tolman EC. There is more than one kind of learning. *Psychol Rev*. 1949; 56(3): 144-155. doi: 10.1037/h0055304

33. Tolman EC. The nature and function of wants. *Psychol Rev*. 1949; 56: 357-369.

34. Archer T, Nilsson LG. *Aversion, Avoidance, and Anxiety: Perspectives on Aversively Motivated Behavior*. Umea, Sweden: Psychology Press; 2014.

35. Niebur E. Saliency map. *Scholarpedia*. 2007; 2(8): 2675.

36. Awh E, Belopolsky AV, Theeuwes J. Top-down versus bottom-up attentional control: A failed theoretical dichotomy. *Trends Cogn Sci*. 2012; 16(8): 437-443. doi: 10.1016/j.tics.2012.06.010

37. Greyer T, Muller HJ, Krummenacher J. Cross-trial priming

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-121

of element positions in visual pop-up search is dependent on stimulus arrangements. *J Exp Psychol Hum Percept Perform*. 2007; 33(4): 788-797. doi: 10.1037/0096-1523.33.4.788

38. Gennaro RJ. *Consciousness and Self-consciousness: A defence of the higher order thought theory of consciousness*. Amsterdam & Philadelphia, Netherlands: John Benjamins; 1996.

39. Grabbe J. *From Soul to Self*. Ed. NY, USA: MJC Grabbe Routledge; 1999.

40. Dennett DC. *Consciousness Explained*. UK: Back Bays Books Edition; 1992.

41. Dennett DC. The self as the center of narrative gravity. In: Kessel F, Cole PM, Johnson DL, eds. *Self and Consciousness: Multiple Perspectives*. Baton Rouge, LA, USA: LEA Inc.; 1992: 103-114.

42. Dennett DC. Explaining the "Magic" of consciousness. *J Cultural and Evolutionary Psychology.* 2003; 1(1): 7-19. doi: 10.1556/JCEP.1.2003.1.2

43. Dennett DC. "My brain made me do it" (when neuroscientists think can do philosophy). Max Weber Lectures (N° 201/01) Florence; 2011.

44. Bignetti E. Cervello e mente ovvero casualità e determinismo. [in Italian]. *AnnaliFacoltà Med Vet*. University of Parma. 2003; 23: 69-78.

45. Bignetti E. I fondamenti del pensiero tra oriente ed occidente. In: *Pregiudizio e Terapie* [In Italian]. Milan, Italy: Proc. XXIII Congresso Nazionale Società Italiana Medicina Psicosomatica; 2011: 30.

ISSN 2380-727X http://dx.doi.org/10.17140/PCSOJ-3-121

APPENDIX

Ancient Indian philosophy, in contrast to other proposals,[38] rules out the idea of a free Soul-inhabited Self since Soul and Self should coincide with the transcendental idea of Atman,[39] an entity to which our imperfect mind cannot confer cognitive responsibility on its behalf. On this base, Dennett's famous question "who is driving the car?" might apparently have no answer.[40-43] "The Bignetti Model" (TBM)[1-5,7,44,45] is a comprehensive approach that considers cognition as a pure neurobiological process, so that car's driver might be a self-referential processor that should not account for his actions to any transcendental entity. In TBM, Self and Free Will (FW) are self-feeding illusions of the mind with a functional role in cognition.[1-6]

Principal elements of "The Bignetti Model" (TBM) are:

1) The so-called "voluntary" action is decided and executed by the agent's unconscious mind (UM) by means of probabilistic responses to inner and outer stimuli.
2) The agent becomes aware of the ongoing action, after a slight delay, through feedback signals (somatosensory, etc.) that are conveyed to the brain on its execution. Thus, the agent's conscious mind (CM) lags behind unconscious activity.
3) The CM, then, cannot be aware of the activity of the unconscious work that precedes its awareness; the CM erroneously believes to have freely decided the action. FW is an illusion that is subjectively perceived by CM as true. This belief is so persistent in the mind that the CM is unable to abandon it.
4) The illusion satisfies psychological needs, those of securing the sense of agency (SoA) and of responsibility (SoR) of the action. Both SoA and SoR inevitably lead CM to self-attribute reward or blame depending on action performance and outcome.
5) Both reward and blame are incentives that foster learning and memory in the CM; updating the knowledge base will hone and refine the skill required for further action (restart from point 1).

The nature and role of all TBM's components (e.g. CM, UM etc.) have been discussed in detail in the past.[5] More recently, the strong analogy between TBM and BLP has also been thoroughly analysed.[6] On the one hand, reward and blame are tools to stigmatize whether a voluntary action has been fruitfully pursued by CM (see points 4 and 5 of TBM); on the other hand, they are not pre-existing but mouldable categories, depending on the experience and SoR, so that pursuing a reward instead of a blame might be rated at maximal priority in order to avoid irresponsible actions.

The post-adaptive learning-and-memory mechanism of TBM, is akin to the Darwinian evolutionary mechanism, and to the operant mechanism of animal intelligence. Theory's main pillars are: In TBM, the action decision making is elaborated by the UM on the basis of previous experience, and the learning and memory process is later elaborated by the CM in order to update the wealth of experience. Obviously, lacking previous experience, trial-and-error seems to be the unique paradigm followed by an individual to respond to a novel stimulus.[6] This paradigm would imply a cooperative sequence of back and forth interactions between UM and CM. Therefore, individual reactions to "repetitive" stimuli should become increasingly efficient (i.e. the goal should be reached correctly and in a shorter time), thus indicating that a learning process is going on. This means that, in repetitive trials, a decrease in reaction times correlated with the subject's increasing experience, should be observed. On the other hand, if different stimuli are introduced in the previous sequence, just as distractors of the ongoing learning process, action-decision making should be slowed down. In any case, the data should describe a hyperbolic curve typical of "Learning Through Experience" (LTE) process, so that, in this work, LTE will be the cognitive process adhering to TBM's principles.