Effects of Progressive Relaxation Training on Heart Rate Variability

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Abstract

Objective: The purpose of the study was to investigate the effect of Progressive Relaxation Training (PRT) on heart rate variability (HRV) recorded at third minute.
Sample: The randomly selected subjects were 210 male sportspersons from the University of Delhi with age ranging from 19 to 21 years.
Selection of the Variables: Variables selected for the above purpose were **Treatment variable including** Progressive Relaxation Training (PRT) aided with Electro-cardio-graph biofeedback (ECG- BF) instrument and **Observational (Performance/ Criterion) variable including** p*ercentage change* of *Heart Rate Variability* (HRV) *at third Minute (3m).*
Statistical Tools: Percentage change, ANOVA (one way) and LSD as post hoc analysis of variance were computed to analyze the data.
Conclusion: Heart Rate Variability (HRV) was found to be a valid measure for evaluating mental training programme namely, Progressive Relaxation Training (PRT).

Introduction: The sports psychologist makes constant efforts in developing the mental skills of an athlete that are essential in the process of interacting with a specific environment and enables the athlete to channelize and meet the demands of the situations effectively (Lazarus, 1991; Mace and Correll, 1989 and Sinha and Singh, 2001).

The arguments on the significance of biofeedback is well established, to be specific the electro-cardiograph (ECG) biofeedback (BF) and that too HRV for the study of the effect of mental training on self-regulation (para-sympathetic dominance) by progressive relaxation training (PRT). Though, Jacobson argued the incompatibility of PRT and BF (exactly seventy years back; Jacobson, 1938) but not heart rate variability (HRV) as BF, because HRV is a modern technological and psycho-neurological development for the study of mental training. Therefore, progressive relaxation training (PRT) aided with electro-cardiograph (ECG-BF) biofeedback have been considered very significant by the coaches and trainers of top class sports persons (Luthe, 1996).

Progressive Relaxation Training aided with ECG biofeedback instrument was adopted for the purpose of the present study to identify the effects of PRT as one of the mental training programme on HRV. Recording of HRV are recommended for three to five minutes ()

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Sample: The randomly selected subjects were 210 male sportspersons from the University of Delhi with age ranging from 19 to 21 years.

Selection of the Variables: Variables selected for the above purpose were as follows:

(1) **Treatment variable**: Progressive Relaxation Training (PRT) aided with Electro-cardio-graph biofeedback (ECG- BF) instrument. The subjects were homogeneously divided into six groups and termed as Group 1, Group-2, Group-3, Group-4, Group-5 and Group-6 for the purpose of the study. Groupings were done to make the study feasible.

(2) **Observational/ Performance/ Criterion variable:** Percentage change of Heart Rate Variability (HRV) variables of pre-session (recordings of HRV before PRT session) and post-session (recordings of HRV immediately after PRT session). Recordings were performed at pre-test (Test-1), intermediate test as post-test-1 (Test-2) and final test as post-test-2 (Test-3).

HRV Recordings were performed at Third Minute (3m) for computation.

Methodology: The experiment was conducted as follows:

The testing phase included the treatment of the selected subjects with Progressive Relaxation Training (PRT) by E. Jacobson} aided with biofeedback instrument (ECG Biofeedback "Bio-trainer" CBF 7000) for a period of six weeks (one and a half months) to obtain **Heart Rate Variability Scores** (HRV scores; the psycho-physiological responses of the subjects). There were three stages of testing with biofeedback device for obtaining the percentage change in HRV scores. The details of the training are as follows:

- **Test-1 (0 Week)**: Before the mental training (PRT aided with BF) began; each subject was tested to obtain the Test-1 (Pre-Test) HRV scores using ECG BF before and immediately after the PRT session, i.e., Pre-Session-1 and Post-Session-1 as follows:

  Criterion Variable: Recording at third minute of heart rate variability

  HRV Percentage change**:** Thereafter, the difference between the pre-session-1 and post session-1 scores for HRV variables was calculated for percentage change in HRV scores for Test-1{the effect of biofeedback training (PRT+BF)} referred as performance variable for Test-1 as follows:

  Pre-Session1 (HRV Scores) – Post Session1 (HRV Scores)/ Pre-Session1 (HRV Scores)

- **Test 2 (3 Weeks)**: The same procedure was adopted after the completion of three weeks of PRT aided with BF to obtain Test-2 (Post-Test-1) HRV scores that is Pre-Session-2 and Post-Session-2 and then HRV Percentage change as in the test-1 as follows:

  Pre-Session 2 (HRV Scores) – Post Session 2 (HRV Scores)/ Pre-Session 2 (HRV Scores)

- **Test 3 (6 weeks)**: Finally, after six weeks of mental training (PRT aided with BF), the subjects were similarly tested to obtain the Test 3 (Post-Test-2) HRV scores i.e. Pre-Session-3 and Post-Session-3 and HRV percentage change as in the test-1 and 2.

Pre-Session 3 (HRV Scores) – Post Session 3 (HRV Scores)/ Pre-Session 3 (HRV Scores

Statistical Tools: Percentage change was calculated by the difference between the two sessions (pre-session and post-session) in each of the three tests to determine the effect of Progressive Relaxation Training aided with Electrocardiograph biofeedback (PRT+ECG-BF) on Heart Rate Variability (HRV) as performance measure of training. ANOVA (one way) and LSD as post hoc analysis of variance were computed to analyze the data.

Analysis of the Data: The analysis of the data has been presented in the tables from 1 to 10

Table-1
Encoding and Decoding

S. No.	Encoding	Decoding
1.	Pre	Pre-session Recordings
2.	Po	Post Session Recordings
3.	T-1	Test-1 (Pre-test)
4.	T-2	Test-2 (Post-test-1)
5.	T-3	Test-3 (Post-test-2)
6.	E	Extraversion
7.	I	Introversion
8.	N	Neuroticism
9.	P	Psychoticism
10.	EHMA	Extraversion with High Mental Ability
11.	IHMA	Introversion with High Mental Ability
12.	NHMA	Neuroticism with High Mental Ability
13.	ELMA	Extraversion with Low Mental Ability
14.	ILMA	Introversion with Low Mental Ability
15.	NLMA	Neuroticism with Low Mental Ability
16.	HRV	Heart Rate Variability
17.	Pre-1T-1m	First Minute's HRV Recordings at Pre-session of Test-1 (Pre-test)
18.	Pre-1T-2m	Minute's HRV Recordings at Pre-session of Test-1 (Pre-test)
19.	Pre-1T-3m	Third Minute's HRV Recordings at Pre-session of Test-1 (Pre-test)
20.	Pre-2T-1m	First Minute's HRV Recordings at Pre-session of Test-2 (Post-test-1)
21.	Pre-2T-2m	Second Minute's HRV Recordings at Pre-session of Test-2 (Post-test-1)

22. Pre-2T-3m	Third Minute's HRV Recordings at Pre-session of Test-2 (Post-test-1)
23. Pre-3T-1m	First Minute's HRV Recordings at Pre-session of Test-3 (Post-test-2)
24. Pre-3T-2m	Second Minute's HRV Recordings at Pre-session of Test-3(Post-test-2)
25. Pre-3T-3m	Third Minute's HRV Recordings at Pre-session of Test-3 (Post-test-2)
26. Pre-3T-2m	Second Minute's HRV Recordings at Pre-session of Test-3(Post-test-2)
27. Pre-3T-3m	Third Minute's HRV Recordings at Pre-session of Test-3 (Post-test-2)
28. Po-1T-1m	First Minute's HRV Recordings at Post-session of Test-1 (Pre-test)
29. Po-1T-2m	Second Minute's HRV Recordings at Post--session of Test-1 (Pre-test)
30. Po-1T-3m	Third Minute's HRV Recordings at Post--session of Test-1 (Pre-test)
31. Po-2T-1m	First Minute's HRV Recordings at Post-session of Test-2 (Post-test-1)
32. Po-2T-2m	Second Minute HRV Recordings at Post--session of Test-2 (Post-test-1)
33. Po-2T-3m	Third Minute's HRV Recordings at Post--session of Test-2 (Post-test-1)
34. Po-3T-1m	First Minute's HRV Recordings at Post--session of Test-3 (Post-test-2)
35. Po-3T-2m	Second Minute HRV Recordings at Post--session of Test-3(Post-test-2)
36. Po-3T-3m	Third Minute's HRV Recordings at Pre-session of Test-3 (Post-test-2)
37. T1-1m%c	Percentage Difference of HRV at first minute of First Test
38. T1-3m%c	Percentage Difference of HRV at Third minute of First Test
39. T2-1m%c	Percentage Difference of HRV at first minute of Second Test
40. T2-3m%c	Percentage Difference of HRV at Third minute of Second Test
41. T3-1m%c	Percentage Difference of HRV at first minute of Third Test
42. T3-3m%c	Percentage Difference of HRV at Third minute of Third Test

Table-2

Descriptive Statistics of HRV Criterion of Six Groups Recorded Collectively for Three Tests (HRV Percentage Change at Third Minute)

Six Groups	Statistics	Test 1	Test 2	Test 3
Percentage Change at 3rd Minute	Mean	7.07	5.81	4.14
	Standard Deviation	4.0	3.66	3.30

N=192

The analysis in Table 2 pertaining to "Descriptive Statistics of HRV Criterion of Six Groups Recorded Collectively for Three Tests (N192) at Pre-Test (Test-1; before beginning the PRT training) Post Test-1 (Test-2; at the end of 3rd week) and Post Test-2 (Test-3; at the end of the 6th Week) of the PRT training programme) illustrates the mean and Standard Deviation of percentage change (HRV Percentage Change) at 'Third Minute' (3m%c) showed a decreasing trend from the Test 1 to Test 3 with least mean and standard deviation at Test 3.

Table-3

Comparison among the Tests (Test-1, Test-2 and Test-3) in Regard to Criterion Measure of the Six Groups

Six Groups	SS (b)	SS(w)	Total	Df	MS (b)	MS (w)	'F' Ratio	Prob.
Group 1	91.078	1227.23	1318.31	2/93/95	45.539	17.615	3.451*	0.047
Group-2	3.679	1142.32	1145.97	2/93/95	1.840	12.283	0.15 NS	0.862
Group-3	12.026	1113.30	1125.33	2/93/95	6.013	11.971	0.502 NS	0.609
Group-4	120.631	1624.89	1744.93	2/93/95	60.315	17.472	3.452*	0.048
Group-5	21.878	312.67	334.55	2/93/95	10.939	17.879	3.25*	0.049
Group-6	137.971	1938.03	2075.99	2/93/95	68.986	20.839	3.31*	0.046

*** Significant at the .05 level. NS: Insignificant at the .05 level.**

The analysis presented in table-1 pertaining to "comparison among the tests (test-1, test-2 and test-3) in regard to criterion measure of six groups (1, 2, 3, 4, 5 and 6)" for observing the sessional effects on the group documented significant 'F' ratio for the criterion variable namely, percentage change at third minute (3m %c) recorded at three tests i.e. test 1, 2 and 3. The findings confirmed that there were regressive sessional effects of biofeedback training on groups 1, 4, 5 and 6. The table-2 also confirmed the findings of table 1 for the aforementioned four groups. The table also documented insignificant 'F' ratios for criterion variable (3m%c) recorded at three tests i.e. test 1, 2 and 3 for groups 2 and 3. The post hoc presented in table-2 confirmed the findings in table-1 that there were insignificant differences found between the tests for groups 2 and 3.

Table-4

Post-hoc Comparisons between the Tests in Regard to Criterion Measures of the Six Groups

Sessional Effects	Comparison Between the Tests		
On Six Groups	1 vs 2	1 vs 3	2 vs 3
Group 1	2.88*	2.95*	0.07
Group 2	0.59 NS	0.84 NS	0.25 NS
Group-3	0.62 NS	1.27 NS	0.65 NS
Group-4	1.30	4.24*	2.94*
Group-5	1.10	4.04*	2.94*
Group-6	1.07	4.16*	3.09*

***Significant at the .05 level.**
NS: Insignificant at the .05 level.

Discussion of Findings:

1. There were significant regressive sessional (acute) effects of PRT+ECG-BF training {i.e. reducing tends in the magnitude of the percentage change on the selected criterion measure i.e. percentage change at third minute (3m%c) determined from pre to post session HRV scores performance variables} for groups 1, 4, 5 and 6.
2. It was found that two groups (2 and 3) exhibited consistent effect {i.e. no reducing tends in the magnitude of the percentage change of HRV on the selected criterion measure (third minute of percentage change of HRV as performance variables) due to the treatment variable i.e. biofeedback training}.
3. The first group exhibited significant sessional (acute) effects of PRT+ECG-BF training with an inverted U trend (increased their learning performance from test-1 to test-2 and then decreased from test-2 to test-3) that may be attributed to brain activity and/or neuro-physiological reactivity. The lowest value of HRV

recordings of G-1 were recorded at test-3, which advocate that sessional effect of PRT+ECG-BF on HRV performance variables led to superior learning curve in comparison to the two groups (G 2 and 3).

4. The two groups of sports person maintained a consistent learning performance over the paradigm of experimentation {i.e. no reducing tends in the magnitude of the percentage change of HRV on the selected criterion measure (third minute of percentage change of HRV as performance variables) due to the treatment variable i.e. biofeedback training}.

Conclusion:

Heart Rate Variability (HRV) was found to be a valid measure for evaluating mental training programme (PRT).

References:

Craig, Ashley and others, "The Electroencephalography of the Ideal Performance State", **Applied Psychophysiology and Biofeedback** 27.4 (December 2002): 2. http://www.wma.net

Carment, W. B. and Miles, C. G., "Persuasiveness and Persuability as Related to Intelligence and Extraversion", **British Journal of Sociological and Clinical Psychology** 4 (1965): 1-7.

Corsini, Raymond J., **Encyclopaedia of Psychology**, (2nd Ed.) (New York: John Wiley and Sons, 1994), p. 173

Bartussek, D. et. al., "Extraversion, Introversion Neuroticism and Event Related Brain Potentials in Response to Emotional Stimuli", **Personality and Individual Differences** 20.3 (1996): 301-312. In Psychological Abstracts 84.3 (1997): 893.

Dienstbier, Richard A. "Arousal and Physiological Toughness: Implications for Mental and Physical Health", **Psychological Review** 96 (1989): 84-100.

Eysenck H. J. and Eysenck, S. B. J. "On the Unitary Nature of Extraversion", **Acta Psychologia** 26 (1967): 383-390. In **Bearings on Basic Psychological Processes**: **Readings in Extraversion-Introversion**, Vol. 3, (Ed.) H. J. Eysenck (London: Staples Press Ltd., 1971), pp. 13-17.

Jacobson, Edmund, **Progressive Relaxation** (1938) Cited in W. Luthe, **Autogenic Therapy: Research and Theory** (New York: Grunne and Stratton, 1970), p. 101.

Jausovec, Norbert, "Neuro-psychological Basis of Creativity", **Intelligence,** (Ed) Lin V. Wesley (Slovenia: Nova Science Publishers, Uni. of Maribor, 2006).

Krishna, K. P. and Aggarwal, V. R., "Personality Pathology in Reading Ability", **Indian Journal of Clinical Psychology** 9 (1982): 167-168. In **Indian Psychological Abstracts** 21.1 (Mar.1983): 94.

Luthe, **Autogenic Therapy: Research and Theory** (New York: Grunne and Stratton, 1970), p. 100.

Eysenck H. J. et. al., **Encyclopaedia of Psychiatry**, A to F (Kugler Publications, 1966), p. 325.

Luthe, W., **Autogenic Therapy: Research and Theory** (New York: Grunne and Stratton, 1970), p. 187.

Venables, Ethel C. "Differences between Verbal and Non-Verbal Ability in Relation to Personality Scores among Part-time Day Release Students", **British Journal of Sociological and Clinical Psychology** 4 (1965): 188-196.