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Cognition, autonomic function, and intellectual outcomes of the paramedical health-care personnel in the hospital settings

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Abstract:

BACKGROUND: In the dedicated intensive care settings, health-care providers need to have higher temporal cognition and sympathovagal balance to optimally deliver critical care interventions.

OBJECTIVE: The objective of the study was to estimate the parameters of the temporal cognition and autonomic function of paramedical staffs in acute health-care settings.

MATERIALS AND METHODS: In this study on 81 healthy adult paramedical personnel, temporal cognition was assessed using auditory reaction time (ART), visual reaction time (VRT), critical flicker fusion frequency (CFFF), Stroop test (ST), and digits forward test (DFT); Autonomic functions were assessed by heart rate (HR) and blood pressure (BP) variability, and all these outcomes were analyzed with their academic performance.

RESULTS: Out of 81 healthy adult nonteaching technical personnel, majority was female; the mean age was 25.10 ± 3.93 years. Age and gender were not significantly related with screen times in terms of smartphone use, playing video games, or regularly using computer; academic performances were also not significantly related with screen times in terms of smartphone use, playing video games, or regularly using computer. In the conventional domains, during analysis of physiological and psychological variables under study, there was no significant relation with screen times when compared with HR, systolic BP, diastolic BP, mean arterial pressure, body mass index, ART, VRT, CFFF, ST, and DFT. Playing video games and regular computer use were significantly correlated with age, gender, AP, CFFF, ST, and DFT.

CONCLUSION: This study on paramedical personnel showed a positive relation of temporal cognition and sympathovagal autonomic balance with performing a task or function.

Keywords:

Academic performance, autonomic function, nonteaching technical personnel, temporal cognition

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Introduction

Cognition and autonomic functions are multifactorial meticulous components of the intellectual process. Temporal cognition is one of the facets that includes among other psychological processes recalling one's experiences, making and executing plans, to accomplish certain roles, namely perception, attention, and memory. Autonomic functions are inborn set of mechanism that promotes fine-tuning of the intellectual capacities with extreme precision and desired outcomes.

Temporal cognition and autonomic functions play a vital role in designing proficiency

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in health-care professionals.[1] Temporal cognition incorporates the set of brain functions to feel the flowing of time and processing the temporal characteristics of earthly phenomena, i.e. relating to worldly as opposed to spiritual affairs. This usually embraces the processing time in health-care settings which is central to our everyday accomplishments by recalling, making and executing plans to achieve precise health-care interventions. Sympathovagal balance is necessary for equilibrium the rate and/or speed of motion or activity of daily life of human existence. Optimization of the vital functions in human life, therefore, needs balance play of both temporal cognition and sympathovagal activities in cohesive and synchronous way. Their key role in human life along with clinicians is further emphasized when a person meets with the emergency situations which load health-care personnel with too many things to carry on sequential and synergistic use of cognition, reflex, reactions, spontaneity, decision-making, and sympathetic activity as occurs in paramedical staff dealing with critically ill patients even after hospital discharge in the domiciliary settings.[2-4]

In the above scenario, this study was conducted on health-care personnel relating to services and professions which supplement and support medical interventions (paramedical staffs) with objectives to find temporal cognition and sympathovagal balance in acute health-care settings.

Materials and Methods

The study was conducted on the census population of 81 healthy adult paramedical staffs engaged in the intensive care settings of this tertiary care teaching hospital of South India.

Inclusion criteria

All the paramedical personnel working in the critical care settings who were willing to participate were included in the study.

Exclusion criteria

Unwilling, noncooperative, sick, and absentee paramedical staffs were excluded from the study.

Ethical considerations

The institute ethics committee approved the study, and necessary permission was obtained from the regulatory authorities before initiation of the study. Declaration of Helsinki was followed in letter and spirit, and all the ethical principles were adhered to while gathering the information with strict confidentiality, followed by the "informed consent process." The paramedical personnel who were recruited following the inclusion criteria were counseled individually prior to participation that they had full autonomy to leave at any point of time during the study period, and no potential harm was involved. Each participant was ensured that the collected data will be kept confidentially with the researchers and would have been only be used for research purpose. Their consent would not have affected their job profile whether they were participating whole period in the job irrespective of their participation in the study. After that, written informed consent was individually obtained from each participant with free mindset without any coercion before enrolling for the study. In this study, any limitations on the sociodemographic criteria of gender, ethnicity, smoking, alcohol, dietary patterns, or precise job profile were set aside for being participant in this study. The participants were also encouraged at the beginning of the study regarding free expression of their disadvantages or problems whether related to study or not and every time reinforced before collecting data. The sanctity and secrecy of the data were maintained and were strictly kept confidential with the investigators and were not being disclosed for the assessment, management, or intervention.

Data collection procedure

The study was performed in a time span of 3–4 h/day for 2 consecutive weeks. Temporal cognition and sympathovagal response were assessed using the following methods:

Visual reaction time and auditory reaction time

Visual reaction time (VRT) and auditory reaction time (ART) were recorded using 1000 Hz square wave generator and one in two keys, in modules A and B to start and stop the oscillator respectively by the red color visual stimulus LED light. The number of oscillations produced was recorded as reaction time with millisecond accuracy. Similarly, ART was recorded as the participants were asked to hear a tone of 1000 Hz in the headphones, provided to them, instead of red color light.[5-10]

Critical flicker fusion frequency

Critical flicker fusion frequency (CFFF) was measured using red light-emitting diode that flickers at different frequencies in the range of 10 Hz–60 Hz in a partial dark room. The participants were asked to prompt with increasing frequency from 10 Hz till they no longer were able to discriminate individual flickers and perceived as single stimulus at CFFF; the total experiment was reversed by lowering the frequency till the participants responded that they were identifying distinctively the flickers again.[11-19]

Stroop test

The participant was asked to verbalize both colour of the 'name' and the 'font' and this activity was recorded vis-a-vis reaction time for correctness in two unlike conditions viz. congruent: colors of names and fonts were

kept the same. Incongruent: color name and font differed; participants took longer time to respond in the latter.[20-23]

Digits forward test

Ascertaining forward and backward digit span is popularly used neuropsychological tests to assess short-term verbal memory. Digit span measured for forward and backward recall of digit sequences commencing with a length of two digits and two trials. Test ceases when anyone fails to precisely report either single sequence length or maximal list length was reached.[24-26]

Heart rate variability

A sympathovagal balance was assessed by 5-min recording of lead II electrocardiogram (ECG) for heart rate (HR) variability analysis. Audacity software was used for recording the ECG waves and storing raw files of ECG and also to create the RR interval file. HRV analysis software for HR variability (HRV) analysis was used. The latest available is KUBIOS HRV, which was freely downloadable (just requires a simple registration procedure). The recorded ECG from audacity was providing the RR interval in seconds. (Three decimal which meant 1 ms accuracy). This column with millisecond data for RR interval was copied and pasted in a notepad and labeled as final RR interval file.[4,27-29]

Data analysis

The data were collected only by principal investigator as per the detailed questionnaire for all the participants by face-to-face interview technique comprising of personal details, clinical history including family history, and examination details. The collected data were cleaned and entered in the "Master table" and were imported in the IBM SPSS version 20 (IBM SPSS Statistics for Windows, Version 20.0. IBM Corp, Armonk, NY, USA) software to analyze the data. Bootstrapping was done during each spell of analysis of each of the variables. Chi-square test was applied to find significance of relationship of the dependent and independent variables; an alpha level of 5% was considered significant at 95% confidence interval for all the parameters.

Results

This hospital-based study was designed to find the conventional domains of temporal cognition and autonomic function of paramedical personnel working in critical care settings in the tertiary care teaching hospital.

Out of 81 healthy adult nonteaching technical personnel participants in this study, 17 were male; 78 were right-handed persons, 2 both handed (both female), and 1 ambidextrous (male). The mean age of the participants was 25.10 ± 3.93 years. Age and gender of participants were not significantly related with screen times in terms of smartphone use, playing video games, or regularly using computer. Further academic performances were also not significantly related with screen times in terms of smartphone use, playing video games, or regularly using computer [Table 1].

In the conventional domain, during the analysis of physiological and psychological variables under study, there was an important change in digits forward test (DFT) with smartphone use, but this was not significant; in HR and VRT, changes were noted with regular computer use, but this was also not significant. In other parameters, there was no significant relation with screen times when compared with HR, systolic blood pressure (BP), diastolic BP, mean arterial pressure, body mass index, ART, VRT, CFFF, Stroop test (ST), and DFT [Table 2].

In Pearson correlation (partial) analysis, playing video games and regular use of computer by the participants were significantly correlated with age, gender, academic performances, CFFF, ST, and DFT. However, when compared with the use of smartphone, ART and VRT, the age, gender, or academic performances were not found significantly correlated [Table 3].

In Pearson correlation (partial) analysis, 'Age' was significantly related with smart phone use, HR, and VRT while 'Gender' was with smart phone use and CFFF. ART was significantly related with smart phone use, VRT and ST; DBP was significantly related with playing video games, MAP, BMI and VRT while MAP with BMI only [Table 4].

Discussions

The study was carried out to find association between temporal cognition, autonomic function, and academic performance in healthy nonteaching technical personnel to quantify the temporal cognition using ART, VRT, CFFF, ST, and DFT, to assess the sympathovagal balance using HRV analysis, to correlate their intellectual outcomes with temporal cognition and sympathovagal balance.

Auditory and visual reaction time

The assessment of reaction times facilitates the evaluation of sensorimotor association and performances as well as alertness to acknowledge and respond to a stimulus depending on various perceptions, namely see, hear,

Table 1: Age and gender in relation to screen time and intellectual performances

Parameters	Smartphone use	Play video games	Regular use of computer	AP (%)
Age	0.32	0.83	0.40	0.70
Gender	0.24	0.57	0.14	0.31
AP (%)	0.30	0.46	0.52	

All the values in the table are Chi-square values and none was significant at the alpha level of 0.05., asymptotic significance (two-sided). AP=Academic performance

Table 2: Screen time in relation to physiological and psychological variables under study

Parameters	Smartphone use	Play video games	Regular use of computer	Remarks
HR (beats/min)	0.17	0.40	0.07	
SBP (mm/Hg)	0.31	0.30	0.22	
DBP (mm/Hg)	0.76	0.38	0.60	
MAP (mm/Hg)	0.26	0.40	0.45	
BMI (wt/m2)	0.24	0.49	0.34	
Auditory reaction time(s)	0.10	0.82	0.38	
Visual reaction time(s)	0.69	0.64	0.06	
Critical flicker fusion frequency (Hz)	0.20	0.59	0.09	
Stroop test (time s)	0.41	0.62	0.78	
Digits forward test (score)	0.06	0.65	0.17	

All the values in the table are Chi-square values and none was significant at the alpha level of 0.05, asymptotic significance (two-sided). HR=Heart rate, SBP=Systolic blood pressure, DBP=Diastolic blood pressure, MAP=Mean arterial pressure, BMI=Body mass index

Table 3: Correlation among screen time variables

Age	Smartphone use	Play video games	Regular use of computer
Age			
Smartphone use		0.99	0.11
Play video games	0.99		0.03
Regular use of computer	0.11	0.03	
Gender			
Smartphone use		0.76	0.23
Play video games	0.76		0.04
Regular use of computer	0.23	0.04	
AP			
Smartphone use		0.80	0.19
Play video games	0.80		0.04
Regular use of computer	0.19	0.04	
Auditory reaction time(s)			
Smartphone use		0.82	0.17
Play video games	0.82		0.05
Regular use of computer	0.17	0.05	
Visual reaction time(s)			
Smartphone use		0.84	0.22
Play video games	0.84		0.05
Regular use of computer	0.22	0.05	
Critical flicker fusion frequency (Hz)			
Smartphone use		0.79	0.17
Play video games	0.79		0.47
Regular use of computer	0.17	0.47	
Stroop test (time s)			
Smartphone use		0.82	0.17
Play video games	0.82		0.046
Regular use of computer	0.17	0.046	
Digits forward test (score)			
Smartphone use		0.63	0.20
Play video games	0.63		0.04
Regular use of computer	0.20	0.04	

Significance level was set at the alpha level of 0.05. Pearson correlations (partial) two-tailed test was done with bootstrap results based on 1000 bootstrap samples

feel, or responses namely agility to act with the optimal response time. Reaction times will be the sum total outcome including motor components augmented by the physical activities as an important correlate of the good and alert nervous system, and different studies reported on the relation of ART/VRT, gender, and physical activities in different settings.[5-10]

Critical flicker fusion frequency

Human vision requires finite time varying from man to man to collect and process information; intermittent stimuli reaching eyes are perceived separately till certain threshold, i.e. the CFFF evaluating visual temporal resolution. Perceptual internalization of visual stimuli transfer from the real world depends on the complexity

Table 4: Correlation among independent and dependent variables (*P*<0.05 significance at 95% confidence interval)

Parameters	Age	Gender	Use smartphone	Play video games	Regular use of computer	HR	SBP	DBP	MAP	BMI	ART	VRT	CFFF	ST	DFT
Age		0.14	0.07	0.811	0.308	0.044	0.199	0.317	0.689	0.307		0.003	0.11	0.90	0.87
Gender	0.000		0.021	0.461	0.938	0.702	0.862	0.193	0.157	0.068	0.956	0.872	0.011		
Smartphone use	0.001	0.021		0.647	0.371	0.395	0.514	0.990	0.560	0.938	0.010	0.283	0.937		
Play video games	0.811	0.461	0.647		0.869	0.810	0.586	0.044	0.986	0.762	0.882	0.153	0.886		
Regular use of computer	0.308	0.938	0.371	0.869		0.694	0.762	0.119	0.106	0.451	0.461	0.444	0.659		
HR	0.044	0.702	0.395	0.810	0.694		0.659	0.373	0.226	0.522	0.330	0.623	0.412		
SBP	0.199	0.862	0.514	0.586	0.762	0.659		0.165	0.588	0.906	0.132	0.157	0.222		
DBP	0.317	0.193	0.990	0.044	0.119	0.373	0.165		0.000	0.000	0.245	0.043	0.121		
MAP	0.689	0.157	0.560	0.986	0.106	0.226	0.588	0.000		0.001	0.172	0.228	0.358		
BMI	0.307	0.068	0.938	0.762	0.451	0.522	0.906	0.000	0.001		0.768	0.097	0.756		
ART												0.003	0.11	0.003	0.11
VRT											0.003		0.48	0.32	0.11
CFFF											0.11	0.48		0.81	0.08
ST											0.90	0.32	0.81		0.30
DFT											0.88	0.11	0.08	0.30	

Significance level was set at the alpha level of 0.05. Pearson correlations (partial) two-tailed test was done with bootstrap results based on 1000 bootstrap samples. BMI=Body mass index, weight (kg)/height (m^2), HR=Heart rate, AP=Academic performance, SBP=Systolic blood pressure mm/Hg, DBP=Diastolic blood pressure mm/Hg, MAP=Mean arterial pressure, ART=Auditory reaction time(s), VRT=Visual reaction time(s), CFFF=Critical flicker fusion frequency (Hz), ST=Stroop test, DFT=Digits forward test

of the tasks. Hence, the health-care personnel need to be trained to improve CFFT threshold in critical care settings.[11-19]

Stroop test

Irrespective of the color of the font, readability is spontaneous at the word level, whereas automaticity is generally accepted to be a major goal of reading instruction and practice unless there are major problems of acuity and color vision as well as dyslexia. Literature supports Stroop hindrance is optimistically interconnected to reading ability and automaticity.[20-23]

Digits forward test

In their given situations of studies, various researchers have noted the effects of age, education, and gender on verbal forward and backward digit span tasks. Literature supports the existence of age-related declines in forward and backward digit span tasks, although it appears that adjusting for education and gender differences reduces modestly.[24-26]

Heart rate variability analysis

HRV analysis is preferred as one of the important noninvasive methods to assess the autonomic nervous system (ANS). ECG HRV analysis in both time and frequency domain from differences between consecutive R waves in the ECG signal candidly reflecting intentionally generated responses to internal and external stimuli as ANS is the primary regulator of cardiac chronotropy. Other cardiovascular variability signals (e.g. BP changes) and respiratory efforts provide supplementary value to assess traumatic brain injury, posttraumatic stress disorder, and peripheral neuropathy.[27,29,30] Neurocognitive impairments have been studied in critically ill patients present alterations in ANS which can persist even after hospital discharge; in particular, it has been observed an increasing number of cases. Neurocognitive rehabilitation has been suggested to improve cognitive deficits, and HRV parameters are proposed to analyze its response and effectiveness to improve the ANS integrity.[4] The temporal cognition is essential for life for normal human behavior. Temporal cognition and sympathovagal balance are the most important factors for serving critically ill patients. On the other hand, agitation is a frequent complication in critically ill adults, can result in life-threatening events for patients or care providers, and extends the hospital length of stay, thereby increasing hospital costs for which studies are needed to clarify patients' risk factors and to identify strategies (both pharmacological and nonpharmacological) to prevent, ameliorate, or treat this complication.[28,31]

Strengths and limitations

The study on the temporal cognition and sympathovagal balance healthy adult nonteaching technical personnel was a novel study in this subcontinent. The data collected in this study can help the stakeholders to set minimum norms pertaining to cognition and sympathovagal balance required for technical personnel to serve the patients in a better way in the near future but needs to be validated by further researches as this was a single-center study.

Conclusion

To sum up, the results of current and related research point toward urgent need of capacity building for the entire spectrum health-care provider team from a physician through nursing and paramedical technical personnel in the critical care settings. Further, this has to be extended to all levels of health-care settings for the comprehensive intervention schemes till the domiciliary household levels. To accomplish, we need holistic goal with targeted training and retraining, so that the workforce resources are optimally competent with the armamentarium of temporal cognition and sympathovagal balance to optimally serve critically ill patients.

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Conflicts of interest

There are no conflicts of interest.

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