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Original Research Article

Study of Effect of Cold Pressor Test on Reaction Time among First Professional Medical Students

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ABSTRACT

Effect of stress (cold) on visual reaction time (VRT) and auditory reaction time (ART) was studied in 100 healthy subjects (17-25 yrs) by computer based software. During the standard cold pressor test (CPT), there was significant increase ($p< 0.001$) in VRT. There was significant increase ($p< 0.001$) in ART. There was increase in blood pressure and heart rate. This increase in VRT and ART with CPT was probably due to decreased conduction velocity of nerves, which could be due to vasoconstriction attributed to increased sympathetic activity caused by cold.

***Key words*:** CPT, ART, VRT

INTRODUCTION

Reaction time is the time interval between onset of stimulus to the appearance of appropriate voluntary response by the subject (Asmita S. Nene et al, 2010). [1] It is important in everyday life and requires association between sensory and motor systems (Shenvi D. et al, 1994). [2]

Reaction Time is described as:-

1) Simple Reaction Time:- Here one stimulus is presented which commands single response (Dr. Pranjali C. Shinde et al, 2014). [3]

2) Choice Reaction Time:- Here several different stimuli are presented and subject has to respond to a specific stimulus by discriminating various stimuli and making a choice amongst response (Dr. Pranjali C. Shinde et al, 2014). [3]

3) Mental Processing Time:- It is time required by subject to perceive stimulus and then identify, analyze and decide for the proper motor response.

RT is also affected by stress. In our study we utilized Cold Pressor Test to induce stress which will be useful to study the effect of the acute stress on reaction time. Sudden and painful cold stress causes massive activation of Sympathetic Nervous System and release of norepinephrine. This results in responses in the cardiovascular system which combines to increase B.P. This is known as pressor response (Velasco M. et al, 1997). [4]

It causes global sympathetic activation in response to cold stress (Victor et al, 1987). [5] Due to increased response of autonomic nervous system it is believed that cold pressor test affects a person's reaction time. Hence, in our study we planned to utilize Cold Pressor Test for testing Reaction Time, both auditory and visual in the age group of 17-25 years to observe the effect of stress on human reaction time.

MATERIALS AND METHODS

The study was conducted over first year medical students of the age group 17 to 25 yrs in Government College.

Selection of Subjects

The study comprised of 100 normal First Professional medical students of Government College. An informed consent was taken and a Proforma for a detailed medical history was filled for all the students.

Inclusion criteria:-

1. Subjects of either sex in age group of 17 to 25 yrs.
2. Subjects having normal hearing.
3. Subjects having normal vision.

Exclusion criteria:-

1. Patients with <17 and >25 yrs in age.
2. Patients with any type of musculoskeletal disability.
3. Subjects with metabolic disorders, known to affect hearing and or vision like diabetes, hypothyroidism etc.
4. Subjects with history of taking medicines affecting emotional status and endocrinological disorder.
5. Subject with any external ear, middle ear or cochlear disease.
6. Subjects taking ototoxic drugs .
7. Subjects with history of chronic smoking and /or alcohol abuse.

Study Design

Control Group

To eliminate as many confounding variables with our experiment as possible, each participant was his or her own control, meaning that physiological measurements of heart rate, blood pressure (systolic and diastolic), and reaction time were recorded prior to and during the cold pressor test, so that a statistical comparison could be analyzed.

1) Baseline measurements of B.P, Heart Rate and Reaction Time were done.
- B.P and Heart Rate were measured by a digital sphygmomanometer.
- Reaction Time was recorded by Edinburgh University Software.

2) After recording the baseline measurements, subjects were made to place their left foot into a container filled with water at temperature between 22^{O}C-25^{O}C to a point just above the ankle for 3 minutes and the temperature was measured by a lab thermometer.

3) During the last minute of the 3 minutes, B.P and Reaction Time were recorded.
- B.P was recorded by digital sphygmomanometer placed on subject's left arm.
- Reaction Time included visual and auditory reaction time tests.

4) The subjects were then made to place their same foot into the cold water at 4^{o}C – 5^{O}C for 3 minutes and at the end of this, B.P and Reaction Time were recorded.
- The temperature was measured by a lab thermometer.

5) Again the subjects were made to place their same foot into the room water bath for 3 minutes and at the end of this, B.P and Reaction Time were recorded.

6) During this procedure, there was continuous E.C.G recording.
- The recording was made using PhysioPac machine.
- Lead II E.C.G was recorded.

Statistical Analysis

Graphpad Prism version 5 was employed for statistical analysis of data.

RESULTS

Table 1 'Baseline', 'Before CPT', 'During CPT' and 'After CPT' values of SBP, DBP and HR

	BASELINE	BEFORE CPT	DURING CPT	AFTER CPT	Rise (Baseline to CPT)	P value (Baseline Vs CPT) (P<0.05 is Significant)
SBP (mm Hg)	115.5±6.01	115.7±7.57	122.1±7.66	116.2±8.25	6.620 ± 0.97	< 0.0001
DBP (mm Hg)	79.47±4.11	78.94±4.94	84.93±4.96	80.81±6.13	5.460 ± 0.64	0.0197
HR (times/min)	75.48±6.06	75.66±7.22	82.42±7.18	75.79±7.35	6.940 ± 0.93	< 0.0001

There was increase in SBP, DBP and Heart rate of subjects during the cold pressor test. The rise in these parameters from baseline to during CPT is shown in Table 1. There was significant increase in SBP ($p< 0.0001$), DBP ($p< 0.05$) and Heart rate ($p< 0.0001$). Table 2 shows the comparison of VRT and ART between baseline and during cold pressor test. A significant increase in VRT ($p< 0.05$) and ART ($p< 0.05$) were noted during CPT.

Table 2 'Baseline', 'Before CPT', 'During CPT' and 'After CPT' values of VRT, ART

	BASELINE	BEFORE CPT	DURING CPT	AFTER CPT	Rise (Baseline to CPT)	P value (Baseline Vs CPT) (P<0.05 is Significant)
VRT (msec)	294.1±30.5	294.4±29.46	296.8±28.48	293.6±29.60	2.742 ± 4.173	0.0009
ART (msec)	230.7±21.84	229.8±18.16	237.2±17.86	229.6±18.85	6.558 ± 2.821	0.001

DISCUSSION

In the present study Baseline systolic blood pressure in all 100 subjects was observed with a mean value of 115.5±6 mm Hg and the corresponding figures for the diastolic blood pressure are 79.47±4.1 mm Hg.

On application of Cold Pressor Stimuli for 3 minutes in entire series of 100 subjects an average rise of systolic blood pressure was 6.62 mm Hg ($P<0.001$) and for diastolic blood pressure it was 5.46 mm Hg ($P=0.0197$). This is in accordance with study conducted by Briggs and Oerting. [6]

CPT exposure leads to profound changes in cardiovascular parameters notably a rise in blood pressure through peripheral vasoconstriction and to a lesser extent cardiac output resulting from an increase in both vascular alpha-adrenergic and cardiac beta-adrenergic drive.

The CPT is a predominantly adrenergic stressor observed by Pascualy et al, 2000 [7] inducing alpha- and beta-adrenergic activation. Cold induces stress which causes physiological changes to occur in body like release of catecholamine hormones. These hormones include epinephrine, norepinephrine and cortisol. The main stress hormone Cortisol is permissive of adrenergic receptors which supports the sympathetic system and helps in maintenance of B.P. The other catecholamines epinephrine and nor-epinephrine then lead to rise in H.R. and vasoconstriction and consequently leading to rise in B.P by acting on the presented adrenergic receptors.

Our study observed a significant increase in both auditory reaction time ($p<0.001$) 'During CPT' (237.2±17.86) compared to 'Baseline' (230.7±21.84) and visual reaction time ($p=0.0009$) 'During CPT' (296.8±28.48) compared to 'Baseline' (294.1±30.5). The increase in duration of reaction time is explained on the fact that cold causes increased sympathetic activity which causes vasoconstriction that leads to decrease in nerve blood flow which causes decrease in conduction velocity of nerve and leads to an increase in reaction time. Similar effect is observed in study by Sethi et al. [8] However, Fagius et al [9] have reported that intensity to cold did not produce any sympathetic discharge and response during CPT is not cold dependent but is rather due to nociception caused by cold observed in few other studies.

CONCLUSION

It can be concluded that stress affects reaction time, both visual and auditory. This study attempted to discover whether or not non-experimentally induced stress has an impact on reaction time. While there was a difference, it is not conventionally considered to be quite statistically significant. This study is one of the rare studies that has focussed solely on stress and reaction time. Its findings provide support for the hypothesis that stress impacts reaction time, although future

research and more conclusive results regarding this type of stress are needed.

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