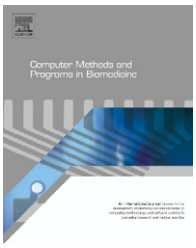
COMPUTER METHODS AND PROGRAMS IN BIOMEDICINE 107 (2012) 468–477

journal homepage: www.intl.elsevierhealth.com/journals/cmpb



Evaluating the human ongoing visual search performance by eye tracking application and sequencing tests

Giacomo Veneri[a,b,c,*], *Elena Pretegiani*[b], *Francesca Rosini*[b], *Pamela Federighi*[a,b], *Antonio Federico*[b], *Alessandra Rufa*[a,b]

[a] *Eye tracking & Vision Applications Lab, University of Siena, Italy*
[b] *Department of Neurological Neurosurgical and Behavioral Science, University of Siena, Italy*
[c] *Etruria Innovazione, Italy*

ARTICLE INFO

Article history:
Received 5 March 2010
Received in revised form
12 December 2010
Accepted 9 February 2011

Keywords:
Spatial visual search
Trail making test
Fixations
Saccade planning

ABSTRACT

Human visual search is an everyday activity that enables humans to explore the real world. Given the visual input, during a visual search, it is necessary to select some aspects of input to shift the gaze to next target. The aim of the study is to develop a mathematical method able to evaluate the visual selection process during the execution of a high cognitively demanding task such as the trial making test part B (TMT). The TMT is a neuropsychological instrument where numbers and letters should be connected to each other in numeric and alphabetic order. We adapted the TMT to an eye-tracking version, and we used a vector model, the "eight pointed star" (8PS), to discover how selection (fixations) guides next exploration (saccades) and how human top-down factors interact with bottom-up saliency. The results reported a trend to move away from the last fixations correlated to the number of distracters and the execution performance.

© 2011 Elsevier Ireland Ltd. All rights reserved.

1. Introduction

The eye gaze analysis represents a challenging field of research for neuro physiologist and neuro scientists, since it offers a reproducible method to study the mechanisms of the brain. Since the visual system has limited computational resources, it is necessary to limit detailed processing to selected aspects of the input: for this reason, humans alternate rapid eye jumps (saccades) from a region of the input to another region and fixations, while information is acquired (Fig. 1). This selection process is an important mechanism driven by different brain's areas [1] and a measure of its performance, during visual search, should provide interesting information to make the diagnosis or to study the cognitive behavior. In the last decade various psychological tests, applied to eye-tracking, have been proposed [2–5]; in this context, we developed a mathematical method that takes into account the intention to explore the next target with respect to already explored regions, which contribute to make the internal spatial map of a scene [6]. We analysed saccade (rapid eye jump from a target to next target) versus fixations (the act to fixate and acquire information from the input): the aim of this method is to provide valuable information about search strategies. The developed method, which we call "eight pointed star" (8PS), was applied and verified on a sequencing task such as the trial making test part B (TMT) and on a simple visual search test.

* *Corresponding author at*: Department of Neurological Neurosurgical and Behavioral Science, University of Siena, Viale Bracci 2, 53100 Siena, Italy. Tel.: +39 0577 233136; fax: +39 0577 40327.
E-mail addresses: g.veneri@unisi.it (G. Veneri), federico@unisi.it (A. Federico), rufa@unisi.it (A. Rufa).
URLs: http://www.etinnova.it (G. Veneri), http://www.evalab.unisi.it (A. Rufa).
0169-2607/$ – see front matter © 2011 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.cmpb.2011.02.006