

COMPARISON OF VISUAL AND EMOTIONAL CONTINUOUS PERFORMANCE TEST RELATED TO SEQUENCE OF PRESENTATION, GENDER AND AGE

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A b s t r a c t. Continuous Performance Tests (CPTs) form a group of paradigms for the evaluation of attention and, to a lesser degree, the response inhibition (or disinhibition) component of executive control. The object of this study was to compare performance on a CPT using both visual and emotional tasks in 46 normal adult subjects. In particular, it was to examine the effects of the type of task (VCPT or ECPT), sequence of presentation, and gender/age influence on performance as measured errors of omission, errors of commission, reaction time and variation of reaction time.

From the results we can assume that there are significantly worse performance parameters for ECPT than VCPT tasks, with a probable explanation of the influence of emotional stimuli on attention and information-processing and no significant effect of order of presentation and gender on performance. Significant differences with more omission errors for older groups were obtained, showing better attention in younger subjects.

Key words: VCPT, ECPT, omission errors, commission errors, reaction time, variation of reaction time, normal adults.

Introduction

A Continuous Performance Task/Test, or CPT, is a neuropsychological test which measures a person's sustained and selective attention and impulsivity.

Sustained attention is the ability to maintain a consistent focus on some continuous activity or stimuli, and is associated with impulsivity. Selective attention is the ability to focus on relevant stimuli and ignore competing stimuli. This skill is associated with distractibility (Conners, 2000).

Since 1956, the CPT has been used in the study of attention and impulsivity, through multiple variations in the components of the task. Greenberg and Waldman (1993) suggested over 100 different versions of the CPT, the most commonly used being the Test of Variables of Attention (TOVA) and Conner's CPT-II. Although variations of the tests in terms of length and type of stimulus have been used, the basic nature of the tests remains the same. Halperin (1991) commented that there are as many versions of the CPT available as there are clinicians who use them. One difference across versions of the CPT is the choice of target and non-target stimuli.

These attention tests are often used as part of a battery of tests to understand a person's 'executive functioning' or their capacity to sort and manage information. They may also be used specifically to support a diagnosis of Attention Deficit Disorder.

While scoring varies from test to test, standard performance is measured by the four main scores: the number of times a subject fails to respond to the correct target (errors of omission), the number of times a subject responds to an incorrect target (errors of commission), reaction time and variation of reaction time (sign of variation of attention). Errors of omission are regarded as a measure of sustained attention (high omission rates indicate that the subject is either not paying attention (distractibility) to stimuli, or has a sluggish response) and errors of commission as an indicator of impulsivity. Reaction time measures the amount of time between the presentation of the stimulus and the client's response, while variation of reaction time corresponds to the variation of attention during the task. These last two measures are used for evaluating the speed of cognitive processes and their trial-to-trial stability.

In many studies, modality differences of CPTs have been compared, with corresponding variations found in CPT performance (e.g. D. Baker, Taylor & Leyva, 1995; Draeger, Prior & Sanson, 1986; Driscoll, 1994; Sandford, Fine & Goldman, 1995a, 1995b; Sykes, Douglas & Morganstern, 1972). Baker D. and colleagues administered both the Gordon Diagnostic System (GDS; Gordon, 1983) and the Comprehensive Auditory Visual Attention Assessment System (CAVAAS; L.E. Becker, 1993) to 82 college students aged from 17 to 45 years. Using a counterbalanced design, the students completed four tasks (auditory vigilance, visual vigilance, auditory and visual distractibility). Based on comparison of omission and commission errors by tasks they found that college students performed better on visual than auditory tasks. Similar findings (more commission errors when the stimuli were presented in the auditory

format) with children with ADHD were reported by Sandford and Turner (1995). These findings suggest that auditory vigilance tasks may be more sensitive and, hence, more useful in the identification of problems with sustained attention and executive control.

The VCPT has enjoyed widespread use in clinical practice and is used frequently in research on the validity of laboratory measures in the assessment of ADHD (Kropotov, 2009). On the other hand ECPT for the Mitsar system (Meier N., Müller A., Kropotov J., 2007) is a new test, with limited use up till now. In this task stimulus material was taken from the set of pictures of facial affect by Ekman and Friesen (1976) and consisted of black and white slides of the faces of female and male actors, each presenting an angry, a happy, and a neutral face. In the past decade, the number of studies devoted to the neurophysiological basis of human emotional reactions has substantially increased (Robinson, 1995; Damasio, 1998). In the updated models of mental processes, the researchers more actively take into account the role of emotions in the regulation of behaviour at the organism level and at the level of the most important psychophysiological processes, e.g. memory and attention (Damasio, 1998).

Like other CPTs, the VCPT presents visual stimuli, and the results of a subject's performance are considered as a measure of attentional capacity. However, consideration has not been given to the similarities and differences in performance measures related to the facial emotion expression of the visual stimuli. Thus, the purpose of this study was to compare performance on a CPT using both visual and emotional tasks. In particular it examined the effects of the type of task (VCPT or ECPT), sequence of presentation, and gender/age influence on performance as measured errors of omission, errors of commission, reaction time and variation of reaction time.

Methods

2.1. Subjects

Forty-six healthy, right-handed volunteers, with normal or corrected vision (24 males, 22 females), aged between 18 and 50 years (mean = 25.6; SD = 7.90) participated in this study and gave written informed consent. All participants were briefly interviewed before testing to exclude those with a history of head injury, substance abuse, and/or severe psychiatric disturbances.

2.2. Procedure

All clients were individually assessed with neuropsychological and neurophysiological testing individually in an environment free from distrac-

tions. Only the administrator was present during the testing. All subjects were tested in two sessions (one neuropsychological and one neurophysiological assessment) that lasted approximately 2.5h each.

In the first assessment the interview and questionnaires (Current and Childhood Symptoms Scale (Barkley); Brief Symptom Inventory (Derogatis); Health History (Barkley); Trauma questionnaire (Müller & Thomann) and Semi-structured Interview for Adults with ADHD (Barkley) for excluding the ADHD (attention deficit hyperactivity disorder) symptoms were applied. Then, a neuropsychological assessment consisting of Amsterdam Neuropsychological Tasks (10 tasks) (ANT 3.0, de Sonneville, 1999) and Cogmed Working Memory Testing Tool (6 tasks) were completed.

During the second session all subjects had QEEG recorded by the Mitsar 21-channel QEEG system for:

- 5 minutes eyes closed resting and 5 minutes eyes open resting condition (sufficient for 2 minutes artefact-free data EC and EO);
- Visual continuous performance test – VCPT (two-stimulus Go/NoGo paradigm) with duration for 20 min, from Psytask.
- Emotional continuous performance test – ECPT (two-stimulus Go/NoGo paradigm) with duration of 20 min, from Psytask.

Separate channels for recording a signal from the button were used for monitoring the accuracy of the test performance and measuring the response trial.

The VCPT and ECPT were administered using the standard protocol. During the test, a subject sat in a comfortable armchair with armrests. Pictures were presented in a pseudo-randomised order in the centre of a computer monitor placed 100 cm from the subjects' eyes. Before each session, the test was explained to the subject in detail and 10–20 training tasks were performed. Accuracy and speed were encouraged. Each test lasted for 20 minutes, with a 5-minute rest between the tests. The order of the task administration was counterbalanced to control for order effects. The object of this paper is the comparison of the performance during visual and emotional CPT, regarding the sequence of presentation, gender and age.

2.3. Stimuli

We used the two-stimulus CPT task developed specifically for the Human Brain Institute Data Base. The task consisted of 400 trials. The duration of stimuli was equal to 100ms. Trials consisted of presentation of a pair of stimuli with inter-stimulus intervals of 1.1 sec. the interval between trials was equal to 3100ms and the response interval was from 100 to 1000ms.

In the VCPT task (Fig. 1) there are four categories of stimuli: 1) 20 different images of animals – referred to later as **A**, 2) 20 different images of plants – **P**, 3) 20 different images of humans presented together with an artificial novel sound – **HS**. Four categories of trials were selected: **Animal-Animal**, **Animal-Plant**, **Plant-Plant**, and **Plant-Human+Sound**. The trials were grouped into four sessions with one hundred trials each. In each session a unique set of five **A** stimuli, five **P** and five **HS** stimuli was selected. Each session consisted of a pseudo-random presentation of 100 pairs of stimuli with equal probability for each category and each stimulus. Subjects were instructed to press a button with the index finger of their right hand as fast as possible every time when an animal was followed by an animal (Go-condition) and to withhold or ignore pressing on the other three trials (NoGo-condition).

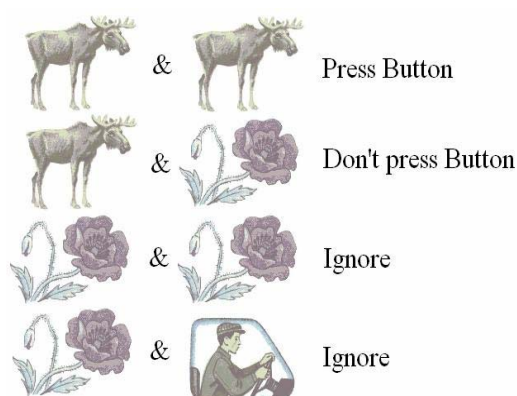


Figure 1 – Stimuli for the VCPT task
Слика 1 – Стимулуси за VCPT задача̑а

In the ECPT task (Fig. 2) four categories of stimuli were presented: 1) 20 different images of angry faces – referred to later as **A**, 2) 20 different images of happy faces – **H**, 3) 20 different images of neutral faces presented together with an artificial novel sound – **N+S**. Trials consisted of presentation of a pair of stimuli with an inter-stimulus interval of 1.1sec. Four categories of trials with the following facial expression of emotions were selected: **Angry-Angry**, **Angry-Happy**, **Happy-Happy**, and **Happy-Neutral+Sound**. The trials were grouped into four sessions with one hundred trials each. In each session a unique set of five **A** stimuli, five **H** and five **N+S** stimuli was selected. Trials were presented randomly with equal probability.

Subjects were instructed to press a button with the index finger of their right hand as fast as possible every time when an angry face was followed by an angry face (Go-condition) and to withhold the pressing on the other three trials (NoGo-condition).

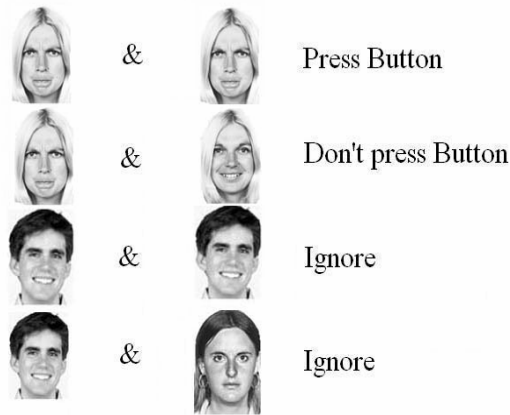


Figure 2 – Stimuli for the ECPT task
Слика 2 – Сџимулуси за ECPT задачаиџа

Results

A series of multivariate analyses of variance (ANOVAs) for main effects was conducted to examine the effects of the type of task (VCPT or ECPT), order of presentation, and gender/age influence on performance as measured errors of omission, errors of commission, reaction time and variation of reaction time. The ANOVA statistical analysis showed significant effects of the type of a task on performance data, with poorer performance during ECPT than in VCPT. The statistical differences of the measures between VCPT and ECPT are presented in Table 1.

Table 1 – Tabela 1

Differences in performance parameters between VCPT and ECPT
Разлика на џерформансџиџе џарамеџури џомеџу VCPT и ECPT

Measure	VCPT (n = 46)		ECPT (n = 46)		$F_{1,45}$	p
	Mean	(SD)	Mean	(SD)		
Omission errors (attention)	1.43	1.64	3.54	2.77	18.615	0.00009
Commission errors (impulsivity)	0.72	1.20	1.96	2.28	12.901	0.00081
Reaction time (RT)	365	65.04	413	74.04	9.8768	0.00296
Variation of RT	7.16	2.64	9.76	3.50	16.791	0.00017

No significant effect of the sequence of presentation on the performance was registered. Means and standard deviations of performance parameters in two ways order are presented in Table 2 and 3. Namely, ANOVAs repeated measurement of the difference in the performance at the first and second time presented with VCPT showed: omission $F_{1,20} = 0.27149$, $p = .608$; commission $F_{1,20} = 0.53333$, $p = .474$; RT $F_{1,20} = 1.0581$, $p = .316$ and varRT $F_{1,20} = 0.4786$, $p = .829$. Similar non-significant results were obtained also for ECPT measures: omission $F_{1,20} = 3.8579$, $p = 0.063$; commission $F_{1,20} = 1.5785$, $p = 0.223$; RT $F_{1,20} = 3.6206$, $p = 0.07157$ and varRT $F_{1,20} = 0.00426$, $p = 0.94859$.

Table 2 – Табела 2

Means, standard deviations and statistical significance of performance data for two different groups according to the presentation order of VCPT as first or second task

Средни вредносїи, сїандардни девијацији и сїаїиїсїиїчка сїгнїфиканїїносїи на їпарамеїриїїе добиени їри изведбаїїа на VCPT како їрва или вїїора задача на редослед на їрезенїїациїа, за двеїїе исїїїїувани їруїїи

	Mean (SD) VCPT I N = 25	Mean (SD) VCPT II N = 21	$F_{1,20}$	p
Omission errors	1.40 ± 1.38	1.48 ± 1.94	0.27149	0.608
Commission errors	0.88 ± 1.27	0.52 ± 1.12	0.53333	0.474
RT (ms)	354 ± 57.57	378 ± 72.26	1.0581	0.316
Var RT	7.2 ± 2.36	7.08 ± 2.30	0.4786	0.829

Table 3 – Табела 3

Means, standard deviations and statistical significance of performance data for two different groups according to the presentation order of ECPT as first or second task.

Средни вредносїи, сїандардни девијацији и сїаїиїсїиїчка сїгнїфиканїїносїи на їпарамеїриїїе добиени їри изведбаїїа на ECPT како їрва или вїїора задача на редослед на їрезенїїациїа, за двеїїе исїїїїувани їруїїи

	Mean (SD) ECPT I N = 21	Mean (SD) ECPT II N = 25	$F_{1,20}$	p
Omission errors	2.71 ± 2.30	4.24 ± 2.98	3.8579	0.063
Commission errors	1.52 ± 1.77	2.32 ± 2.60	1.5785	0.223
RT (ms)	435 ± 92.50	395 ± 48.94	3.6206	0.072
Var RT	9.6 ± 3.68	9.9 ± 3.40	0.00426	0.949

On Figs. 3 and 4 no influence of presentation order on task performance is shown. Namely, as can be seen, the expectation that the second task that is performed will be with a poorer performance than the first one is not confirmed since there are more commission errors in the first order VCPT compared to the second one (when more commission errors are expected due to tiredness) or longer reaction time in the first ECPT, compared to the second one (when a influence of a tiredness factor on attention is expected).

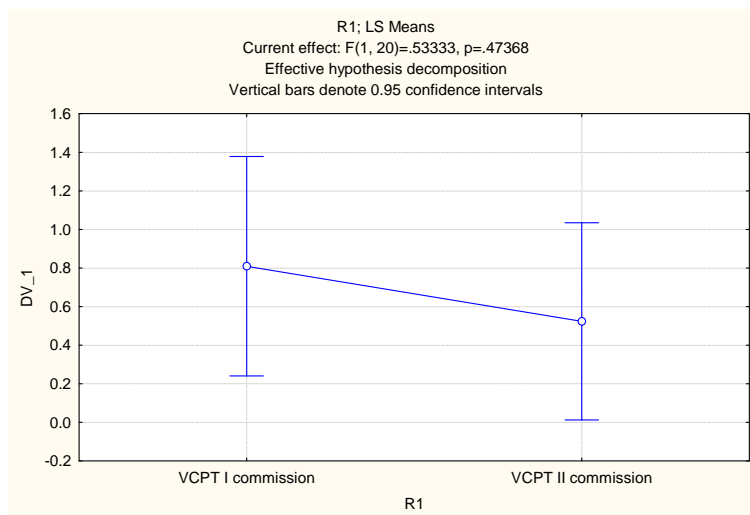


Figure 3 – Differences of commission errors in VCPT I and II
Слика 3 – Разлика на зрешки при VCPT I и II

The independent *t*-test by group parameters showed that there was no significant gender effect within group and intergroup differences on tasks performance, even if the values for all performance data (omission, commission errors, RT and varRT) were slightly higher for the males compared to the females.

Concerning age as a factor that could influence the performance, the participants were divided into four groups: 18–20; 21–30; 31–40 and 41–50 years. Within and inter-group differences obtained with the *t*-test for independent samples showed a significant difference in omission errors in VCPT in the group aged 31–40 years compared to the group aged 41–50, with more errors in the latter ($t = 3.873$, $p < 0.03$). While in ECPT there was better performance in groups from 18–20 compared to the group aged 21–30 ($t = 3.523$, $p < 0.003$), and the group aged 21–30 was better than 31–40 ($t = 3.000$, $p < 0.03$) and 41–50 ($t = 3.963$, $p < 0.03$) respectively.

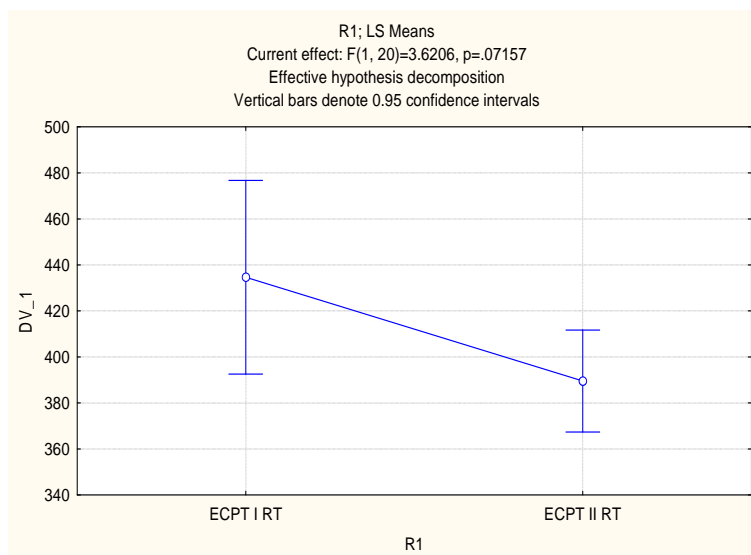


Figure 4 – Differences of reaction time in ECPT I and II
Слика 4 – Разлика на реакционото време помеѓу ECPT I и II

Discussion

The main purpose of this study was to examine the effects of the sequence of presentation of CPT stimuli on performance. It is clear that there is a significantly poorer performance (more omission and commission errors, longer reaction time and higher variation of reaction time) in ECPT than in VCPT for all subjects. This could be explained by the influence of emotional stimuli on attention and information-processing, (i.e. a longer reaction time as a result of the separate process of decoding of facial expressions from face perception, Herrmann *et al.* 2002).

The research designs included counterbalancing of task order; therefore, the results did not reflect the practice effect (noted by Schachar *et al.* 1988) which resulted in making the VCPT task easier to perform than the ECPT task.

There were no significant main effects or interactions of participant gender group on any performance measure. This is in accordance with the results obtained from Schulz *et al.*, 2007. On the other hand, there were significant differences by age groups, with lower omission errors of groups between age 18–20 and 21–30, showing better attention in younger subjects.

The present study examined only a restricted range of subjects (volunteers with university education or university students) and generalizations beyond this population should not be made until data on a broad range of subjects with volunteers of different levels of education have been obtained.

The next step in research will be an assessment of performance differences and early components of event-related potentials obtained during VCPT and ECPT for individuals with attention deficit hyperactivity disorder (ADHD).

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Резиме

СПОРЕДБА НА ВИЗУЕЛНИОТ И ЕМОЦИОНАЛНИОТ КОНТИНУИРАН ПЕРФОРМАНС ТЕСТ ВО ОДНОС НА РЕДОСЛЕДОТ НА ПРЕЗЕНТАЦИЈА, ПОЛ И ВОЗРАСТ

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Апстракт. СРТ е група на парадигми која се користи за испитување на вниманието и, во помал степен, за инхибицијата на одговорот, како компонента на егzekутивната контрола. Често се употребуваат СРТ задачите за да се добие квантитативна информација во врска со индивидуалната способност за одржување на вниманието во текот на времето. Целта на оваа

Студија беше да се споредат перформансите во текот на визуелна и емоционална СРТ задача кај 46 здрави возрасни субјекти. Поточно, да се испитаат ефектите од видот на задачата (VCPT или ECPT), редоследот на презентирање и, влијанието на полот и возраста на перформансите преку мерени грешки при изостанување на одговор или пропусти (omission errors) и грешки при погрешен одговор (commission errors), реакционо време и варијација на реакционото време.

Во резултатите можеме да резимираме дека сигнификантно полоши перформансни параметри се добиваат при ECPT задачата, во споредба со VCPT (со можно објаснување за влијанието на емоционалните стимулуси врз вниманието и процесирањето на информацијата) и несигнификантен ефект на редоследот на презентацијата и полот врз перформансите. Земајќи ја пак во предвид возраста, добиени се значајни разлики за грешките при пропуст кај постарата популација, укажувајќи на подобро внимание кај помладите субјекти.

Клучни зборови: VCPT, ECPT, реакционо време, грешки при пропуст, грешки при погрешен одговор, варијација на реакционото време, здрави возрасни.

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