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Isolation Stress-Individual Susceptibility in Terms of Psychophysiological Manifestations

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Twenty two healthy male volunteers were subjected to isolation stress in the isolation stress laboratory of the Institute of Aviation Medicine, Bangalore. Twenty one subjects could endure 72 hrs of isolation. The study was conducted in three phases : Ante, Experimental and Post-experimental. The study has utilised comprehensive approach where psychological, physiological and biochemical method are used to arrive at correlates of those behavioural manifestations that are produced by isolation stress. The subjects belonged to two groups— Extraverts (15) and introverts (7). All subjects showed evidence of stress and emotional symptomatology. All subjects depicted stimulus searching behaviour and better performance on vigilance task Mean weight loss of 1.35 kg was noted during isolation. Cognitive process showed a transient impairment under isolation stress. Extraverts show a statistically signficant higher levels of urniary 17 OHCS during isolation. Extravert group showed a statistically significant better performance on NRC stresslyser.

AN individual is isolated when he is confined to a limited space with a general reduction of areas of stimulation or he is cut off from socially valued stimuli. In such a situation isolation is generally referred to as social isolation. Isolation, prolonged or short, singly or in groups, brings in a complex response pattern which is qualitatively and quantitatively different from the normal behaviour pattern of individuals. The study has general application in several areas especially among the Armed Forces. Quite often the personnel of the Armed Forces have to stay in socially restrained conditions This holds true with personnel manning the advance landing grounds, mobile observation posts, mountain pickets and in commando operations. The crew members of a space vehicle not only have to function in very restricted quarters under relatively monotonous conditions, but also, more importantly they are

subjected to prolonged separation from their accustomed environment. In enforced indoctrination/ interrogation, isolation is used as a means to subdue individuals or to extract information. Further the phenomenon of isolation plays a role in certain clinical situations as well as where in patients have been subjected to isolation in a small hospital room.

In the present study emphasis is placed exclusively upon well controlled laboratory experiments that have employed human subjects individually exposed to 72 hours of isolation. The study aims to utilise an integrated approach where psychological, physiological and biochemical methods are used. All the reported studies have been conducted abroad and no studies are known to have been conducted on Indian sample. In the context of social isolation studies a cross cultural difference in results could be a probability, hence this study.

Material & Methods

Twentytwo male volunteers in the age group of 20-40 years were taken for this study. They were subjected to 72 hours of isolation in the isolation stress laboratory (ISL) of the Institute of Aviation Medicine, Bangalore. The ISL is sound proof (20 db hearing loss), air conditioned and has attached toilet facilities. It has lights although controlled from outside. ISL is self contained in terms of food articles. The study was conducted in three phases.

(a) Ante
(b) Experimental
(c) Post experimental

(a) *Ante*

The following tests were administered during this phase :

(i) Eysenck's personality inventory—This test measures introversion, extroversion and neurotic dimension of personality.

(ii) MMPI—Provides an objective assessment of some of the major personality characteristics that affect personal and social adjustment.

(iii) 16 PF—It is an objective personality test where the subject's total personality profile is drawn on sixteen primary traits.

(iv) Bell's adjustment inventory This test measures adjustment level of an individual.

(v) Hamilton's anxiety rating scale—Gives anxiety rating

(vi) Self rating mood inventory—It gives an index of the rate of the mood fluctuations of the individual.

(vii) Numerical ability test—It assesses numerical ability of an individual.

(viii) Progressive matrices—It measures comprehension and analytical and integrative capacity of the individual.

(ix) NRC Stresslyser with IAM Flight Stressor Task—NRC Stresslyser is a subject paced, step input pursuit tracking task used for measuring general psychomotor skill IAM flight stressor task is a vigilance test used as a secondary task of NRC stresslyser

(x) Flight oriented psychomotor test—Performance of this test involves comprehension short term memory and gross psychomotor coordination.

(xi) Critical Flicker Fusion Frequency—This is an index of subject's psychophysiological state.

(xii) Pulse, BP and temperature.

(xiii) Galvanic skin response—GSR is a transient decrease in resistance of the skin occurring in response to an externally applied stimulus. The amplitude decrease in resistance is proportional to emotional loading of the stimulus.

(xiv) Biochemical analysis of urine—24 hours sample of urine was analysed for 17 OHCS and magnesium.

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(xiv) Biochemical analysis of urine—24 hours sample of urine was analysed for 17 OHCS and magnesium.

(b) *Experimental*

The subject under went isolation stress in the ISL. Two recordings were made between 0900-1000 and 1600-1700 hrs. The parameters recorded were pulse rate, BP, GSR and performance on various psychomotor tests. Records were made by the experimenter with the aid of remote controlled system. The subject was unaware of the results and the time of the recording as he was not provided with any wrist-watch or clock. The subject placed in the communication window his daily self rating mood inventory, CFF readings and subjective feelings. The experimenter could make behavioural observations through one way mirror. At the end of 48 hrs of isolation the subject was asked to solve numerical ability test and complete progressive matrices test. From the 48th hr of isolation to the 72nd hr of isolation subject would collect the urine sample in a jar for biochemical analysis.

(c) *Post Experimental*

On completion of 72 hrs of isolation, the door would be opened. Immediately the subject would undergo all the tests used in ante, except personality tests. Exit interview was conducted. Another post isolation reading was taken after 24 hrs of isolation.

Results

Results and findings are given in tables No. I to IX (b).

Discussion

In our study, 21 of the 22 subjects could complete 72 hours of isolation, one subject quitting after 24 hrs. In many of the reported studies there was a constant quitting rate, approximately one third of the subjects failed to endure an initially prescribed period, whether the duration was 2, 4, 7 or 14 days[11]. All our subjects belonged to the Air Force. It may be that a wish to avoid a loss of face might have been a critical factor in accounting for this unusual tolerance for isolation. Similar result like our is reported by a Japanese study where all the 23 male subjects were able to endure 18 hrs of isolation without quitting[7].

As a first step, on the basis of personality studies subjects were divided into two groups, namely extraverts and introverts. These two groups formed the criterion group for our further analysis. This initial classification of introversion and extraversion had been done on the basis of scores obtained from the Eysenck's personality inventory. These groupings have been further substantiated by the findings on 16 PF and MMPI (tables I and II). Bell's adjustment inventory revealed both groups to be well adjusted though extravert group shows better magnitude of adjustment (table IV). The difference in the neurotic index between the two groups is not significant though it is in higher introvert group (table III)

Table - I

Mean and SD from Basal for 16 PF Test - form C & D combined in Extraverts (n=15) and Introverts (n=7)

Personality Factors	Extraverts		Introverts		Mean difference
	Mean	SD	Mean	SD	
A	4.9	2.1	4.3	1.7	
B	6.7	1.4	7.0	2.3	
C	6.5	1.5	6.1	1.3	
E	5.9	1.6	6.7	1.3	
F	5.7	2.2	3.6	1.4	-2.1* (Lower in introverts)
G	6.9	1.5	6.4	1.1	
H	6.1	1.6	5.3	2.1	
I	4.7	1.4	4.6	1.6	
L	5.5	2.1	6.9	2.4	
M	5.3	1.6	5.6	1.3	
N	4.4	2.0	5.4	1.9	
O	4.7	1.8	4.1	1.8	
Q1	5.7	1.9	5.1	1.9	
Q2	6.0	1.8	6.1	1.1	
Q3	6.7	1.7	5.9	1.9	
Q4	5.1	1.5	4.7	1.5	
I	4.5	1.9	5.0	1.4	
II	5.8	1.6	4.8	1.2	
III	6.4	1.4	6.5	1.3	
IV	5.8	2.0	6.3	1.1	

*=$P<0.05$

Table - II

Mean and SD from Basal for MMPI Test in Extraverts (n=15) and Introverts (n=7)

MMPI	Extraverts		Introverts	
	Mean	SD	Mean	SD
HS	13.1	6.6	11.0	2.9
D	18.7	4.3	21.6	5.3
HY	17.4	4.3	15.9	4.0
Pd	16.5	5.0	20.1	6.7
mf	25.2	4.9	23.7	1.8
Pa	10.9	6.8	11.0	4.8
Pt	22.4	5.7	24.4	4.4
Sc	29.1	13.2	26.9	8.3
Ma	18.9	2.6	19.9	2 5
Si	20.9	8.2	25.3	5.9

Table - III

Mean and SD from Basal for Neurotic Index in Extraverts (n=15) and Introverts (n=7)

	Extraverts		Introverts	
	Mean	SD	Mean	SD
Neurotic Index	4.7	2.4	6.7	2.2

Table - IV

Mean and SD from Basal for Bell's adjustment Inventory in Extraverts (n=15) and Introverts (n=7)

Adjustment	Extraverts		Introverts	
	Mean	SD	Mean	SD
a	2.5	1.8	2.0	3.5
b	2.9	2.2	4.3	3.0
c	8.9	6.2	11.9	5.6
d	3.9	4.0	3.7	4.7
e	6.2	3.4	8 0	4.1
Total	24.3	12.2	30.9	19.2

Bell's Adjustment inventory-Score-Lower the score better the adjustment.

Table-IV

Max-Hamilton anxiety rating scale for Extraverts (n=15) and Introverts (n=7)

	Extraverts			Introverts		
	Pre-isolation (basal)	During isolation	Post isolation	Pre-isolation (basal)	During isolation	Post isolation
Mean	0	10.9	0.1	0	12.9	1.1
SD	0	5.5	0.4	0	3.8	1.6
Mean difference		10.9 ***	0.1 NS		12.9 ***	1.1 NS

*** : P<0.001, NS : Not Significant

Hamilton anxiety rating scale showed a gradual increase in anxiety level and it showed up even after the cessation (table V). Self rating mood inventory showed a positive mood change on post isolation ratings. Both groups developed psychophysiological symptoms like backache, headache, bodypains, frequency of micturition reduced appetite etc. Haythorn and Altman[5] have also reported that social isolation is associated with increased stress and emotional symptomatology.

Stimulus searching behaviour has been noted in both groups. All subjects had been trying to make use of any sensory incentive particulary to orient themselves. Sensory stimuli like beard growth, temperature of tap water, very loud sounds etc. were utilised as sensory incentives. Stimulus searching behaviour on the part of the subjects had been one of the important manifestations one might expect a subject in isolation to seek an increase in sensory input to restore his desired level of stimulation. A similar type of hypothesis has been suggested by Schlutz[6] who postulated a homeostatic drive mechanism for sensory variation, called sensoritasis.

In our study it is evident that there is affliction of cognitive processes during isolation. They showed impaired performance on Numerical ability test and on standard progressive matrices given to them on completion of 48 hrs of isolation, (table VI). Bexton et al have reported that cognitive processes are affected during isolation.

Table - VI

Mean, SD and Mean differences from basal and their significance for psychological test in Extraverts (n=15) and Introverts (n=7)

Factors	Test parameters	Statistical parameters	Extraverts (n=15)		Introverts (n=7)	
			During isolation (On completion of 48 hrs)	Basal	During isolation (On completion (of 48 hrs)	Basal
Standard progressive matrices	time	Mean	34.2	23.9	24.0	19.8
		SD	5.0	3.1	7.2	5.2
		Mean difference		10.3 ***		—4.2 *
"	Score	Mean	52.9	55.7	50.3	52.9
		SD	4.9	4.7	11.4	6.0
		Mean difference		2.8 **		2.6 (NS)
Numerical ability test	time	Mean	28.8	21.6	27.9	23.1
		SD	6.8	4.5	12.2	4.7
		Mean difference		—7.2 ***		—4.8 (NS)
"	score	Mean	54.9	55.9	52.7	52.7
		SD	3.5	3.0	7.0	6.9
		Mean difference		1.0 *		0 (NS)

Standard progressive matrices and Numerical ability test } —Time score — Lower the time better the performance

Standard progressive matrices and Numerical ability test } — Performance score — Higher the score better the performance

* : $P < 0.05$

** : $P < 0.01$

*** : $P < 0.001$

NS : Not significant.

Table VII (a)

Mean, SD and Mean difference from basal and their significance for Psychomotor test performance in Extraverts (n = 15)

Factors	Statistical parameters	Pre-isolation (basal)	During isolation						Post isolation	
			1st	2nd	3rd	4th	5th	6th	1st	2nd
NRC stressalyser (total response time in sec)	Mean	174.7	172.4	166.2	162.5	160.9	157.1	156.2	152.7	149.3
	SD	20.7	23.9	20.0	15.0	15.9	14.8	14.3	12.3	10.8
	Mean difference		—2.3	—8.5	—12.2	—13.8	—17.6	—18.5	—22.0	—25.4
			(NS)	*	*	**	***	***	***	***
FST (response time in sec)	Mean	2.1	1.7	1.8	1.5	1.6	1.5	1.4	1.6	1.7
	SD	0.7	0.7	0.4	0.4	0.4	0.7	0.8	0.4	0.7
	Mean difference		0.4	0.3	—0.6	—0.5	—0.6	—0.7	—0.5	—0.4
			*	(NS)	**	**	*	*	*	(NS)
FOPT (Response time in sec)	Mean	9.3	10.7	12.1	11.0	11.7	10.1	10.1	9.4	8.9
	SD	2.4	2.9	5.5	2.8	4.1	3.5	4.4	3.2	2.2
	Mean difference		1.4	2.8	1.7	2.4	0.8	0.8	0.1	—0.4
			*	*	**	**	(NS)	(NS)	(NS)	(NS)
Flicker fusion frequency (FFF) (Flicker rate/ sec)	Mean	37.8	37.1	37.9	38.1	38.5	39.7	38.9	38.9	39.1
	SD	3.0	3.3	3.7	3.0	3.1	4.7	3.6	3.2	6.3
	Mean difference		—0.6	—0.1	0.3	0.7	1.9	1.1	1.1	1.3
			(NS)	(NS)	(NS)	(NS)	(NS)	(NS)	(NS)	(NS)

* P< 0.05
** P< 0.01
*** P<0.001
NS Not significant

NRC stressalyser time score
FST -do-
FOPT -do-
FFF — performance score

Lower the time better the performance

Higher the flicker rate better the performance

Table VII (b)

Mean, SD and mean difference from Basal and their significance for Psychomotor test performance in Introverts (n = 7)

Factors	Statistical parameter	Pre-isolation (basal)	During isolation						Post isolation	
			1st	2nd	3rd	4th	5th	6th	1st	2nd
NRC stressalyser	Mean	185.9	193.7	185.3	180.1	176.3	172.4	172.1	172.9	161.1
(total response	SD	23.2	21.4	24.7	21.7	20.3	18.4	29.6	43.2	11.3
time in seconds)	Mean difference		7.8	−0.6	−5.8	−9.6	−13.5	−13.8	−13	−24.8
			(NS)	(NS)	(NS)	(NS)	**	(NS)	(NS)	*
FST	Mean	9.3	10.7	12.1	11.0	11.7	10.1	10.1	9.4	8.9
(Response time	SD	2.4	2.9	5.5	2.8	4.1	3.5	4.4	3.2	2.2
in seconds)	Mean difference		1.4	2.8	1.7	2.4	0.8	0.8	0.1	−0.4
			*	*	**	**	(NS)	(NS)	(NS)	(NS)
FOPT	Mean	7.7	11.2	9.2	9.7	8.5	9.0	9.0	9.7	7.7
(Response time	SD	2.7	9.5	4.5	4.5	5.0	5.2	5.4	5.4	3.3
is seconds)	Mean differences		3.5	1.5	2.0	0.8	1.3	1.3	2.0	0
			(NS)	*	(NS)	(NS)	(NS)	(NS)	(NS)	(NS)
Flicker Fusion	Mean	35.9	36.6	37.9	37.6	37.6	36.6	37.9	36.6	36.7
Frequency test	SD	5.1	5.1	5.5	4.9	5.1	6.9	5.6	5.1	4.2
(FFP)	Mean difference		0.7	2.0	1.7	1.7	0.7	2.0	0.7	0.8
(Flicker rate/second			(NS)	*	(NS)	(NS)	(NS)	(NS)	(NS)	(NS)

* P < 0.05
** P < 0.01
*** P < 0.001
NS : Not significant

NRC Stressalyser — Time score — Lower the time better the performance
FST -do- -do-
FOPT -do- -do-
FFT — Performance — Higher the flicker rate better the performance

Table VIII

Mean SD and mean differences from Basal and their significance for Bio-Chemical analysis in extraverts (n = 12) and Introverts (n = 7)

Factor	Statistical parameter	Extraverts		Introverts	
		Basal	During Isolation	Basal	During Isolation
Urine	Mean	10.7	16.7	16.7	13.5
17 OHCS	SD	3.8	4.9	11.9	6.6
(mg/day)	Mean difference		6.0		−4.2
			**		(NS)
Urine	Mean	0.239	0.213	0.147	0.170
Magnesium	SD	0.472	0.428	0.065	0.209
(gms/day)	Mean difference		−0.026		0.023
			(NS)		(NS)
Urine	Mean	1527	1542	1690	1569
Volume	SD	446	568	762	863
(ml/day)	Mean difference		15		−121
			(NS)		(NS)

* : $P < 0.05$
** : $P < 0.01$
*** : $P < 0.001$
NS : Not significant

Table IX (a)

Mean, SD and Mean difference from Basal and their significance for Physiological factors in Extraverts (n = 15)

Factor	Statistical parameters	Pre-isolation (Basal)	During isolation						Post isolation	
			1s	2nd	3rd	4th	5th	6th	1st	2nd
Weight (in Kg)	Mean	67.9							66.6	
	SD	6.6							6.5	
	Mean difference from basal								−1.3 ***	
Pulse (beats per minute)	Mean	72.4	74.9	71.3	77.6	72.6	71.3	72.6	76.5	71.4
	SD	7.2	6.0	4.5	12.6	7.8	5.0	7.7	14.1	4.5
	Mean difference		2.5 (NS)	1.1 (NS)	5.2 (NS)	0.2 (NS)	1.1 (NS)	0.2 (NS)	4.1 (NS)	−1.0 (NS)
Systolic BP (mm Hg)	Mean	121.5	126.3	122.2	124.0	124.4	122.1	121.3	122.6	119.9
	SD	7.2	9.4	9.8	10.9	10.0	11.8	12.8	7.7	5.8
	Mean difference		4.8 (NS)	0.7 (NS)	2.5 (NS)	2.9 (NS)	0.6 (NS)	−0.2 (NS)	1.1 (NS)	−1.6 (NS)
Diastolic BP (mm Hg)	Mean	73.9	70.8	69.6	68.6	68.3	69.0	71.3	70.7	69.4
	SD	11.2	9.3	10.8	8.9	7.4	8.5	8.9	8.4	7.2
	Mean difference		−3.1 (NS)	−4.3 (NS)	−5.3 (NS)	−5.6 *	−4.9 *	−2.6 (NS)	−3.2 (NS)	−4.5 (NS)
Temperature (in °F)	Mean	98	97.8	98.0	98.1	98.0	98.0	97.9	97.9	98.0
	SD	0.4	0.6	0.6	0.5	0.4	0.3	0.7	0.4	0.4
	Mean difference		−0.2 (NS)	0 (NS)	0.1 (NS)	0 (NS)	0 (NS)	−0.1 (NS)	−0.1(NS)	0(NS)
Galvanic skin response (Kohms)	Mean	32.1	25.2	24.0	26.2	37.9	43.6	36.6	30.6	30.1
	SD	26.4	18.3	15.7	14.4	34.7	35.2	21.1	31.3	24.9
	Mean difference		−6.9 (NS)	−8.1 (NS)	−5.9 (NS)	5.5 (NS)	11.5 (NS)	4.5 (NS)	−1.5 (NS)	−2.0 (NS)

* : $P < 0.05$. ** : $P < 0.01$, *** : $P < 0.001$, NS : Not significant

Table IX (b)

Mean, SD and mean difference from Basal and their significance for Physiological factors in Introverts (n = 7)

Factors	Statistical parameters	Pre-isolation (Basal)	During isolation						Post isolation	
			1st	2nd	3rd	4th	5th	6th	1st	2nd
Weight (in Kgs)	Mean	66.1							64.7	
	SD	3.6							4.0	
	Mean difference								−1.4	
									**	
Pulse rate	Mean	71.6	69.9	76.3	75.1	75.6	72.9	71.1	84.0	76.9
	SD	10.1	5.3	4.7	7.5	4.4	6.1	7.8	9.2	10.8
	Mean difference		−1.7	4.7	3.5	4.0	1.3	−0.5	12.4	5.3
			(NS)	(NS)	(NS)	(NS)	(NS)	(NS)	*	*
Systolic BP (in mm Hg)	Mean	117.7	124.0	125.1	124.1	120.6	122.9	126.3	137.7	122.6
	SD	10.4	12.2	10.3	11.9	6.1	13.4	12.5	14.2	11.8
	Mean difference		6.3	7.4	6.4	2.9	5.2	8.6	20.0	4.9
			***	**	*	(NS)	*	(NS)	**	(NS)
Diastolic BP (mm Hg)	Mean	77.4	80.3	74.0	84.0	78.3	82.3	80.0	85.7	78.3
	SD	5.3	12.2	14.4	7.8	6.3	9.9	6.4	9.3	5.2
	Mean difference		2.9	−3.4	2.6	0.9	4.9	2.6	8.3	0.9
			(NS)	(NS)	(NS)	(NS)	(NS)	(NS)	*	(NS)
Temperature (in °F)	Mean	98.1	98.1	98.5	98.1	98.5	98.1	98.1	98.3	98.0
	SD	0.5	0.5	0.4	0.6	0.3	0.3	0.5	0.2	0.5
	Mean difference		0	0.4	0	0.4	0	0	0.2	−0.1
			(NS)	*	(NS)	*	(NS)	(NS)	(NS)	(NS)
Galvanic skin response (K Ohms)	Mean	59.3	26.3	48.9	19.4	31.3	34.4	47.6	36.6	28.3
	SD	61.8	20.2	54.7	20.7	36.4	59.0	61.6	45.1	32.0
	Mean difference		−3.3	−10.4	−39.9	−28.0	−24.9	−11.7	−22.9	−31.0
			*	(NS)	*	(NS)	(NS)	(NS)	(NS)	(NS)

* : $P < 0.05$, ** : $P < 0.01$, *** ; $P < 0.001$, NS : Not significant

Both groups showed improvement on vigilance task (IAM-Flight stressor task) which comprises both visual and auditory components (tables VII 'a' and 'b'); isolation appears to have facilitatory effecton vigilance. Probably these brief tones, high flashes had sensory incentive role in an attempt to achieve optimal level of stimulation. Subject in isolation tends to seek an increase in sensory input to restore his desired level of stimulation Similar results have been reported.[9] Extraverts showed improvement in their performance on NRC stressalyser which was found to be statistically significant while the introvert group did not show any constancy in their performance (tables VII a and b). It can be explained in terms of arousal that mild degree of stress has facilitatory effect on performance. Similar findings have been reported.[5]

Flight oriented psychomotor test involves cognitive factors like comprehension, immediate memory and recall apart from coordination Both groups showed decrement in performance on this test. (tables VII a and b) The decrement of performance on this test appears to be on account of affliction of cognitive processes during isolation. Critical flicker fusion frequency did not reveal any signifi cant change (tables VII a and b). Similar results have been reported by others [3,10].

Extravert group showed rise in the level of 17 OHCS during the isolation while the introvert group did not show any significant change (table VIII). Probably extravert group had higher arousal levels as compared to the introvert group which could activate adrenal cortex Gorbov, et al[4] have reported increase in 17 ketosteroids in subjects individually confined for 15 days in an altitude chamber under conditions of no intercommunication. No significant trend was seen in the urinary levels of magnesium during isolation (Table VIII).

Conclusion

The experiments reveal that extraverts have shown higher levels of 17 OHCS. higher arousal and better performance on NRC stresslyser. Evidence of stress, emotional symptomatology, weight less and transient affliction of cognitive processes is present.

Indoctrination about isolation and learning of behavioural technique to alleviate cognitive dissonance and emotional stress may play a useful role for those who are to be subjected to isolation. Role of special diets needs to be looked into, considering the weight loss during isolation stress.

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