

Comparative Effect of Audio-Visual Biofeedback Therapy and Yoga Nidra on Lactate Clearance and Heart Rate during Recovery of Badminton Players

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Abstract: *The present study was aimed at comparing the immediate effect of audio-visual biofeedback therapy and Yoga Nidra on blood lactate removal and heart rate among badminton players. 10 (ten) male badminton players were selected using simple random method for the study, aged 18 to 23 years (mean, SD of age 21±1.15 as the scores were normally distributed). Each subject had to repeatedly undergone through Audio-Visual Biofeedback Therapy and Yoga Nidra and control training for a session of 30 minutes. Data were collected on blood lactate (with the help of lactic acid analyzer), heart rate (with the help of heart rate monitor) before and after the training of all the three training which was given immediately in different day after a badminton match of best of 3 sets. It was hypothesized that there would be significant difference of post effect among audio-visual biofeedback, Yoga Nidra and control group on lactic acid and heart rate. Two-way repeated measure ANOVA was employed for the analysis of result at 5% level of significance. Finally, interaction effect of time and three different treatments were found significant on selected variables. Lactic acid concentration and heart rate were decreased significantly ($p < 0.05$) in relation to the time in Yoga Nidra and biofeedback therapy respectively. No significant difference ($p > 0.05$) was found in control group in both the variables between pre and post time. In with-in treatment effect of Yoga Nidra had shown significant difference with ($p < 0.000$) than the biofeedback training and control group ($p < 0.001$) in lactic acid. No significant difference ($p > 0.116$) was shown between Yoga Nidra and Biofeedback method in heart rate reduction. Thus, it can be concluded that Yoga Nidra is more effective for faster recovery than the Audio-visual Biofeedback method as it increases the alpha activity, activating the parasympathetic nervous activation which leads to decreased psycho-physiological functions and muscles tension.*

Keywords: Biofeedback Therapy, Yoga Nidra, Blood Lactate (BL), Heart Rate (HR)

1. Introduction

Now a days sports have been playing an important role in the society increasingly with scientific investigation on performance of sportsmen to attain excellence of performance. High-intensity exercise training results in production and accumulation of blood lactate which is one of the major reasons of peripheral fatigue (Gladden, 2004)¹ leading towards central (mental) fatigue. Thus, optimum recovery is required in the sense of physical and mental for attaining the next highest performance.

Many investigators have shown that the rate of lactate removal occurs more rapidly during active recovery than passive at rests (Paul Menzies, 2010; Spierer et al., 2004; Holden H.S. et. al., 1992)^{2,3,4}. Different cooling down exercise, stretching, massage manipulation, cold water immersion, psychotherapy and many means are implemented for faster recovery in the sense of physiological and psychological aspects.

Yoga nidra and audio-visual biofeedback therapy have been used as a method to reduce anxiety and as a mean of exercise training for recovery purpose as well. Yoga nidra is a systematic technique to amplify complete physical, mental and emotional relaxation which is performed in shavasana with the eyes closed. The state of relaxation is touched by turning inwards, ahead of outer experiences and can be applied in many ways. According to the ancient Indian scriptures, sages are known to sleep using yoga nidra. Yoga nidra is derived from 'pratyahara' of raja yoga

and tantric practise, done in supine position and unlike meditation which is a mindful awake state (Saraswati, 1998)⁵ or also called psychic sleep. Yoga nidra starts from physical relaxation to mental relaxation controlling the psycho-physiological functioning like decreasing heart rate, blood pressure, muscular tension, decreasing neural activities and activation of rhythmic brain wave.

On the other hand, biofeedback is psycho-physiological therapy machine, assisted by audio-visual instruction through which patients learn to control over their bodily functions that are normally involuntary, such as muscle tension, blood pressure, or heart rate, body temperature. This machine helps to improve the psycho-physiological functions by getting feedback from the machine of psycho-physiological functions.

Heart rate and blood lactate clearance is the prime indicator of recovery. Activation of parasympathetic nervous system helps to reduce the lactate content and provide physical relaxation. So, this present study was investigated which technique is more effective for faster recovery in the sense of blood lactate clearance and heart rate variability.

It was hypothesized that there would be significant differences between the effect of Audio-Visual Biofeedback Technique and Yoga Nidra on blood lactate clearance and heart rate reduction.

2. Methods and Materials

Subjects: 10 healthy advance badminton player aged ranging from 19-23 (male) were selected randomly using simple random sampling method (as the sample population group was homogenous) from badminton match practice group, LNIPE, Gwalior and participated in the study. The mean and SD of age is 21 ± 1.15 respectively as the scores were normally distributed. All the subjects gone through three different training programs and data were collected on selected variables repeatedly before and after the training intervention.

Variables and Design of the study:

Three training group were designed and each subject (all 10) was undergone through different training programs repeatedly in definite time interval. All the subjects were tested repeatedly on selected variables before and after the training intervention immediately and the mean differences of post training effect were compared. The test was taken from the in an order (counter balanced design) to avoid the carry over effect of the training (shown below in figure. 1)⁶. And two-day rest was given between the each training interventions on the selected variables. Interaction effect of treatments factors of three levels (audio-visual biofeedback training, Yoga Nidra with progressive relaxation techniques and placebo training for control group) and time factor of two levels (pre and post) was tested simultaneously on selected variables. The impact of given treatments were tested on blood lactate concentration and heart rate of the subjects.

Training protocol

Three different training protocol i.e. Audio-Visual Biofeedback Therapy, Yoga Nidra with progressive muscle relaxation technique and placebo (supine rest) control program were designed for 30 minutes and compared the post effect of all the training on heart rate and blood lactate concentration. Biofeedback training was accompanied with the audio-visual relaxative instructions through biofeedback machine monitor. Biofeedback therapy is a technique that train people to improve involuntary physiological functions by getting the real time feedback from the machine. The programme was customized for 30 minutes in the monitor with audio-visual instructional (guided imagery) aids for mental and physical relaxation.

The Yoga Nidra was guided by the researcher where progressive muscle relaxation followed by deep relaxation was used. In progressive muscle relaxation whole-body was scanned by producing tension in different muscles group isometric contraction and relaxation repeatedly. After this deep relaxation practice was assisted with deep inhalation and exhalation of abdominal breathing. And simply rest was given to the control group as placebo.

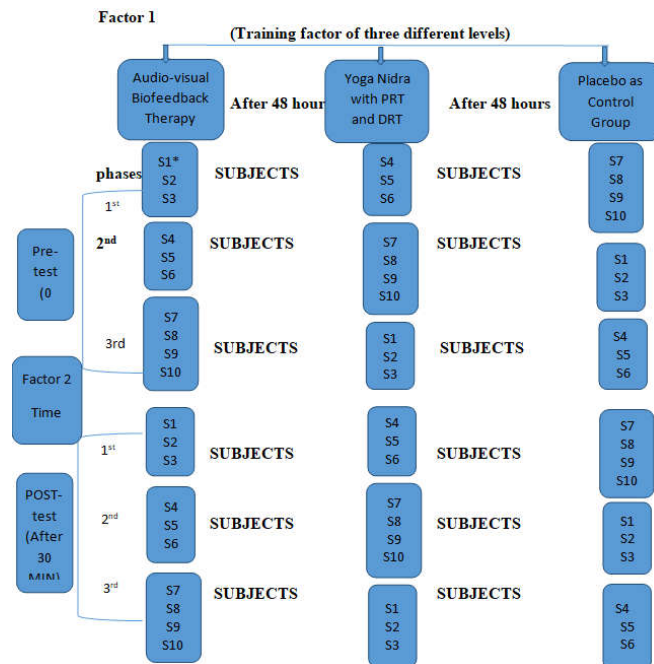


Figure 1: Layout of Sample Distribution of Two-Way Repeated ANOVA Design with Two Factors and Levels

Test administration:

All the participants were examined immediately after a badminton match of 3 sets and the treatments were given to them according to the order for 30 minutes at different day to minimize the order and counter effect of the training. The equipment's and tests were administered in the badminton courts for collection of data. After the training session of 30 minutes the subjects were again tested on following variables.

The subjected were instructed immediately after the match for data collection on selected variables. Heart rate variability and blood lactate were measured by heart rate monitor and lactate analyzer respectively immediately after the match.

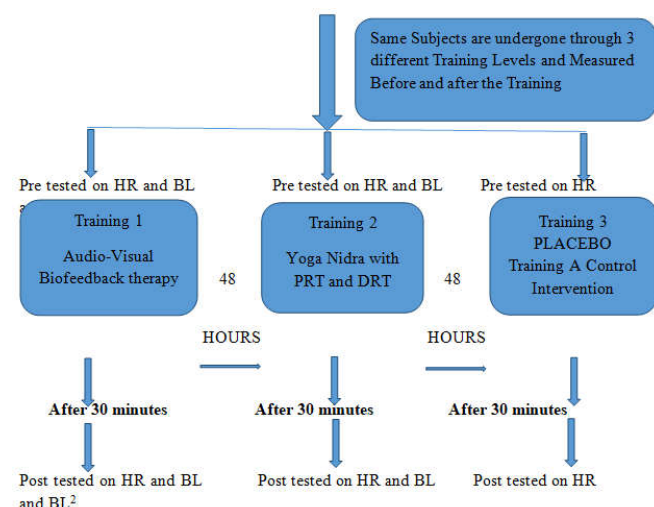


Figure 2: Experimental Model of This Research Design

Statistical analysis

Two-way repeated measure ANOVA (r-ANOVA) was employed at 5% level of significance to analyze the result as the effect of two factors (treatment and time) in different levels was tested simultaneously on same participants. The data were analyzed in SPSS 20.

3. Results

Two-way Repeated ANOVA was used for analysis of the result. In this repeated measure design, there are two independent factors time and treatment whose effect need to be investigated. Table no. 1 shown with-in subject interaction effect of treatment and time was significant with p-value ($p < 0.003$) associated with the F-value 8.14 (sphericity assumed, Mauqly's test of Sphericity) is in heart rate reduction.

Table 1: F-table for testing significance of within-subjects effect on Heart Rate

Source		df	F	Sig.	Partial Eta Squared
Treatment	Sphericity Assumed	2	12.77	.000	.587
	Greenhouse-Geisser	1.56	12.77	.001	.587
	Huynh-Feldt	1.83	12.77	.001	.587
Time	Sphericity Assumed	1	332.77	.000	.974
	Greenhouse-Geisser	1.00	332.77	.000	.974
	Huynh-Feldt	1.00	332.77	.000	.974
treatment * time	Sphericity Assumed*	2	8.14	.003*	.475
	Greenhouse-Geisser	1.88	8.14	.004	.475
	Huynh-Feldt	2.00	8.14	.003	.475

df: degree of freedom

*significant at 0.05. (Sphericity is not significant in Mauchli Test, ($p > 0.05$).

^aPartial Eta Square (effect size of the independent variables on dependent variables) .475 is moderate

Table 2: Descriptive Statistics of Post Heart Rate in Different Treatment Groups

Measure variable	Mean	Std. Deviation	N
post heart rate biofeedback	70.10	5.70	10
post heart rate yoganidra	65.80	6.39	10
post heart rate control	77.70	4.64	10

Here, the interaction effect of time and treatment is significant, hence the simple effect of time and different treatment is investigated. The simple effect of time on heart rate in each level of treatment is investigated. Heart

rate was decreased significantly ($p < 0.05$) from 90 ± 5.00 to 65 ± 6.00 beat/min and 91 ± 5.12 to 70 ± 5.70 beat/min in Yoga Nidra and Biofeedback therapy respectively with no significant difference in control group ($p > 0.05$).

Table 3: Pairwise Comparisons of Heart Rate in different Treatment Groups

(I) treatment_post_time	(J) treatment_post_time	Mean Difference (I-J)	Std. Error	Sig. ^a
1 biofeedback	2 yoga nidra	4.300	1.777	.116
	3 control	-7.600*	2.526	.044
2 yoga nidra	1 biofeedback	-4.300	1.777	.116
	3 control	-11.900*	2.643	.004
3 control	1 biofeedback	7.600*	2.526	.044
	2 yoga nidra	11.900*	2.643	.004

*The mean difference is significant at the .05 level.

^aAdjustment for multiple comparisons: Bonferroni

Here, Table no. 3 had shown the pairwise comparison done by Bonferroni among three different training program as simple effect of each treatment on heart rate reduction was significant ($p < 0.05$) with F-value 13.82 (Sphericity assumed). Heart rate was significantly reduced in post time factor both biofeedback ($p < .040$) (70.10 ± 5.70) and Yoga Nidra (65.80 ± 6.39) ($p < .004$) than

control group (77 ± 4.64). But no significant difference was found in post heart rate variability (HRV) ($p > .116$) between biofeedback (70.10 ± 5.70) and Yoga Nidra (65.80 ± 6.39). It means here audio-visual biofeedback and Yoga Nidra both the intervention is equally effective in reduction of heart rate in recovery.

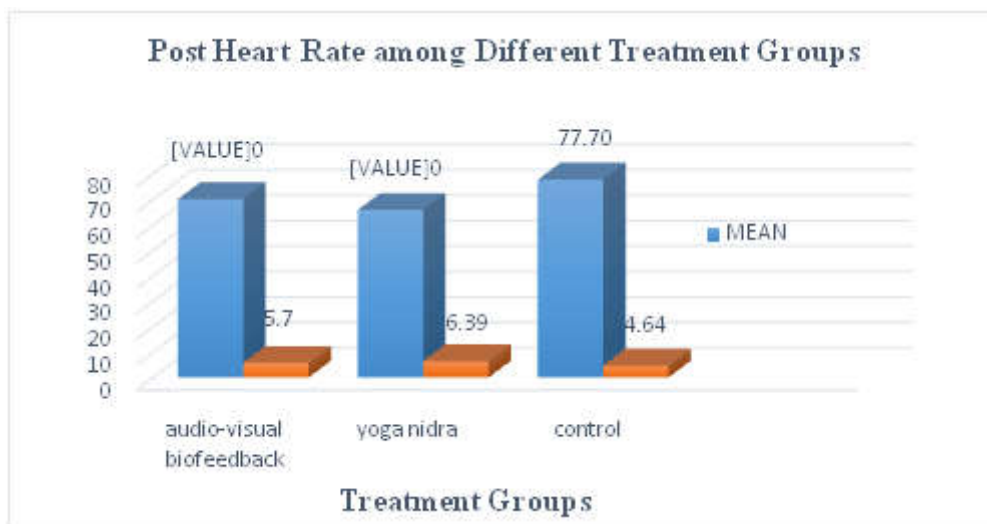


Figure 3: Mean and SD of Post Heart Rate of Different Treatment Groups

Table 4: F-Table for Testing Significance of Within-Subjects Effect on Blood Lactate

	Source	Df	F	Sig.	PartialEta Squared
Treatment	Sphericity Assumed	2	32.708	.000	.784
	Greenhouse-Geisser	1.201	32.708	.000	.784
Time	Sphericity Assumed	1	1.100	.322	.109
	Greenhouse-Geisser	1.000	1.100	.322	.109
treatment * time	Sphericity Assumed	2	17.938	.001*	.666 ^a
	Greenhouse-Geisser	1.112	17.938	.001	.666

*Significant at 0.05.

^aPartial Eta Square (effect size of the independent variables on dependent variables).666 is moderate

Table no. 4 shown with-in subject interaction effect of treatment and time was significant with p-value (p<0.001) associated with the F-value 17.938 (Sphericity assumed, Mauqly’s test of Sphericity) is in blood lactate.

Table 5: Descriptive Statistics of Blood Lactate of Different Treatment Groups

	Mean	Std. Deviation	N
post lactate in biofeedback group	2.66	.58	10
post lactate in yoga nidra group	2.32	.63	10
post lactate in control	3.38	.84	10
pre lactate biofeedback	3.99	1.13	10
pre lactate yoga nidra	4.03	1.27	10
pre lactate control	3.94	1.05	10

Table no 5. Shown, that blood lactate was also decreased significantly (p<0.05) from 4.03±1.27 mmol/L to 2.32±0.63 mmol/L and 4.00±1.13 mmol/L to 2.66±0.58 mmol/L in Yoga Nidra and Biofeedback therapy respectively with no significant difference in control group (p>0.05) (as the simple effect of time factor was significant in blood lactate).

Table 6: Pairwise Comparison of Blood Lactate Clearance in different groups

(I) treatment_post_time	(J) treatment_post_time	Mean Difference (I-J)	Std. Error	Sig.
1 biofeedback	2 yoga nidra	.340*	.048	.000
	3 control	-.720*	.196	.015
2 yoga nidra	1 biofeedback	-.340*	.048	.000
	3 control	-1.060*	.187	.001
3 control	1 biofeedback	.720*	.196	.015
	2 yoga nidra	1.060*	.187	.001

*The mean difference is significant at the .05 level.

Table no. 6 shows within treatment group effect (pairwise comparison of Bonferroni test) of blood lactate clearance and Yoga Nidra with PRT and DRT (2.32±0.63) have shown the significant difference (p<0.05) than biofeedback therapy (2.66±0.58) and control group (3.38±0.84).

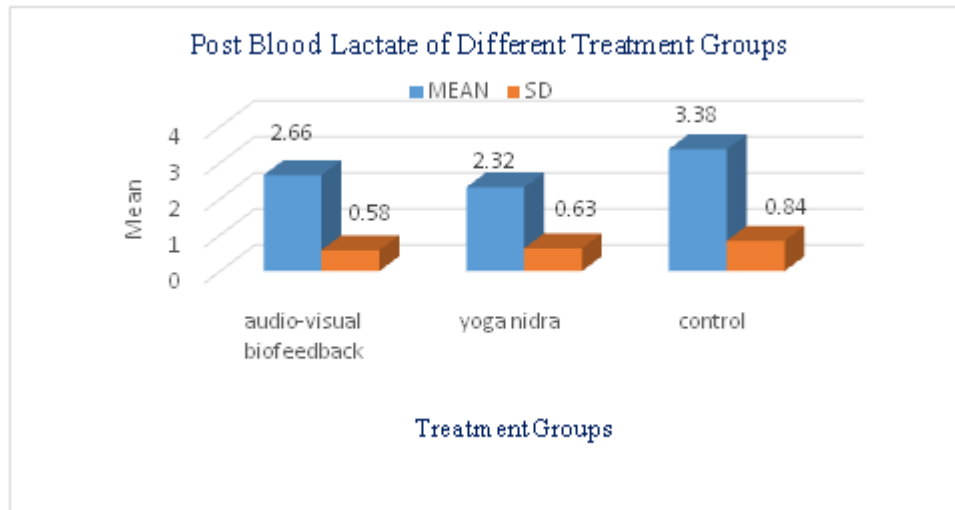


Figure 4: Mean and SD of Post Blood Lactate Concentration of Different Treatment Groups

4. Discussion on Findings

Heart rate and blood lactate both were decreased in relation to the time in both the treatment group Yoga nidra and Biofeedback after giving the intervention. But in the simple effect of treatment effect Yoga nidra was found to be more effective than audio-visual biofeedback therapy in reduction of and blood lactate removal. The findings could be attributed due to that during Yoga Nidra in progressive relaxative technique muscles tension was scanned by continuous isometric muscle contraction and relaxation in different muscles group repeatedly which is consciously released and also assisted with deep breathing simultaneously.

Due to the repetitive muscle contraction and relaxation of different muscle group blood flow is increased in the contracting muscles which helps in clearance of blood lactate with the help of rich recovery oxygen supply and Cytochrome a-a3 was more oxidized during contractions then rest (Stainsby W.N, et.al., 1991, L. Kevin M.K, et.al, 2011)^{7,8} which is not occurred in biofeedback therapy. In active recovery pattern with low volume muscular action bloods is redistributed to the active muscles group and enhance the oxygen consumption by the muscle leading to the faster lactate clearance from the blood.

More lactate production is caused due to the fact that the pyruvate is converted to lactate by lactate dehydrogenase (LDH), primarily as a result of changes in the intramuscular redox state, and oxidation of the excess lactate relies on redistribution by the blood flow to other muscles and the heart and liver (Gladden, 2004; Wasserman, Beaver & Whipp, 1986)¹. Most of the lactate is oxidized by skeletal muscles working at a lower intensity, and the lactate redistribution occurs via the blood flow (Gladden, 2004)¹, as after lactate-accumulating active exercise appears to be more effective at clearing accumulated lactate rather than passive recovery (Paul Menzies, 2010; Spierer et al. 2004; Boileau, Misner, Menzies, P. and Menzies C., 2010)^{2,3,9}.

Moreover, practice of Yoga Nidra brings alpha dominance (Kjaer, T. W. et. Al, 2002)¹⁰ in the brain, which is

responsible for mental relaxation and release of certain hormones which is mainly responsible for faster physiological recovery (Kumar, K. & Joshi, B. (2009); I.S. Isa, Z. Hussain; John, Gruzelier, (2009)^{15,16,17}. During a yoga-nidra relaxation meditation dopamine production in the ventral striatum which is also responsible for deep physical and mental relaxation (Kjaer et al., 2002)¹⁰. Alpha wave is raised highly in Yoga Nidra than the audio-visual bio-feedback therapy as high amplitude slow alpha rhythm is appeared in closed eyes which enhance the relaxation of conscious mind. Slow and deep abdominal breathing is also enhance the slow alpha rhythm as it increase the neural oxygen consumption (Wannie, R.). More oxygen consumption by the muscles is also associated with deep abdominal breathing. Audio-visual biofeedback was given in open eyes. In open eyes condition the alpha frequency increases and alpha rhythmicity is disappeared due to visual perception increased brain activity. So relaxation and recovery is delayed in audio-visual biofeedback technique.

Yoga Nidra also enhance the venous return as in shavasana has less gravitational force (Nobouhiro, W., et.al. (2007)¹¹. So, the blood circulation from the lower body is increased towards the heart, helping ion faster recovery process. But in biofeedback therapy venous return does not enhances as the person was seated for audio-visual training. Thus, Yoga Nidra with isometric muscle relaxation reduces the central (psychogenic) peripheral (myofascial) fatigue.

The heart-rate variability spectrum reduced, signifying a reduced sympathetic activity through the yoga nidra (Nina, M., Michael, W. (2012)¹⁸. guided relaxation and deep breathing have the effect on autonomic variables, (Telles, 2002, Swani, P, (2015)^{12,13}. Slow deep breathing stimulate the vagus nerve and enhance parasympathetic activity leading to parasympathetic dominance and enhanced cardiac function, mood, and energy states, as well as enhanced neuroendocrine, metabolic, cognitive, and immune responses (Tyagi, A. et.al, 2016)¹⁴. In heart rate reduction both the technique audio-visual biofeedback therapy and yoga nidra was effective equally, activating the parasympathetic nervous system as in biofeedback therapy patients are instructed audio-visually to get control

over their sympathetic nervous system or psycho-physiological functions by getting the visual feedback with time (David J. Vernon. (2005)¹⁹. As the venous return is supplementary in Yoga nidra techniques, it also declines the heart rate faster.

5. Conclusion

So, it could be concluded that guided yoga nidra or progressive relaxation technique is more effective for faster blood lactate clearance and psycho-physiological relaxation where for the reduction of heart rate both the technique plays equal role.

Abbreviation:

BL: Blood Lactate; HR: Heart Rate; SD: Standard Deviation; DF; Degree of Freedom, r-ANOVA: Repeated measure analysis of variance; PRT: Progressive Relaxative Technique; DRT: Deep Relaxation Technique.

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