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Relationship between general intelligence, emotional intelligence, stress levels and stress reactivity

Yogesh Singh and Ratna Sharma

Department of Physiology, All India Institute of Medical Sciences New Delhi – 110029 INDIA

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Corresponding Author:

Ratna Sharma, MD
Tel : +919871491260
E-mail : ratnaaiims@gmail.com

ABSTRACT

Background: Stressful life events and daily life stresses have both deleterious and cumulative effects on human body. In several studies, stress has been shown to affect various parameter of higher mental function like attention, concentration, learning and memory. **Purpose:** Present study was designed to explore the relationship among GI level, EI level, psychological stress levels and acute stress reactivity in young normal healthy subjects. **Method:** The study was conducted on thirty four healthy male student volunteers to study a) acute stress reactivity in subjects with varying levels of General Intelligence (GI) and Emotional Intelligence (EI) and b) correlation between GI, EI, acute stress and perceived stress. Baseline GI and EI and acute stress and perceived stress scores were measured by standard assessment scales. Using median value of GI and EI scores as cutoff values, subjects were categorized into four groups. Among different GI-EI groups, acute stress reactivity was similar but salivary Cortisol (especially post stressor level) and perceived stress level was a differentiating factor. **Results:** High level of EI was associated inversely with acute and chronic perceived stress level. Significant correlation was found between acute and chronic perceived stress levels. Level of general intelligence showed no relation to acute or chronic stress levels as well as acute stress reactivity. The differences in various groups of GI and EI had no effect on the baseline and post stress performance on Sternberg memory test and all the three conditions of Stroop test. **Conclusion:** In conclusion emotional intelligence as an attribute is better suited to handle day to day acute stress and chronic perceived stress.

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Introduction

In the modern times of globalization and enhanced performance demands stress is present universally, and none of us can escape daily life stresses. Stressful life events and daily life stresses have both deleterious and cumulative effects on human body. In several studies, stress has been shown to affect various parameter of higher mental function like attention, concentration, learning and memory.[1,2] Generally all stressful events generate certain category of emotions of varying intensity, which may also affect cognition and performance.[3]

According to Lazarus and Folkman[4] stress is the result of an interaction between the individual and the environment in which the individual assesses deficiencies in her/his coping strategies in response to a demanding situation. There is the existence of four processes during this interaction. The first is the perception of an internal or external stimulus; the second is the evaluation of that stimulus as a threat to wellbeing; the third is the appraisal of cognitive and/or physical coping resources, and the fourth is a complex set of cognitive and somatic responses known as the stress response.[3] Apart from a few exception like an actual threat that can directly lead to the stress response, there is a consensus that it is the individual's appraisal of that event which will determine if an event will be experienced as stressful and what are key player for the appraisal response? Cognitive capacities are key players in the appraisal response of the individual. The stress response begins, not after the perception of the stimulus, but after the cognitive appraisal of that stimulus as a threat.[5] The stress response that follows is also based on the environmental and personal characteristics of the individual.[3]

Individuals make their cognitive appraisals by using their cognitive capacities and abilities. So it is plausible that our level of general intelligence and emotional intelligence should affect stress response.

The related literature points to a negative correlation between cognitive or general intelligence and stress symptoms. Individuals with low cognitive ability and highly neurotic personalities are more vulnerable to stress. Investigations using advanced brain imaging reported a reduction in hippocampal volume in individuals with long-term Post Traumatic Stress Disorder (PTSD). It is thought that this shrinkage is responsible for the observed memory problems.[6] Also chronic and intense stress has negative effects on intelligence. The complex and relatively unexplained relationship between cognitive intelligence and stress remains ambiguous. It is not yet clear whether low intelligence leads to chronic stress or if chronic stress leads to a deficient hippocampus and, consequently, to lower cognitive intelligence.

A growing body of research has found a wide range of important life outcomes that are not adequately predicted by traditional measure of cognitive intelligence but can be predicted by the emotional intelligence. Emotional intelligence is the ability to recognize emotion, reason with emotion and emotion-related information, and process emotional information as part of general problem solving.[7] High-level of emotional intelligence can significantly predict healthy functioning, as well as the distress and experience of traumatic stress.[8] It has been reported that individuals with high level of emotional intelligence experienced less stress at work.[9,10]

It is also well known that we react differently to same type of stress because each of us is shaped by our own experience and our unique genetic makeup. Can different levels of General Intelligence (GI) and Emotional Intelligence (EI) contribute to differential stress responses in different individuals? Can our level of intelligence save us from the daily life stressors and its harmful effects on body & mind? Or is it the reverse, that is, intelligent people are more prone to experiencing the stress

and its related deleterious health consequences? Moreover, as stated earlier that all stressful events are also associated with generation of different type of emotions, can our level of emotional intelligence helps us to cope better with the stress?

To answer these intriguing questions, present study was designed to explore the relationship among GI level, EI level, psychological stress levels and acute stress reactivity in young normal healthy subjects. Literature search, to the best of our knowledge has not revealed any previous comparable studies.

Methods

The study was conducted on thirty four (34) male volunteers (age 18-30 years; mean $\pm$ SD, 24.4 $\pm$ 3.2). Subjects with a history of practicing meditation or any other relaxation technique, indulging in substance abuse, smokers, alcoholics or those known to be having any disease or undergoing treatment for any medical condition were excluded. Only male subjects were taken because females have different level of stress and stress reactivity during different phases of menstrual cycle. All the experiments were done in the forenoon to minimize, the diurnal variation in cortisol levels.

Ethical clearance for the study was taken from the ethics committee for human subjects of All India Institute of Medical Sciences (AIIMS), New Delhi, India. On the first visit, the subjects were briefed about the study with the help of subject information sheet and informed written consent for participating in the study was obtained. The subjects were familiarized with the procedure for conducting the study. Their GI, EI, Acute Stress level (AS) and Perceived Stress levels (PS) were assessed. Then the subjects were asked to play a few computer games while ECG and GSR recordings were done. The computer game that gave subjective feeling of maximum stress and resulted in an increase in GSR as well as heart rate was chosen as the stressor for that subject (Table 1).

Duration of stressor as computer game was kept as ten (10) minutes in the study. ECG and GSR were recorded continuously so that the effect of stressor on these parameters were analyzed by comparing basal values with values obtained during early (first five minutes) and late (second five minutes) stress phase. Salivary cortisol was assessed before and after the stressor. On the bases of median value of GI and EI level subjects were divided into the four groups as follows:

a) Group 1: Low GI level & Low EI level
b) Group 2: High GI level & Low EI level
c) Group 3: Low GI level & High EI level
d) Group 4: High GI level & High EI level

Group wise differences in Salivary Cortisol, Heart Rate (HR), GSR, AS levels, PS levels, and reaction time for cognitive functions were collated and analyzed. Correlation coefficients amongst GI, EI, AS and PS were also collated & analyzed.

Computer game as a lab stressor

Computer games usually give immense pleasure after a win. However, in the initial stages of the game when an individual suffers repeated defeats or constraints, the game becomes very stressful.[11] The games required working with very few keys so that the subjects did not take much time to get familiar with the game and rapidly reached a stage where they could prevent repeated defeats or losses. The game which the subject could not master, acted as a stressor for him. The games which the subjects played easily or showed dis-interest, were not selected for the subject to induce stress.

Measurement of physiological stress parameters

Recordings were done using computerized recording system using a Personal Computer running Windows® 98 coupled with RMS POLYWRITE-D system. The following parameters were recorded:

ECG (0.5-35 Hz) was continuously recorded using Lead-2, at sample rate of 200/sec and gain X 2000. HR was calculated from the R-waves using mean value of beats per min from artifact free graph.

GSR (0-35Hz): Two Ag/AgCl electrodes were tied round the index and middle finger of left hand to record the GSR which is a relatively reliable index for sweat gland activity and noting changes in activation levels of the sympathetic nervous system.

Salivary cortisol

Salivary cortisol is well established biochemical marker for stress. Its estimation was done using commercial ELISA kits (DRG International Inc., USA). The inter and intra assay coefficients of variation were below 5.4% and 2.8% respectively.

Acute stress level (AS)

Acute stress questionnaire was used to assess the mental and emotional stress.[12]

Perceive stress scale (PS)

Chronic stress level was assessed using Perceived Stress scale.[13]

General intelligence (GI)

General intelligence of subjects was assessed using Indian adaptation version of Wechsler adult performance intelligence scale by Prabha Ramalingaswamy.[14]

Emotional intelligence (EI)

Emotional intelligence was assessed by N.S. Schutte Emotional Intelligence scale.[15]

Table 1: Overview of study design

Assessment of IQ, EQ, Acute stress level and Chronic stress level
Salivary sample for cortisol (baseline value)
ECG & GSR recording begins
Cognitive function testing
Introduction of the Stressor (computer game)
Post-stress salivary cortisol sample
Cognitive function testing
ECG and GSR recording stopped

Table 2: Acute stress reactivity (n = 34)

Parameter	Baseline	During Stress
HR early phase	81 ± 10	85 ± 10***
HR late phase		85 ± 11***
GSR early phase (micro-mho)	8.4 ± 8.7	10.3 ± 9
GSR late phase (micro-mho)		11 ± 10*
Parameter	**Pre stress**	**Post stress**
Cortisol (ng/ml)	2.5 ± 1.4	2.4 ± 1.4
MEM RT (ms)	887 ± 179	797 ± 182***
Stroop RT N (ms)	782 ± 111	749 ± 101**
Stroop RT I (ms)	904 ± 138	833 ± 131***
Stroop RT F (ms)	719 ± 106	678 ± 67**

*represents significance between pre versus post values at $p < 0.05$, **at $p < 0.01$; ***at $p < 0.001$; GSR: Galvanic skin response; HR: heart rate; MEM RT: Memory reaction time; Stroop RT N: Stroop reaction time neutral condition; Stroop RT I: Stroop reaction time interference condition; Stroop RT F: Stroop reaction time facilitation condition

Statistical analysis

The statistical analysis was done using STATA Software. The distribution of the data was both Gaussian and non Gaussian. For Gaussian data distribution parametric tests were applied and for non Gaussian, the non parametric tests were used. Comparison of pre stress and post stress data was done using paired t-test. Wilcoxon sign – rank test and Kruskal – Wallis test were used for non Gaussian data (EI score, AS and PS score). The p value of less than 0.05 was considered as significant and is denoted by*, $p < 0.01$ by** and $p < 0.001$ by***.

Results

Acute Stress Reactivity

Computer game as a lab stressor was associated with a significant rise in heart rate and GSR in all the subjects (Table 2). The rise in HR was immediate whereas GSR increased significantly in late stress phase only. Salivary cortisol however showed no change. Post stress testing of cognitive function revealed a decrease in the reaction time in Sternberg Memory test and all the three conditions of Stroop test, namely, neutral, interference and facilitation.

Baseline characteristics of Groups with varying levels of GI and EI

The GI of the subjects ranged from 86 to 128 whereas the EI ranged from 107 to 158. On the basis of median values of GI and EI the subjects were categorized into four groups (Table 3). When the baseline values of various parameters were assessed group wise the following results were noted (Tables 4a & 4b):

a) HR and GSR were not different in various groups.
b) Cortisol level was significantly high in Group 3 (Low GI- High EI) compared to Group 4 (High GI- High EI)

Table 3: Subject grouping according to median IQ (106) & EQ (131) scores

Group Name	Number of Subjects	IQ score (average)	EQ score (average)
Group 1: 'Low IQ - Low EQ'	7	99.4 ± 4.2	123.1 ± 5.2
Group 2: 'High IQ - Low EQ'	9	115.2 ± 6.3	121.1 ± 9.5
Group 3: 'Low IQ - High EQ'	10	98.9 ± 5.3	143.9 ± 10.0
Group 4: 'High IQ - High EQ'	8	113.8 ± 7.5	136.8 ± 6.1

Table 4a: Baseline cortisol, acute & chronic stress levels, HR and GSR in various IQ – EQ Groups

Group Number	Cortisol (ng/ml)	Perceived chronic Stress Level	Acute Stress	HR	GSR
1	1.8 ± 0.8	20.7 ± 4.8	43 ± 13.1	77 ± 10	7.4 ± 6.9
2	1.9 ± 0.7	19.3 ± 4.3	35.9 ± 10.7	85 ± 11	11.2 ± 8.1
3	3.9 ± 2.5#	13.2 ± 5.8##	33.5 ± 14.9	80 ± 9	4.7 ± 1.6
4	1.7 ± 0.5	13.8 ± 9.1	33.8 ± 10	81 ± 9	11.1 ± 14.0

#: *3 vs 4
##: *1 vs 3, * 2 vs 3, * 4 vs 3

Table 4b: Baseline reaction time in cognitive functions in various IQ – EQ Groups

Group Number	MEM RT (ms)	Stroop RT N (ms)	Stroop RT I (ms)	Stroop RT F (ms)
1	918 ± 176	763 ± 73	900 ± 98	7121 ± 81
2	922 ± 140	826 ± 113	947 ± 139	722 ± 752
3	907 ± 239	769 ± 127	910 ± 143	745 ± 152
4	795 ± 127	764 ± 123	851 ± 165	691 ± 98

*represents significance between pre versus post values *$p<0.05$; GSR: galvanic skin response; HR: heart rate; ASR: acute stress reactivity; MEM RT: Memory reaction time; Stroop RT N: Stroop reaction time neutral condition; Stroop RT I: Stroop reaction time interference condition; Stroop RT F: Stroop reaction time facilitation condition

c) Perceived chronic stress level was significantly lower in Group 3 (Low GI- High EI) compared to Group 1 (Low GI- Low EI).
d) Performance of subjects in terms of reaction time in all the cognitive functions tested was comparable in all the groups.

Acute stress reactivity in Groups with varying levels of GI and EI

During and after stress, subjects with varying levels of GI and EI were similar in terms of changes in HR, GSR and reaction time in cognitive functions (Table 5). Significant differences between

Table 5: HR, GSR, cortisol and reaction time for cognitive function during / post stress in various IQ – EQ Groups

Group No	HR (During Stress)	HR (PS)	GSR (During Stress)	GSR (PS)	Cortisol (PS)	MEM RT (PS)	Stroop RT N (PS)	Stroop RT I (PS)	Stroop RT F (PS)
1	80 ± 13	3.1 ± 4.2	9.9 ± 12.0	1.7 ± 3.1	1.8 ± 0.7	804 ± 112	780 ± 77	863 ± 83	710 ± 52
2	89 ± 10	3.6 ± 2.2	16.0 ± 12.6	4.8 ± 5.0	2.0 ± 0.8	800 ± 179	774 ± 103	860 ± 116	697 ± 67
3	85 ± 11	4.6 ± 6.6	5.3 ± 1.4	0.6 ± 1.0	3.7 ± 1.8#	857 ± 257	726 ± 112	840 ± 175	667 ± 70
4	87 ± 10	6.3 ± 4.4	13.1 ± 9.1	0.1 ± 7.8	1.6 ± 0.5	711 ± 100	723 ± 111	766 ± 113	645 ± 68

#: *3 vs 1, 2, 4; *represents significance between pre versus post values at $p<0.05$; GSR: galvanic skin response; HR: heart rate; ASR: acute stress reactivity; PS: post stress; MEM RT: Memory reaction time; Stroop RT N: Stroop reaction time neutral condition; Stroop RT I: Stroop reaction time interference condition; Stroop RT F: Stroop reaction time facilitation condition

Table 6: Correlation between GI, EI, Acute Stress and Perceived Stress

Parameter	Correlation Coefficient
GI/EI	-0.26
GI/AS	-0.12
GI/PS	-0.14
EI/AS	-0.33*
EI/PS	-0.51**
AS/PS	0.44**

*represents significance correlation between pre versus post values at $p<0.05$ and **at $p<0.01$; GI: general intelligence score, EI: emotional intelligence score, AS: acute stress level, PS: perceived chronic stress level

four groups were seen only for post stress cortisol levels. Group 3 (Low GI- high EI) subjects had significantly higher post stress cortisol level as compared to rest of the groups.

Correlation results

EI score of subjects correlated negatively with acute and perceived chronic stress levels with correlation coefficient of 0.33 and 0.51 respectively. Correlation coefficient between acute and chronic stress level was 0.44. There was no correlation seen among GI score, acute stress level and chronic stress level of the subjects in various groups (Table 6).

Discussion

Each individual has different levels of general and emotional intelligence, and a differential combination of GI and EI may be predictive of baseline stress level or stress reactivity. In present study the subjects were categorized into four groups on the basis of median GI and EI scores. The relationships between general intelligence, emotional intelligence, acute stress reactivity, acute stress level and chronic stress level were investigated in the context of young healthy subjects. Salivary cortisol (baseline and post stress) and perceived chronic stress level emerged as differentiating factor in group analysis. Subjects with low GI - high EI showed lower level of perceived chronic stress in spite of high cortisol levels at baseline compared to low GI – low EI subjects. No significant differences among groups were seen for heart rate, GSR, cognitive functions and acute stress reactivity.

Further high level of emotional intelligence was associated with low level of the acute and chronic stress level. General intelligence on the other hand showed no significant correlation with emotional intelligence and stress level. Even though general intelligence was not directly related to baseline stress level or reactivity, subjects with low GI, but having different levels of EI showed different results. High emotional intelligence rather than general intelligence in subjects might have a role in choosing the right coping resources and strategies for managing stress.

The inverse correlation observed in the present study between emotional intelligence and stress is similar to earlier studies.[9,10,16] It may be noted that an ability to perceive and understand the feelings of others, and to use this information to solve interpersonal problems, can help people lead more satisfying lives and hence may experience less stress. Higher EI level has been reported to contribute positively towards a healthy doctor-patient relationship, increased empathy, teamwork & communication skills, stress management, organizational commitment and leadership.[17] Patients of the dental students with high emotional intelligence scores were significantly more satisfied with treatment than patients of students with low emotional intelligence.[18] Goldenberg *et al.*[19] reported a positive correlation between emotional intelligence and problem-focused coping. Lu *et al.*[20] reported that participants with the lowest EI scores had greater intensity of precompetitive cognitive anxiety than those with the highest EI scores. As emotional intelligence scores increase, people seem to employ more effective coping strategies rather than using less ineffective coping strategies. It is suggested that those with high levels of emotional intelligence would understand their own emotions along with the emotions of others and therefore they can adapt to challenging situations leading to solving their problems more effectively. Consequently, individuals with high emotional intelligence are expected to experience fewer symptoms of stress.

In the present study, it has been found that the GI scores have shown no significant correlation with the stress level. Van Beilen *et al*.[21] reported that low GI was not associated with low active coping skills in patients of psychogenic movement disorders & paralysis. However, studies by McNally and Shin,[22] Sarač *et al.*[23] investigated the relationship between post traumatic stress disorder and cognitive intelligence and reported a predictive role for cognitive intelligence. It has been reported that while intense stress experienced in response to traumatic

events might be mediated by general intelligence, it is also possible that intense stress leads to a decrease in hippocampal volume, which in turn results in problems with memory[6] and, perhaps, with how one copes with stress. It may be the intensity and severity of stressor that determines the physiological response, initiation of organic diseases and step wise execution of effective coping strategies in the form of emotional intelligence and general intelligence.

In the present study, computer game stressor was more close to daily life stressor, instead of traumatic stress symptoms, it is understandable that emotional intelligence and not cognitive or general intelligence, was associated with stress level. The performance on cognitive functions was not dependent on the GI or EI of the subjects and the better performance after stress also remained equivalent in all the groups. A study with larger sample, probably a stronger stressor and more complex cognitive assessment is needed to find differentiating physiological acute stress reactivity in relation to GI and EI level. Finally, the results of the present study may be specific to the type of subjects chosen, their perception of computer game as stressor in the lab settings.

Conclusion

Emotional intelligence as a faculty of brain is better suited to handle day to day acute stress and perceived stress. On the contrary general intelligence has shown no significant correlation with the stress level. High levels of salivary cortisol, a biochemical marker of stress, improve the coping strategies of subjects with high EI both at baseline and especially during acute stress reactivity.

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