

**COMPUTER ADAPTED STROOP COLOUR-WORD CONFLICT TEST
AS A LABORATORY STRESS MODEL***
**Laboratuvar stres modeli olarak bilgisayarca uyarlanmış
Stroop renk-sözcük girişim testi**

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Abstract

Purpose: Stress is blamed as a factor responsible in the pathogenesis of many diseases. In stress literature, instead of initiating daily stress, to activate sympathetic system and hypothalamo-pituitary-adrenal axis are preferred. For this reason, we modified the Stroop colour-word interference test as a laboratory stress test.

Subjects and Method: We developed a software using visual basic programming language and generated a test composed of 3 sessions each lasting three minutes. Stress response was determined with the test applied to healthy subjects (n=38) who were informed that their performance would be evaluated. Heart rates, blood pressures and plasma cortisol, urinary metanephrine and vanillylmandelic acid values of the subjects who underwent Stress Test were measured as the evidence of stress system activation.

Results: Heart rate and blood pressure increase significantly throughout the test ($p<0.01$) and returned to basal levels after the test was completed. Basal and post test levels of plasma cortisol, urinary metanephrine and vanillylmandelic acid values were significantly different ($p<0.05$). Our computer adapted Stroop test had test retest reliability. Subjects performing the test more than once did not differ neither in their success nor in the stress parameters ($p>0.05$).

Conclusion: The Stroop test on our computer adapted modification may be a standard, objective, repeatable method easily applicable to stress research.

Key Words: Computer; Stress, psychological

Özet

Amaç: Stres pek çok hastalığın etiolojisinde suçlanan bir faktördür. Stres literatüründe günlük stresli durumları oluşturmak yerine sempatik sinir sistemini ve hipotalamo-pitüiter-adrenal aksı aktive eden standart yöntemlerin kullanılması tercih edilmektedir. Bu nedenle, laboratuvarda uygulanabilecek bir stres testi olarak, Stroop renk-sözcük girişim testini modifiye ettik.

Denekler ve yöntem: Visual basic programlama dili kullanılarak hazırlanan yazılımla, üçer dakikalık üç bölümden oluşan bir test bilgisayar ortamında uygulanır hale getirildi. Testin başında performanslarının değerlendirileceği söylenen sağlıklı deneklere (n=38) uygulanan testle, oluşan stres yanıtı değerlendirildi. Stres yaratıldığı, deney süresince yapılan kan basıncı ve kalp hızı ölçümleri ile, plazma kortizol, idrar vanilmandelik asit ve metanepfrin düzeyleri ile desteklendi.

Bulgular: Deneklerin test süresince kalp hızı ve kan basınçları anlamlı seviyede yükseldi ($p<0.01$) ve test sonlandırıldıktan sonra normal değerlerine döndü. Bazal ve test sonrası plazma kortizol ve idrar metanepfrin ve vanilmandelik asit seviyelerinde de artış saptandı ($p<0.05$). Bilgisayara uyarlanmış stres testimizde test-tekrar test güvenilirliği de vardır. Testi iki kez yapan deneklerde doğru yanıt yüzdesinde veya stres değişkenlerinde fark saptanmamıştır ($p>0.05$).

Sonuç: Stroop testi bilgisayara uyarlanmış bu şekli ile, standart, objektif, tekrarlanabilir bir yöntem olarak stres çalışmalarında kullanılabilir.

Anahtar Kelimeler: Bilgisayar; Mental stres

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Long before we knew about cells and body systems, it was realized that emotions and tension in daily life could influence health (1). Today, many scientists agree that the 21st century will be the age of stress related disorders. Since its first description by Hans Selye in 1936, stress has been the subject of increasing number of scientific studies. Stress is one of the well-defined factors blamed both in

pathogenesis and in exacerbations of many diseases from the common cold to severe cardiovascular disorders. Because, results from animal and human studies suggest that dysregulations of the hypothalamus-pituitary-adrenal (HPA) axis are involved in many behavioral, circulatory, endocrine and immune disorders (2,3). Although much interest has been focused on consequences of stress on body functions, systematic investigations of the relationship between behavioral, endocrine and immunological factors are still incomplete. Thus, the field of stress research is still open for investigations. However, applying an objective stress mimicing daily stressors is difficult and there are different ways of producing stress. On review of the literature for different stress tests on man, we concluded that an objective, standart test that could be reproduced is essential. Based on these facts, we developed a computerized version of the Stroop colour-word conflict test for use in future research and for establishing a standardized stress test applicable in laboratory conditions.

Stress Tests:

There are a variety of methods used as mental stress tests amongst which various questionnaires to asses daily stress, arithmetical tasks (eg; subtracting 7 from 700 each time until 0 or serial arithmetical calculations), public speaking (talking on a specified subject after a short preparation), solving a problem and convincing somebody of the solution, completing a puzzle, examination stress, colour-word conflict test can be listed (4, 5, 6, 7). However almost all of these have limitations, some of the tests requires high concentration and intellectual ability where as others, although more analogous to natural stressors, may exhibit adaptation. Moreover, performance in these tasks shows gender specificity (8). Keeping all these in mind, we chose a colour-word conflict test as an objective, non-gender specific method having test-retest reliability as a mental stress test applicable in the laboratory (9).

The Stroop test, primarily induces b-adrenergic response, and for the sympathetic system to be activated by both components it is applied with cold

pressor test (10). The Stroop test is also used as a neuropsychological tool in assesment of many cognitive functions such as selective attention, cognitive elasticity, general dysinhibition (11).

In its classsical version defined in 1935, the subject is asked to name the colour of the letters of a word, naming a colour written in incongruent colours. It has many different versions, using cards, video or projections with different time and plate combinations developed since its first description by Stroop (4). In a modified version of the Stroop test, the colours and words are spatially seperated. There is a colour bar which the participant should name, and ignore the colour word placed at a distance (12). Explanations for the Stroop interference mechanism remain a topic for debate. Some authors attribute the effect to stimulus conflict (13), while others, propose that the colour of the word and word itself produces two seperate potentials which compete with each other. Since word reading is faster, it interferes with slower process of colour naming (14,15). Although the exact mechanism creating Stroop effect is unclear, the data based on literature reveals that Stroop test increases physiological autonomic response.

COMPUTER ADAPTED STRESS TEST

The stress test was programmed using visual basic programming language in a Windows environment. The computer program does not need any special hardware but requires a minimum Windows 95/32 bit operating system. After execution of the program, a black background screen appears with 4 buttons placed at the bottom and the test words which have corresponding colours are placed in the center of the screen. The total test duration time and keyboard controls could be changed by the subjects taking the test. The Stress Test we used had 3 levels each lasting 3 minutes. Before beginning each part, instructions about the task were presented and the subject was warned that the performance would be evaluated. In the first level, colour words written in incongruent colours appeared on the screen and the subject was asked to indicate the word itself. In the second part, the

subject was expected to label the colour of the word and during the final 3 minutes, the colour of the word but with a warning sound created by a recorded warning or a beep sound presented concurrently with some words. The subject should indicate the colour of the word appearing simultaneously with the sound, or otherwise name the word itself. At the end of each session, the program presented a table of the testing subject's correct and incorrect answers.

SUBJECTS

Men (n=13) and women (n=25) volunteers, mostly employees of Hacettepe University were considered eligible if they were between 25-35 (mean age 30,22±3,19) years of age, healthy, normotensive, nonsmoking, medication free and had 20-25 kg/m² of body mass index (Table 1). Before participating in the study all the subjects provided written consent and underwent a complete physical examination. The study protocol was approved by the Ethics Comitee of the Hacettepe University

METHOD

The subjects visited the laboratory twice, aproximately 2 weeks apart to perform test. On the day of testing, the subjects are told to have a light breakfast and refrain from caffeinated beverages for 12 hours before test. The experiments were

always started between 9-10 a.m. in a room with a temperature between 21-25°C. A catheter to the nondominant arm for blood sampling, surface electrodes to both arms and left leg for EKG to determine heart rate (HR) and a sphygmomanometer cuff to the dominant arm for blood pressure (BP) measurement were placed after 15 minutes of rest. After instrumentation, the computer version of the Stroop test was started and followed by the cold pressor test. BP and HR were measured every 3 minutes before, during and after the test until baseline values were reached. Cortisol was measured with an autoanalyzer (Umlight 2000, Germany) in pre- and post-test plasma samples. The subjects collected urine for 24 hours the day before and after the test for urinary vanillylmandelic acid (VMA) and metanephrine determinations performed spectrophotometrically (Perkin-Elmer, Coleman Junior III 6/8, USA) (16,17).

STATISTICS

Data were evaluated with a software, SPSS® 10.0 for Windows®, on an IBM® compatible PC. To compare the pretest results with corresponding posttest values "paired t test" was used. "ANOVA for repeated measures" was used for HR and BP measurements. The data were presented as mean±SEM and p<0.05 is considered statistically significant.

Table I. General characteristics of the subjects

	Women (n=25)	Men (n=13)
Age	30,22 (±2,86)	31,3 (±3,62)
Body Mass Index (kg/m ²)	20,89 (±2,04)	21,51 (±2,41)

Table II. Heart Rate And Mean Blood Pressure Changes Observed During The Test

	Heart Rate (beats/min)	Mean Blood Pressure (mmHg)
Pre-test	79,4 (±6,94) [#]	90,2 (±7,18) [#]
End of the 1st part	83,6 (±7,66)*	101,2(±6,69)*
End of the 2nd part	89,5 (±8,12)*	109,8 (±7,53)*
End of the 3rd part	96,4 (±8,74)*	114,3 (±5,97)*
End of the cold-pressor test	110 (±7,28)*	118,9(±4,99)*
15th minute post-test	81,2 (±5,63)	93,5 (±3,85)*

Test effect $p < 0.05$ * Test effect $p < 0.01$ **Table III.** Plasma Cortisol, Urinary Metanephrine and Vanillylmandelik Acid Values in Pre-test and Post-test Samples

	Pre-test	Post-test
Plasma Cortisol (mg/ml)	17,56 (± 3,61)	28,03 (± 1,72)*
Urine Metanephrine (mg /24 hours)	0,51 (± 0,129)	1,43 (± 0,38)*
Urine Vanillylmandelik Acid (mg /24 hours)	4,07 (± 1,63)	13,22 (2,53)*

* Test effect $p < 0.05$

RESULTS

Stress response was followed with HR and BP measurements, both of which increased significantly ($p < 0.01$) as the test proceeds and compared to baseline values (Table II). After the test was terminated all values returned back to pre-test levels in 15 minutes .

Plasma cortisol and urinary metanephrine and VMA, indicating activation of the stress system were found to be significantly elevated ($p < 0,05$) in post-test samples compared to pre-test samples

(Table III).

The Stroop test also did not exhibit any difference in stress response when re-applied to the same subject after a period of 2 weeks. Neither cardiovascular parameters nor hormonal response following test was significantly different between the first and the second trial ($p > 0.05$). There was a strong correlation for HR ($r = 0,81$), BP ($r = 0,78$) and plasma cortisol levels ($r = 0,89$) in test-retest samples.

DISCUSSION

Originally described by J. Ridley Stroop in the

early 20th century and carrying his name, Stroop test in addition to its use as a psychological stressor, is also widely used as a neuropsychological tool for evaluation of some cognitive functions such as selective attention, cognitive elasticity, general dysinhibition (4,11,13,14). For both purposes it has many different versions, using cards, video or projections with different time and plate combinations (15). Since it has superior features compared to other stress models used in different studies, we chose this method to develop a standardised and objective computer adapted stress test which would be applicable in the laboratory. The modifications used in previous studies mainly comprised of 1 or 2 parts (18,19,20). The third part, giving the subject more conflict, is unique to our modification. Based on our data, it can be stated that this helped to elicit a stronger stress response. In accordance with the literature, the computer adapted Stroop test is also non-gender specific and has test-retest reliability which allows the test to be used easily on every subject, and if necessary more than once (20,21).

Based on these information, we propose the modified Stroop test as a beneficial alternative for use in laboratory as a mental stressor.

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