Correlation between attention assessment tasks

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Abstract: Paying attention makes all the difference, in both professional and personal lives. This cognitive attribute therefore needs to be enhanced. To measure the enhancement it is essential that the cognitive attribute of attention be assessed before and after intervention. There are several types of tasks that may vary by a shade for assessing attention. The present study on young healthy engineering students reveals that the scores attained by subjects in three different tasks of attention namely Continuous Performance Task (CPT) and Go/No-GoP and Go/No-GoR are uncorrelated and therefore all 3 tasks will be required for assessing visual spatial attention.
Keyword: Attention, Attention Task, Psychology Experiment Building Language (PEBL), Pearson Coefficient.

1. Introduction to Attention

Attention is a process of focusing on particular information while ignoring other information. Attention can be broadly classified into three types [1]:

1.1 Sustained attention

It is the ability to direct and focus cognitive abilities on to a specific task or stimuli. In order to complete any cognitively planned activity, any sequence of action or a thought one must use sustained attention. For example: reading a newspaper article. In this act one must be able to focus on the activity of reading for very long. Problem occurs when a distraction arises. A distraction can interrupt and interfere in sustained attention. Sustained attention enables a person to continue doing one task for long period of time. The attention of the person in this case does not move away from a given task.

1.2 Selective attention

This type of attention can also be called as "freedom from distractibility". It enables a person to focus on the task even when surrounded by distraction. It can also be called as the ability to maintain a behavioural or cognitive set in the face of competing or distracting stimuli. For example: While playing in the field, a player should selectively focus on the game while ignoring other factors like noises, tension and anxiety.

1.3 Divided attention

It is considered as the highest level of attention. It is the ability to respond simultaneously to many tasks. It is also called as multitasking. Multitasking can be defined as the attempt to perform two or more tasks simultaneously. Research shows that while multitasking, people are more prone to make mistakes and perform their tasks more slowly [2] because in this case attention is divided among all the component tasks to perform them. Vast research on selective attention is being done on students while they were doing two tasks simultaneously. Study was done on subjects who were doing two tasks together, like driving and listening to the radio or attending a phone call. It was found that human attention system has limits to what it can process. Driving performance of human is reduced if he is engaged in some other task simultaneously like listening to music or attending a phone call. Multitasking while driving thus increases the risk of accidents [3].

2. Attention Assessment

Attention can be assessed broadly by two ways:

2.1 Physiological assessment

Attention can be assessed by physiological methods like Electroencephalography (EEG), Electrocardiography (ECG), Galvanic skin response (GSR), Heart rate variability (HRV) etc [4].

2.2 Psychological assessment

In this assessment, the candidate who is to be assessed is made to undergo various tests. Performance of the candidate in the task produces the task score that determines how well the candidate performed in the task. It also gives an idea of psychological parameters like response time of an individual. Such assessment can be done with paper-pencil or with the help of psychological test batteries available like Psychology Experimental Building Language (PEBL), Prevention and Early Intervention Program for Psychoses (PEPP) etc.

We are assessing attention by using psychological assessment task. We have used PEBL for psychological assessment of the participants. PEBL is an open source software program that allows researchers to design and run psychological experiments. PEBL includes a set of more than 50 common psychological testing paradigms as part of its Test Battery [5]. PCPT and Go/No-go are part of these testing paradigms.

The participants are made to undergo 3 psychological tasks related to different types of attention [6, 7, 8 and 9].

2.2.1   PEBL continuous performance task (PCPT)

It is a kind of neuropsychological task that measures a person's sustained and selective attention. In PCPT, the participant is given a reward point of 1 on responding to any character except 'X'. A reward point of 1 is also given on not responding to 'X'. Different characters are flashed 360 times on the screen. A score at the end of the task is given out of 360. Figure 1 shows a screenshot of how characters will appear on the PEBL screen, one at a time. This task continues for approximately 14 minutes.
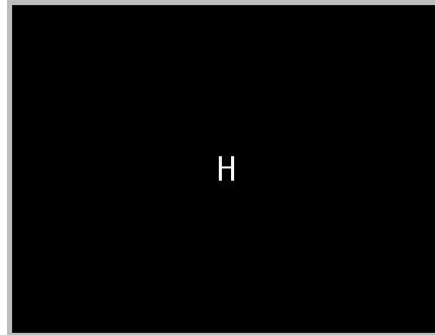

Figure 1: Screenshot of a single alphabet flashing on screen during PCPT

2.2.2   Go/No-GoP

It is a task for selective and sustained attention. In this task, participant will see a series of 'P' and 'R' flashing on the screen. The participant should respond to the 'P's (pressing the right shift key) flashing on screen while ignoring the 'R's (not pressing the right shift key). On each press of right shift key on flashing of 'P' and no pressing of any key on flashing of 'R', a reward point of 1 is awarded. In any other situation 0 is awarded. The task continues for over 4 minutes and at the end accuracy with which response to P and R is given is calculated as shown in (1) and (2).

$$\text{Accuracy of responding to 'P'} = \frac{correct\ response\ on\ P}{total\ number\ of\ P's\ flashed} \tag{1}$$

$$\text{Accuracy of responding to 'Q'} = \frac{correct\ response\ on\ Q}{total\ number\ of\ Q's\ flashed} \tag{2}$$

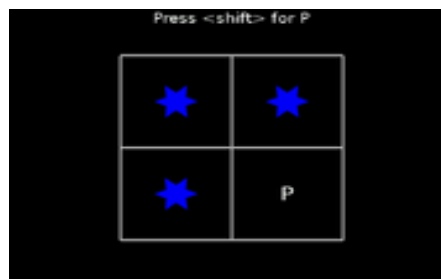Figure 2 shows how 'P' and 'R' will flash on the screen during Go/No-GoP.

Figure 2: Screenshot of stimuli "P" flashing on screen during Go/No-GoP

2.2.3   Go/No-GoR

This task is almost similar to Go/No-GoP and is performed immediately after it. The only difference being that in Go/No-GoR the participant should respond to 'R' while ignoring the 'P's. Accuracy with which response to 'P' and 'R' is given is shown by (1) and (2).

3.   Problem Definition

We have selected three tasks from PEBL related to selective and sustained attention. We are finding out whether these tasks are required to be performed separately or not. If these tasks are correlated then they need not be performed separately for attention assessment.

4.   Method

In this experiment fourteen participants are selected to perform attention tasks. All the participants have been made to play all the three tasks of attention namely Go/No-goP, Go/No-GoR and PCPT on PEBL[1 and 2]. Scores are given at the end of every task on the basis of performance of the participants in various tasks. These scores are automatically generated at the end of every task in PEBL. The scores from these three tasks are compared using Pearson coefficient and their correlation will thus be found.

5. Participants

Fourteen participants are selected to take part in this experiment. All are pursuing masters and bachelors in engineering from Thapar University, Patiala and are in age group of 20-25. None of the participants has any illness related to central nervous system including thyroid, multiple sclerosis, Parkinson's disease, stroke, diabetes and severe hypertension and has reported using no medication affecting the same. The participants have been informed about the purpose, protocol and time taken by the process before starting the experiment. All participants are voluntarily participating in the study.

6. Pearson Coefficient

Pearson coefficient is given by (1):

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})\,(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2}\ \sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}} \tag{3}$$

Where r Pearson Coefficient, x_i is first vector, y_i is second vector, $\bar{x}, \bar{y}$ are mean values.

A value of Pearson coefficient of $|0.1|$ to $|.3|$ represents poor correlation, $|.3|$ to $|.5|$ moderate and $|.5|$ to $|1|$ strong correlation.

Table 1 shows the scores of PCPT and accuracy of Go/No-Go tasks in range of 0 to 1. Mean of the accuracies of P's and R's in the two Go/No-go task is also calculated. Table 2 shows the Pearson coefficient between the three tasks.

For convenience let

Go/No-GoP(P) = A, which is the accuracy of P in Go/No-GoP task.

Go/No-GoP(R) = B, which is the accuracy of R in Go/No-GoP task.

Go/No-GoR(P) = C, which is the accuracy of P in Go/No-GoR task.

Go/No-GoR(R)= D, which is the accuracy of R in Go/No-GoR task.

Thus

$$\text{Mean Accuracy of Go/No} - \text{GoP is} = \frac{(A+B)}{2} \tag{4}$$

$$\text{Mean Accuracy of Go/No} - \text{GoR is} = \frac{(C+D)}{2} \tag{5}$$

Table 1: Scores of PCPT and accuracy of Go/No-Go

S. No.	A	B	Mean Go/No-GoP	C	D	Mean Go/No-GoR	PCPT
1	1	0.78125	0.890625	0.98437	1	0.992185	347
2	0.99218	0.46875	0.730465	0.97656	1	0.98828	323
3	1	0.6875	0.84375	0.9218	1	0.9609	337
4	1	0.9375	0.96875	1	1	1	348
5	1	0.40625	0.703125	0.97656	1	0.98828	346
6	1	0.75	0.875	0.95312	1	0.97656	354
7	0.99218	0.6875	0.83984	0.99218	1	0.99609	347
8	1	0.65625	0.828125	0.99218	1	0.99609	343
9	0.99218	0.9375	0.96484	1	1	1	337
10	1	0.5625	0.78125	0.99218	0.9375	0.96484	323
11	1	0.40625	0.703125	0.95656	1	0.97828	345
12	1	0.84375	0.921875	0.97656	1	0.98828	348
13	1	0.875	0.9375	0.99218	1	0.99609	348
14	0.99218	0.8125	0.90234	0.99218	1	0.99609	326

Table 2: Pearson Coefficient between PCPT, Go/No-GoP and Go/No-GoR

Tasks	Pearson Coefficient
Mean Go/No-GoP-Mean Go/No-GoR	0.448924194
Mean Go/No-GoP-PCPT	0.271126652
Mean Go/No-GoR-PCPT	0.238558289

Conclusion

It can be seen from Table 2 that Go/No-GoP and Go/No-GoR have a moderate correlation with Pearson coefficient of 0.44. The two tasks are almost similar still the correlation between the two task score is not high. This is because Go/No-GoR is immediately performed after Go/No-GoP and it takes time to unlearn the task of Go/No-GoP and learn Go/No-GoR. Go/No-GoP and Go/No-GoR have a very low correlation with PCPT with Pearson coefficient less than 0.3. This is because of the duration for which a subject sustains attention. The Go/No-go tasks are approximately 4 minutes long whereas PCPT is 14 minutes long. A weak correlation between the Go/No-Go tasks and PCPT shows that a person who has a short duration of attention span (as in Go/No-go) might not have an attention span as long as that required in PCPT and vice versa. Since correlation in no two tasks is high therefore it can be concluded that all the three tasks will required to be performed.

Future Work

Since no two tasks in our research have a high correlation between them, thus, for attention assessment through PEBL all three tasks will be performed separately. We can use these three tasks to do pre and post-intervention analysis of attention. Scores of the tasks can be analysed before and after intervention and comparative study can be done on the scores. This will tell us whether the scores are improving or degrading, thus, telling us whether the attention is being enhanced or degrading.

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