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Research Article

ASSESSMENT OF AGE AND GENDER ON PACED AUDITORY SERIAL ADDITION TEST AND PACED VISUAL SERIAL ADDITION TEST IN NORMAL SUBJECTS

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ABSTRACT
Paced Auditory Serial Addition Test (PASAT) has been used as a common research tool for different neurological disorders like Multiple Sclerosis. Recently, technology let researchers to introduce a new version of the visual test, the paced visual serial addition test (PVSAT). In this paper, the computerized versions of these two tests are introduced. The software calculates the number of true responses and the reaction time of subjects. We hypothesize that paying attention to the reaction time is valuable and should be concerned. For this purpose, sixty eight female normal subjects and fifty eight male normal subjects are enrolled in the study. We investigate the similarity between the PASAT3 and PVSAT3 in number of true responses and the new proposed criterion, the average reaction time of each subject. The similarity between two tests were rejected (p-value = 0.000) which means that these two tests differ. The effect of gender in the tests were not approved since the p-values of difference between PASAT3 and PVSAT3 in both gender is the same (p-value = 0.000) which means that male and female subjects performed the tests at no different level of performance. The new criterion shows a negative correlation with the age which offers aged normal subjects may have the same number of true responses as the young subjects but they have latent responses. This will give proof for the importance of reaction time.

Keywords: *Paced Auditory Serial Addition Test, Pace Visual Serial Addition Test, Response Time, Multiple Sclerosis, Age, Gender*

INTRODUCTION
Since 1974, PASAT has been used as a common research tools for different neurological disorders especially Multiple Sclerosis (MS) (Ramagopalan *et al.,* 2010; Tombaugh, 2006). The PASAT has been included as a major test to determine the MS outcome, because of its sensitivity to MS-related cognitive decline (Rogers and Panegyres, 2007), in MS clinics. PASAT is one of the major components of neurological tests as Multiple Sclerosis Functional Composite (MSFC) (Fischer *et al.,* 2008; Kurtzke, 2008).
In PASAT, patients are trained to add 60 pairs of single digits, such that each number is added to the one immediately preceding it. Then, they report the sum orally. The digits are presented by audiotape, first at a rate of 3 s per digit (PASAT3), then, in a second trial, at a rate of 2 s per digit (PASAT2). Scores are the sums of correct responses for the 3- and 2-seconds forms of the task (Fischer *et al.,* 2008; Potagas *et al.,* 2008).
The scores most commonly reported for the PASAT are the number of correct responses for each trial (maximum = 60) and the total number of correct responses summed over all trials (composite score). An alternative score suggested by Gronwall (1977) (Gronwall, 1977) is the average time per correct response (total length of a trial divided by the number of correct responses). The duration of each trial is calculated by multiplying the duration of the inter-stimulus interval (ISI) by 60 (e.g., 2.4×60 s= 144 s). According to Gronwall (1977) (Gronwall, 1977), the main advantage of this procedure is it provides a common method or outcome that permits comparing results from studies that use different number of trials or different number of digits within a trial. This measure, however, is often incorrectly viewed as providing information about the speed at which a person responds. Calculating the average correct response time

merely creates a ratio between the session length and number of correct responses. It does not provide any information about the actual average speed at which a person responded. This is illustrated by the following example where a computerized version of the PASAT recorded trial-by-trial response latencies (Royana *et al.,* 2004). However, the PASAT proves to be a demanding test (Fos *et al.,* 2000), which might cause patient dropout in clinical studies. In recent years, technology has allowed new versions of the visual variant of the test, the paced visual serial addition test (PVSAT) to be developed, using personal computers instead of the tachistoscope used in the past (Sampson, 1956; Razjouyan, 2013). The goal of this study is implement software to apply the PASAT and PVSAT tests. After the software is designed and the number of correct responses extracted, a signal which shows the reaction time of the subjects is prepared. Then, the average of reaction time form the prepared signal is utilized as a criterion for performance of cognition. For investing the software and the defined criteria, 126 normal subjects who have no cognitive deficit are included in the study. The possible effect of age and gender are assessed. The correlation between PASAT3 and PVSAT3 in normal controls is evaluated.

MATERIALS AND METHODS

Subjects

58 male and 68 female subjects were enrolled in this study and they are selected from BSc student of Amirkabir University of Technology. All of the normal subjects were examined by a neurologist specialist to be certain of no sign of cognitive deficit. These neurological tests performed in Hazrat-e-Rasoul Hospital, Tehran, Iran.

Methods

All subjects underwent the paced auditory serial addition test (PASAT) and paced visual serial addition test (PVSAT) using a pace of one stimulus on each 3rd second (PASAT3 & PVSAT3). These tests were administered according to the MSFC manual (Fischer *et al.,* 2008). In this test, 61 numbers below 10 are sequentially heard and shown via headphone and computer screen. In PVSAT, each stimulus was displayed for 1 s and stimulus intervals were 2 s (PVSAT-3) and the visual angle of the number height was 11.3o. In both tests, subjects are asked to say the summations loudly in microphone to estimate the reaction time. Reaction time is calculated when the subject speaks aloud in the microphone more than the settled threshold. All of the patients were first tested with PVSAT then PASAT test is administrated. After the test, patients were asked whether they preferred the auditory or visual variant of the test. Fig.1 shows the general shame of the software implemented for these modalities (PASAT & PVSAT).

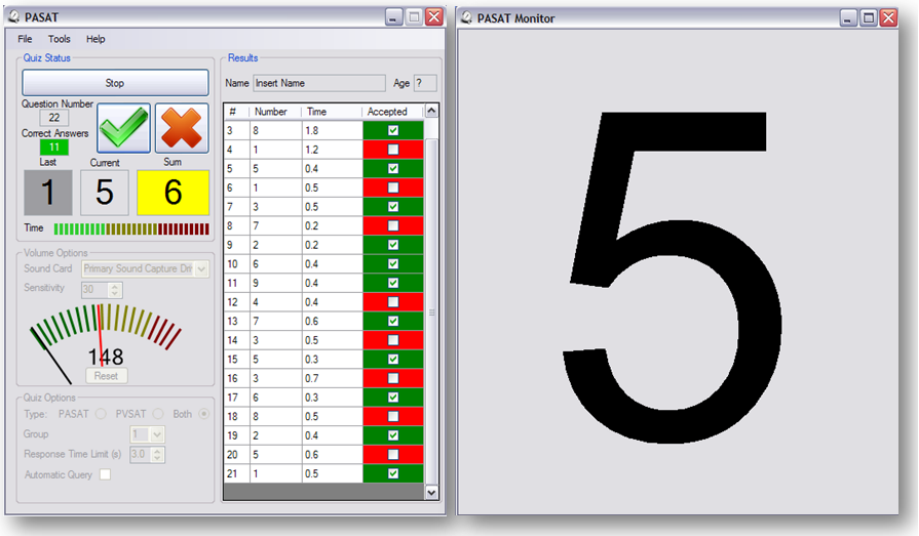

Figure 1: Software Implemented for administrating the modalities (PASAT & PVSAT).

Pasat Signal Preparation

In order to prepare a signal, instead of taking into account the trueness or falseness of response, we consider the time of patient's reply. This signal contains x-axis stands for 60 events (60 pairs of digits) and y-axis stands for the time of reply. The maximum of x axis is 60 which is started from 1 and ended to 60 with unit step, and the y axis maximum is 3 seconds (Fos *et al.,* 2000). The implemented software yields an excel outputs that have three columns. The first column has the number of the test, the second column shows the reaction time (RT) and the third one shows the trueness and falseness of the responses (TFR). The reaction time of true responses comes out with respect to the RT and TFR signals. Figure 2 shows the RT and the TFR for a normal subject.

To apply the effect of false response in the signal, the following approach is used. If the subject replies correct, we consider the time and if he replies false, we consider 3 seconds and if he loses the time, we consider 3 seconds too. Figure 3 shows a signal for a normal young subject.

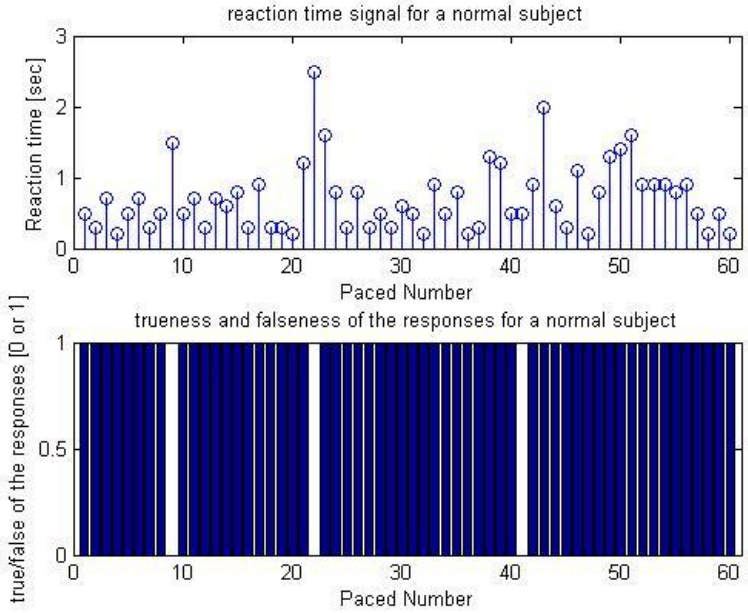

Figure 2: Output of the reaction time and the true/false responses coming from the software

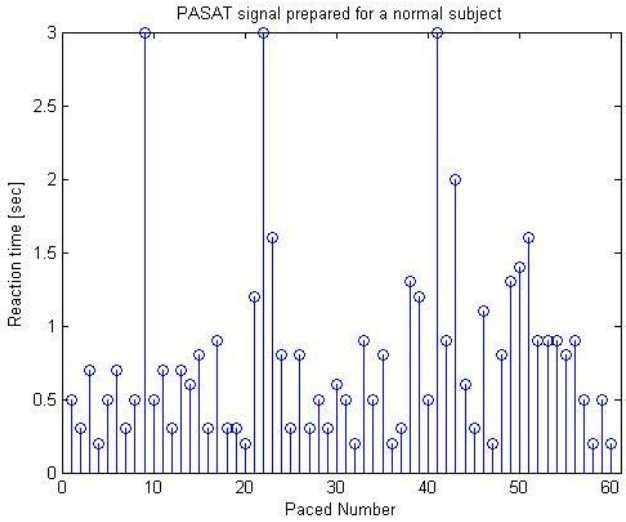

Figure 3: The PASAT signal test for female subjects aged 22 years

Statistical Analysis

Statistical analysis was performed with the Matlab Statistics toolbox (The Mathworks, USA) and SPSS (SPSS Inc., USA). The mean and standard deviation for each person is calculated and compared for each groups. In order to extract the difficult part of the test, the result of all the subjects true/false are put to gather and frequency of false response for each paced is calculated.

RESULTS AND DISCUSSION

Results

The possible influence of age in the two modalities is investigated. The analysis showed that the relationship between age and PASAT3/PVSAT3 performance in number of true responses is not significant (PASAT3; r = 0.033, p-value = 0.711 & PVSAT3; r = 0.066, p-value = 0.459), but the mean PASAT3 and PVSAT3 reaction time signal is increased by age inversely (PASAT3; r = -0.196, p-value = 0.028 & PVSAT3; r = -0.006, p-value = 0.945). The report shows a negative correlation between age and the performance of reaction time and a zero correlation between age and the number of true responses which means that by increasing the age of normal subjects their reaction time may decrease. The effect of gender in the tests were not approved since the p-values of different between PASAT3 and PVSAT3 in both gender is the same (p-value = 0.000) which means that male and female subjects performed the tests at no different level of performance.

The mean reaction of correct responses and false responses were calculated through RT signals. It has been seen that the mean reaction time of true responses for subjects are less than mean reaction time of false responses (Figure 4).

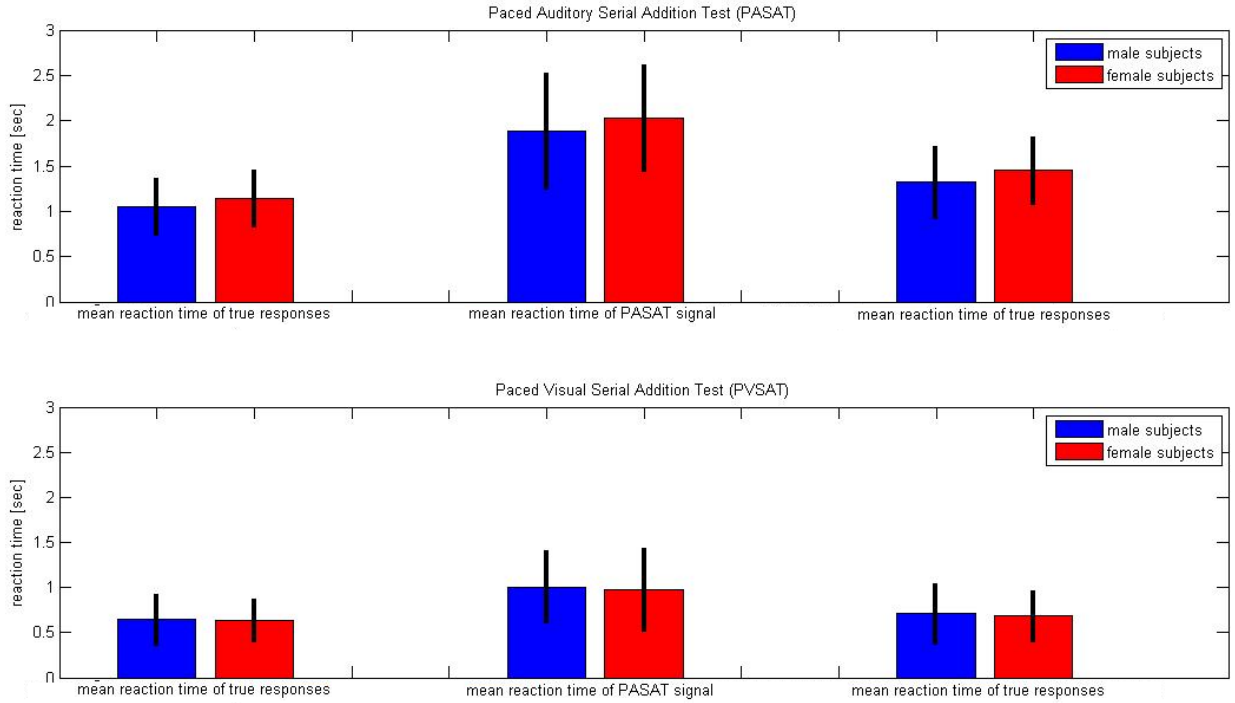

Figure 4: Comparing the mean and standard deviation of reaction time in male and female normal subjects for the true responses, false responses, and the signal. The top figure shows the PASAT test and the bottom one shows the PVSAT test.

In the Figure 5, the PASAT3/PVSAT3 signals of subjects are compared. It is seen that the average reaction time of PVSAT3 are less than the PASAT3. This yields that subjects have better performance in PVSAT3 than PASAT3 and this reason that why participants prefer visual format of test (mean PASAT3 signal = 1.389 (± 0.3897), mean PVSAT3 signal = 0.6959 (± 0.3055)). The number of true responses in

PVSAT3 is higher than PASAT3 (No. of true PASAT3 = 48.90 (± 6.42), No. of true PVSAT3 = 54.40 (± 7.03)).

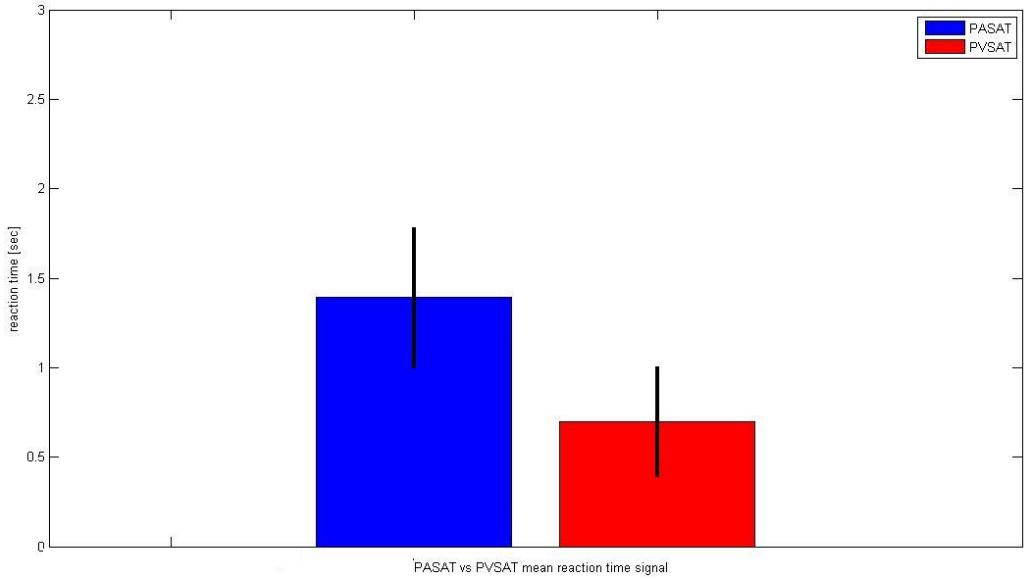

Figure 5: The mean and standard deviation of PASAT3 and PVSAT3 signal for normal subjects.

In the Figure 6 the frequency or of true responses for each paced of all the subjects in series one based on MSFC manual is shown. There are two point at paced seven teen and twenty seven that has the least true responses. Before paced seven teen the subjects heard 6 and they reply back (3+6 = 9) nine, at paced seven teen they heard 8 and their reply must be (6+8 = 14) fourteen. Before paced twenty seven the subjects heard seven and they reply back (1+7 = 8) eight, at paced twenty seven they heard four and their reply must be (7+4 = 11) eleven.

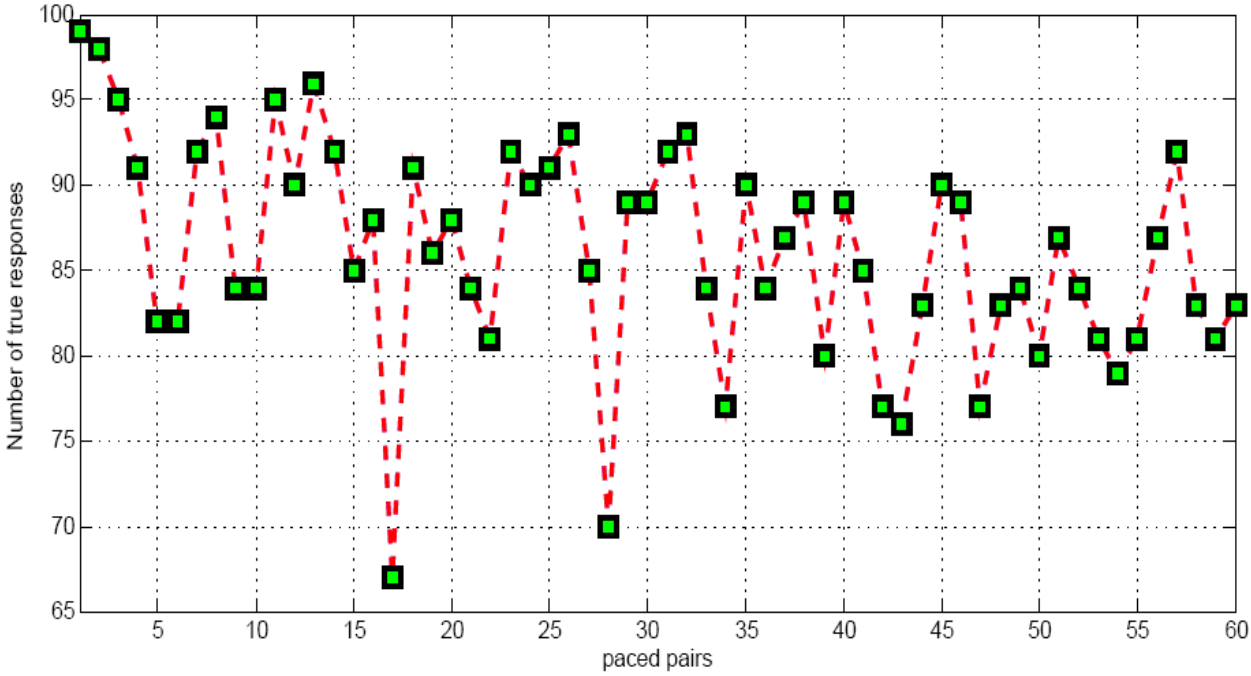

Figure 6: The frequency of true responses for all the subjects in each paced of one series based on MSFC manual

Discussion

In this paper, reaction time of subjects in PASAT3 and PVSAT3 tests is assessed through a software implementation. Sixty eight female and fifty eight male normal subjects (mean age of 22.3 ±1.6) are included in the study. All of the subjects were undergraduate students of Biomedical Engineering Department, Amirkabir University of Technology, and all of them examined clinically for any mental or physical deficit. A low noise place was chosen to eliminate any external interference. In this study a negative correlation between age and the reaction time signal is reported which means that by increasing the age the performance of normal subjects may decrease while a zero correlation between age and the number of true responses is reported. This may suggest that the elder subjects may have the same number of true responses but their reaction time is higher. Hence, the reaction gives better insight to the cognition state in alliance with the common report of these modalities. This statement gives us an insight for further study on elder normal subjects.

As it was reported in (Kurtzke, 2008), the statistical analysis informed us that there is no similarity in the results of PASAT3 and PVSAT3 which means that these two modalities may not replaced and substituted.

The approach in calculating the reaction time and preparing the PASAT3/PVSAT3 signal may provide a better tool in accompanying with the usual report of these modalities. Besides, we believe that such signal might give clinicians better insights to the cognitive status of MS patients specially speed processing. For instance, the mean or the standard deviation of this signal may suggest the mean attention of the patients or the degree of its disturbance. We think that this modified PASAT3 may help improve the MSFC.

REFERENCES

Fischer JS, Rudick RA, Cutter GR and Reingold SC (1999). The Multiple Sclerosis Functional Composite measure (MSFC): an integrated approach to MS clinical outcome assessment. *Multiple Sclerosis* **5**(4) 244-250.

Fos LA, Greve KW, South MB, Mathias C and Benefield H (2000). Paced Visual Serial Addition Test: an alternative measure of information processing speed. *Applied Neuropsychology* **7**(3) 140-6.

Gronwall DM (1977). Paced auditory serial-addition task: a measure of recovery from concussion. *Perceptual and Motor Skills* **44**(2) 367-73.

Kurtzke JF (2008). Historical and Clinical Perspectives of the Expanded Disability Status Scale. *Neuroepidemiology* **31** 1–9.

Potagas C, Giogkaraki E, Koutsis G, Mandellos D, Tsirempolou E, Sfagos C and Vassilopoulos D (2008). Cognitive impairment in different MS subtypes and clinically isolated syndromes, *Journal of the Neurological Sciences* 267 100–106.

Ramagopalan SV, Dobson R, Meier UC and Giovannoni G (2010). Multiple sclerosis: risk factors, prodromes, and potential causal pathways. *Lancet Neurology* **9** 727-39.

Razjouyan J, Gharibzadeh S, Fallah A and Khodadadi A (2010). A Revisited view to the Paced Auditory Serial Addition Test (PASAT) in Multiple Sclerosis. *Journal of Neuropsychiatry and Clinical Neurosciences* **22**(4) 438-451.

Rogers JM and Panegyres PK (2007). Cognitive impairment in multiple sclerosis: Evidence-based analysis and recommendations, *Journal of Clinical Neuroscience* **14** 919–927.

Royana J, Tombaugh TN, Rees L and Francis M (2004). The Adjusting-Paced Serial Addition Test (Adjusting-PSAT): thresholds for speed of information processing as a function of stimulus modality and problem complexity, *Archives of Clinical Neuropsychology* **19** 131-143.

Sampson H (1956). Pacing and performance on a serial addition task. *Canadian Journal of Psychology* **10**(4) 219-25.

Tombaugh TN (2006). A comprehensive review of the Paced Auditory Serial Addition Test (PASAT), *Archives of Clinical Neuropsychology* **21** 53–76.