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Impact of Physical Exercise and Transcendental Meditation on Physiological parameters: An ANN Modelling

R. Bhardwaj[a], Siddhartha Agarwal[b], S.P Singh[c], M.M. Srivastava[d], J.K. Arora[a]
[a]Technical College, Saran Ashram Hospital, Dayalbagh of Psychology, [c]Department of Mathematics, [d]Department of Chemistry
Dayalbagh Educational Institute (Deemed University), Dayalbagh, Agra 282005

Abstract— The present paper is specifically aimed to design an ANN model based on the data on the effect of physical exercise and meditation on some selected physiological parameters, generated from a study on 30 healthy male and female volunteers between the age group of 20-50 years. The performance of the model was evaluated considering 60 % data for training, 20 % data for testing and 20 % data for cross validation with sigmoid axon transfer function, at 1500 Epoch with 0.70000 momentums. The minimum MSE in the group of four variables was determined for training and cross validation were 2.08702E-05 and 0.545759673 respectively.

Index Terms—Physical fitness, Meditation, ANN Modelling, Well Being.

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1 Introduction

Today, modern society is under several stresses, sense of dissatisfaction and lack of well being. Modern era has led to comfortable, convenient, sedentary life style and therefore becoming hypo kinetic and lethargic. Among various reasons, the ignorance of physical exercises in their routine life is also important. Ethical life style having physical and spiritual activities enhancing life satisfaction and well being has been strongly highlighted (**Wallace et al, 1972**). Physical fitness can be improved by regular physical activities and various modes of transcendental meditations . Any transcendental meditation is a spiritual process which involves achievement of harmony among the physical, mental and spiritual state of a person (**Benson & Proctor, 1984, Jedrezak et al, 1988**). Meditation practices are also likely to affect physiological pathways, including immune and neuroendocrine systems (**Alexender et al, 1994**). The biology of meditation reveals the release of higher level of neurotransmitters in their blood, although the exact nature of the relationship between neurotransmitters and meditation has yet to be revealed. However, on the scientific front, increase in alpha rhythm amplitude, decrease in beta–wave activity, decreased heart and respiratory rates, decreased oxygen consumption), decreased blood pressure (**Tooley et al , 2000**), slower heart rate and respiration as well as lower **body temperature** and higher plasma melatonin levels (**Hidderley et al., 2004; Carlson et al., 2007**). The benefits of meditation in physical and mental performance of everyday life are well documented (**Lucas et al, 2012**). Therefore, such non exercising technique has gained a wide popularity world over because of its consequent favorable physiological effects (**Carlson et al, 2007**). Attempts have also been made to correlate the experimental observations on the effect of physical and spiritual activities with wellbeing/life satisfaction/level of consciousness using several mathematical models and empirical equations (**Kramer et al, 2012, Agarwal et al 2013**). Extreme complexity of the phenomenon of the subject and scientific methodological difficulties had marginalized this issue in the field of theological sciences. A well designed network can converge even on multiple numbers of variables at a time without any complex modeling and empirical equations. In recent years, ANN has been used as a powerful modeling tool, particulary in complex environmental and theological research (**Arora et al, 2013**). Artificial Neural Network (ANN) utilizes interconnected mathematical neurons to form a network that can model complex functional relationship.

The present paper is specifically aimed to design a ANN model based on the information on effect of physical exercise and meditation on physiological parameters for the prediction to a large number of population.

2 Methodology

The study was conducted on 30 healthy male and female volunteers between the age group of 20-50 years (mean 34.6 yr) with height of 1.56±0.05m, weighing 61±5.50 kg. All the subjects were not suffering from heart and lung disorders. All the target physiological parameters of the subjects were recorded and were divided into three groups of ten each. All the groups were initially given a warm up light exercise of 5 minutes daily. The subject of first group was considered control. The second group performed physical exercises according to the 5BX physical fitness program including 4 charts of 5 exercises. Hole in the Wall type of meditation was selected for meditation. Subjects were instructed to find a comfortable sitting position and were given 10 minutes to adapt with the environment. The third group volunteers practiced for 30 minutes daily in the meditation room. The fourth group was asked to perform physical exercise followed by meditation also. All the subjects performed their respective techniques for 12 weeks. Subjects were instructed to take moderate-carbohydrate diet of 1500 calories with fats up to 60 gm/day. Target physiological parameters were measured 0time, first, third, sixth, ninth and twelve weeks. All the recoded parameters were statistically analyzed.

3 ANN Structure

Neural Network Toolbox Neuro Solution6.0 ® mathematical software was used. A single-layer ANN model was designed considering base line data of the each group systolic Blood Pressure, Diastolic Blood pressure, Oxygen level, Heart rate While after the physical exercises, meditation process, and physical exercises followed by meditation for one week were considering as output. After a week these improved data of physiological parameters were considered as input and completion of third week data gathered of all physiological parameters were considered as output. This similar type process was going on after completion of sixth, ninth, twelfth week.. Network represents functional relationship between inputs and output, provided sigmoid layer has enough neurons with sigmoid axon transfer function. Levenberg- Marquardt algorithm is fastest training algorithm for network of moderate size, therefore, used in the present study.

Table 1. Group Wise Statistical Analysis of Measuered Phychological Parameters

Duration	Systolic Blood Pressure*			Diastolic Blood Pressure*			Oxygen Level*			Heart Rate*		
	A	B	C	A	B	C	A	B	C	A	B	C
I Week	117	119	115	77	80	75	89	91	94	70	77	91
III Week	115	117	112	75	78	73	91	92.	96	72	75	90
VI Week	116	118	114	76	78	73	92	93	96	71	76	88
IX Week	115	117	113	76	79	74	90.5	91	95	71	76	89
XII Week	115	116	113	75.8	79	74.2	91.5	92.6	95.7	71.2	75.7	90.5
Mean Value	115	117	113	76	78.8	74	91	92	95	71	75	89
Median Value	115	117	113	76	79	74	91	92.5	95.7	71	76	90
Standard Deviation	0.74	1.0	1.14	0.71	0.83	0.85	1.15	0.94	0.85	0.71	1.20	0.87
t value	0.20	0.19	0.16	0.21	0.24	0.19	0.17	0.21	0.19	0.22	0.18	0.20

*N=10 for each group, *average of subjects*

4 Back propagation algorithm

The back propagation algorithm is a generalization of the least mean square algorithm modifying network weights to minimize the mean square error between the desired and actual outputs of the network. Back propagation uses supervised learning in which the network is trained using data for which inputs as well as desired outputs are frozen and used to compute output values for new input samples. Start with randomly selected weights while MSE is unsatisfactory and computational bounds are not exceeded, do for each input pattern. The input is propagated through the ANN to the output and error ek on a single output neuron k is calculated as: ek = dk - yk , where yk is the calculated output and dk is the desired output of neuron k. This error value is used to calculate a δk value, which is again used for adjusting the weights .The δk value is calculated by: δk = ek g′(yk), where g′ is derived activation function. The δk value and δj values were calculated for proceeding layers. The δj values of the previous layer are calculated from the δk values of this layer by the following equation: δj = ng′(yj)Σ δkWjK , where K = 0,1,2………n, where K is the number of neurons and η is the learning rate parameter. Using δ values, the δw values are calculated by: δwjk= δj yk . The δwjk value is used to adjust the weight wjk, by wjk = wjk + δwjk and the back propagation algorithm moves on to the next input and adjusts the weight according to the output. The process goes on until a certain stop criteria is reached. The stop criteria are typically determined by measuring the mean square error of the training data.

5 Results and Discussion

Uprising trend in oxygen level has been observed in all the exercises after 12 weeks in the present study. Heart rate exhibited gradual normalizing trend from WP, SS, MP and MP with SS. Normalizing trend of heart rate in the case MP was found better than SS. In the case of MP with SS heart rate fluctuations were settled quickly towards normalization. The fluctuation in blood pressure (systolic and diastolic) towards normal range is observed in all the three exercises. However, the rate of normalization appears to be more significant in meditation process compared to WP and SS. The observation finds support from reported studies. One of the prominent indicators of physical fitness is tolerance which is physiologically assessed by maximal oxygen consumption providing cardiovascular fitness. Improved exercise tolerance (Oxygen volume) is corroborated with improvement in many cardiovascular functions like vital capacity; blood pressure and reducing anxiety level (**Neumann et al, 2011**). Normalization in the heart rate is governed by the equilibrium of sympathetic and para sympathetic branches of the autonomic nervous system (**Agarwal and Gupta-2005**), which seems to be facilitated by meditation process. A significant fall in BP after two years of regular physical exercises in both sexes depending upon the grade of exercise and physique of the individual has also been demonstrated (**Christopher, 2009**).

6 ANN Model

The output vector is then compared with the desired vector which resulted into error signal for each output unit. In order to minimize the error, appropriate adjustments were made for each of the weights of the network. After several such iterations, the network was trained to give the desired output for a given input vector. The single layer network structure included ten hidden neurons, describing the dynamics of input variables. The sigmoid axon was considered transfer function with 0.7 momentums. The performance of network simulation was evaluated in terms of mean square error (MSE) criterion.

The MSE for the training and cross validation data sets were found at the ninth place of decimal. A sensitivity analysis was conducted to determine the degree of effectiveness of var-

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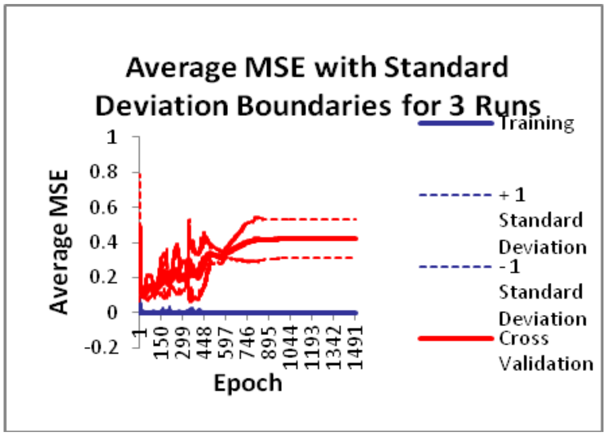
iables. Performance of the group of input vectors included base line data of physiological parameters of the each group, while after the physical.



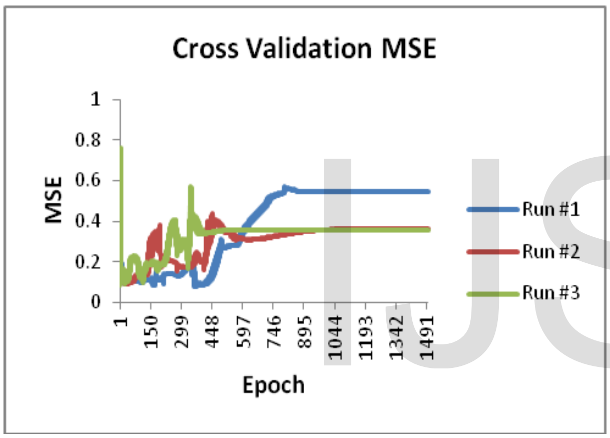
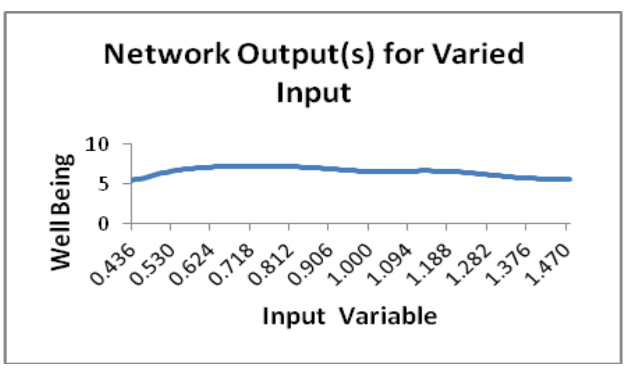


Fig. 1a,b depicts average MSE and Cross Validation for input and output variable.



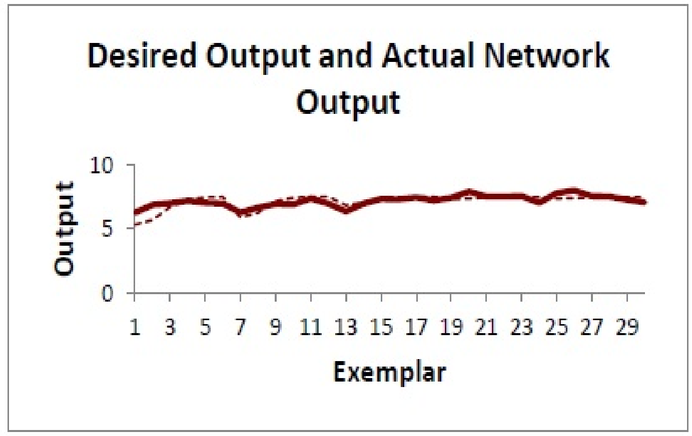
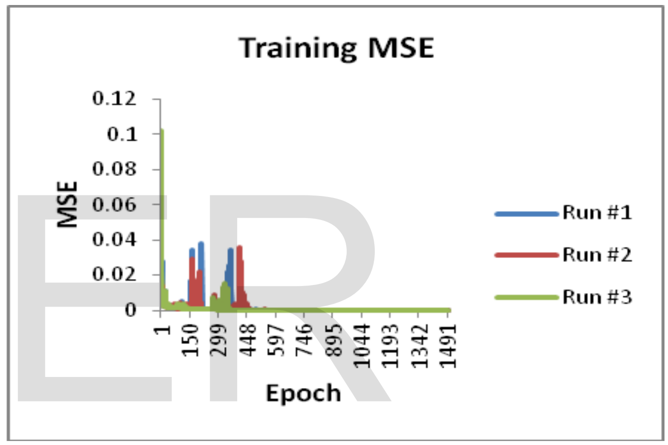


Fig 2a,b Comparison between Net work output and Desired output for Varied Input



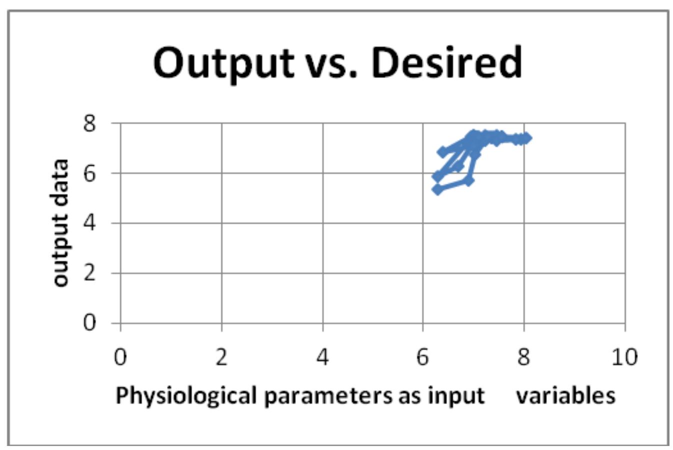


Fig. 3a,b depicts training MSE and cross validation error minimized through three iterations

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Table 2 Optimized data for applied Neural Network

All Runs	*Training Minimum*	*Training Standard Deviation*	**Cross Validation Minimum**	**Cross Validation Standard Deviation**
Average of Minimum MSEs	2.08702E-05	2.35549E-14	0.083969495	0.005682965
Average of Minimum MSEs	2.08702E-05	2.35549E-14	0.422017646	0.107262414

Best Networks	**Training**	**Cross Validation**
Run #	1	1
Epoch #	871	365
Minimum MSE	2.08702E-05	0.077849315
Final MSE	2.08702E-05	0.545759673

exercises, meditation process and physical exercises along with meditation for one week were considered as output. After a week improved data of physiological parameters were considered as input. Data of all physiological parameters completed after third week were considered output. The process was repeated for sixth, ninth and twelfth week.

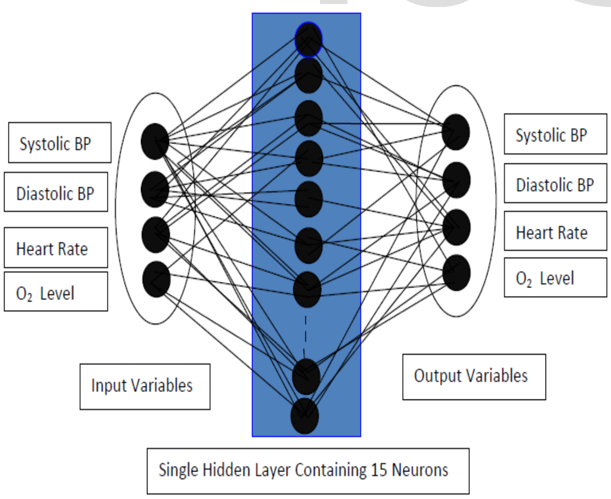

Fig 4 ANN Model of Four Input and Output Variable with Single Hidden layer Containing 15 Neurons

The evaluation of performance based on 60 % data for training, 20 % data for testing and 20 % data for cross validation with sigmoid axon transfer function, at 1500 Epoch with 0.70000 momentums. The minimum MSE in the group of four variables was determined for training and cross validation are 2.08702E-05 and 0.545759673 respectively.

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