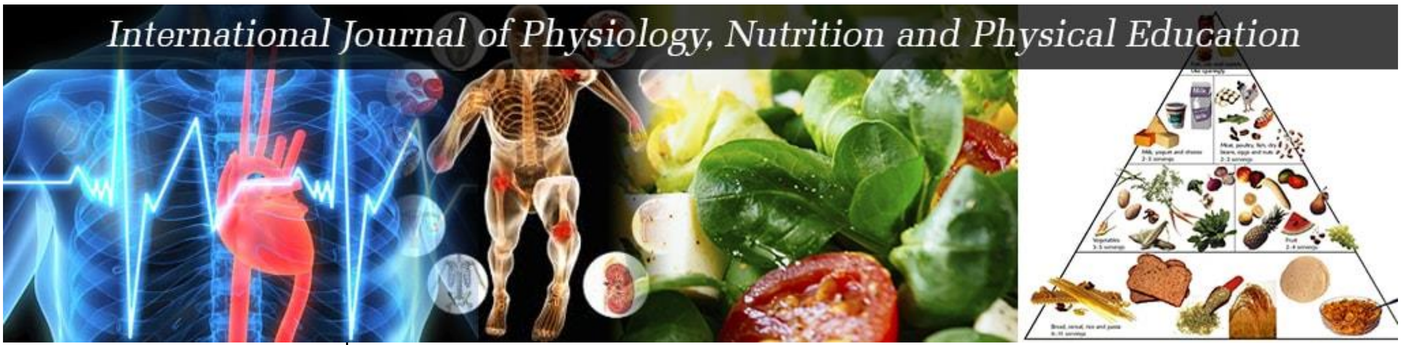

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Effect of weightlifting practice on peripheral sympathetic neural activity

Bijay Kumar Bhagat and Samiran Mondal

Abstract
Background: Skin conductance (SC) is a form of Electrodermal activity (EDA) which often used to understand/predict the neural and brain activity of an individual. A strong neural activity is required before execution of weightlifting to mobilize neural energy resources in various body parts.
Aim: To find out the effect of weightlifting practice on peripheral neural activity before, during and after the event.
Method: 4 State level male weightlifters (15 – 20 years) were purposively selected for the present study. The data were collected for 3 consecutive days with a variation of load intensity i.e. 50%, 60% and 70% of 1RM. The exercise protocol was set for the duration of 10 minutes as per the practice schedule of the weightlifters. SC was measured through NeXus-10 Mark-II which is an instrument used for human Neurophysiological data and feedback training.
Findings: The Peripheral sympathetic neural activity (SC) of weightlifting increases from pre-test to during-test and from during-test to post-test in all 3 days. But it is quite interesting to note that the SC level decreases as the weightlifting load intensity increases. Various physiological mechanisms support these changes.
Conclusion: Peripheral sympathetic neural activity follows an increasing trend from pre to during and during to post-weightlifting practice. However, as load intensity of weightlifting increases, the peripheral sympathetic neural activity decreases to control high central arousal.

Keywords: Weightlifting, skin conductance, peripheral sympathetic neural activity

Introduction
Electrical conductivity of the skin is referred as skin conductance (SC), a form of Electrodermal activity (EDA), which often used as a proxy for neural and brain activity. EDA refers most generally to all (passive and active) electrical phenomena in the skin. Changes in EDA and SC are related to changes in eccrine sweating which relates to the activity in the sympathetic branch of the autonomic nervous system. Sweat is an electrolyte solution, the more the skin's sweat ducts and pores are filled with sweat, the skin becomes more conductive (Figner & Murphy, 2011) [1].
There is a positive relation between SC and Sympathetic nerve whereas inversely relates with Galvanic skin resistance (GSR) (Turankar *et al*. 2013) [2]. SC and GSR have been used in a wide range of research and serves as indicators of various processes like attention, habituation, arousal, and cognitive effort (Figner & Murphy, 2011; Critchley, 2002) [1, 3].
Weightlifting is a very hyperactive event which was introduced in the first modern Olympic Games. It is a competitive sport where a weightlifter has to lift a heavy weight from the ground to overhead. It contains two items- i. Snatch, and ii. Clean & Jerk. Weightlifting requires participants to focus their strong attention in the brain and body level before the execution and then mobilizing neural energy resources in various body parts. The objective of this study was to find out the effect of weightlifting (snatch) practice on peripheral sympathetic neural activity before, during and after the event.

Methods
Subject: Four state level (One Junior and Three Sub-junior) male weightlifters between the age of 15-20 years (mean 17.25±3.77 Years) were purposively selected and voluntarily took part in the study.

All the subjects were free from any recent injuries that might affect their performance.

Place of Data collection: The data were collected at Exercise and Sports Physiology Laboratory, Department of Physical Education, Vinaya Bhavana, Visva-Bharati University, Santiniketan- 731235, West Bengal, India on 19th to 21st December, 2016. The performances were held at 7 p.m., 4 p.m. and 10 a.m. on 19th (1st day), 20th (2nd day) and 21st (3rd day) December, 2016 respectively. The temperature at Santiniketan was 26ºC, 26ºC and 25ºC on 1st, 2nd and 3rd day respectively.

Data collection: The data were collected for 3 consecutive days with a variation of load intensity. 1st day- 50%, 2nd day- 60% and 3rd day- 70% of 1RM (Repetition Maximum) were the load used in this research. The researcher was collected data in Pre, During and Post-test. The subjects were asked to perform snatch in weightlifting as per specific exercise protocol (Table- 1). Before that they used 5 minutes as warm-up period. During the performance as the heart rate of the subject raised above 190 beats/minute then it was suggested to quiet from the practice for the day.

Weightlifting protocol (snatch practice): The exercise protocol was set as per the practice schedule of the weightlifters and with the variation of load intensity i.e. 50% of 1RM for 1st day; 60% of 1RM for 2nd day and 70% of 1RM for 3rd day (Table- 1).

Table 1: Exercise protocol

Set	State to Initial position (once/set)	Bar grip (Position before execution)	Execution	Recovery time after each repetition	Repetition/ Frequency	Recovery time between sets	Total time/ Duration
1st	10 sec.	5 sec.	5 sec.	5 sec.	4 times	25 sec.	90 sec.
2nd	10 sec.	5 sec.	5 sec.	5 sec.	5 times	25 sec.	105 sec.
3rd	10 sec.	5 sec.	5 sec.	5 sec.	6 times	25 sec.	120 sec.
4th	10 sec.	5 sec.	5 sec.	5 sec.	7 times	25 sec.	135 sec.
5th	10 sec.	5 sec.	5 sec.	5 sec.	8 times	25 sec.	150 sec.
600 sec. (10 minutes)							

Instruments Used: The researcher used NeXus-10 MarkII, an instrument for human Neurophysiology and Feedback Training (Medical Device Directive 93/42/EEC; TMS International BV, The Netherlands). It is a multi-channel Physiological Monitoring and Feedback platform that utilizes BlueTooth Wireless Communication, USB and Flash Memory (SD) Technologies. It can measure the following parameters- Blood Volume Pulse, Respiratory Rate, Heart Rate Variability, Skin Temperature, Skin Conductance, Event Related Potentials, EEG, EMG, ECG, EOG, SCP, Pulse Oximetry, Heart Rate, Blood flow in Brain (HEG), etc.

Surface Skin Conductance of the subjects was measured with the assistance of a Biomedical Engineer from Gunjan Human Karigar Pvt. Ltd., New Delhi (www.humankarigar.com). Generally, it is measured from the volar surfaces of the fingers or the palms of the hand, soles and inner sides of the feet. As the hands and feet of the weightlifters were engaged in their performance so the electrodes were placed on the lateral part of the upper arm to measure SC of the subject (Figure- 1).

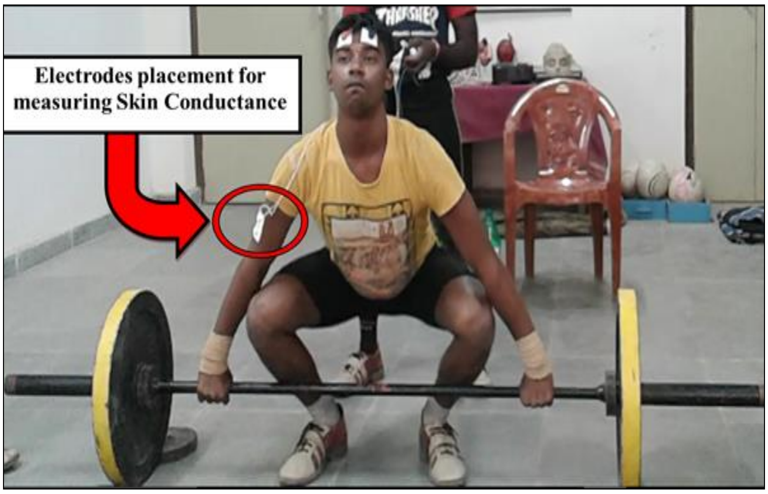

Fig 1: Placement of Skin conductance electrodes on the upper arm

Statistical procedure: The data of the subjects for SC were collected before the performance (Pre-test), during 10 minutes weightlifting practice (During-test) and after performance (Post-test). The Pre-test and Post-test data were taken each for 5 minutes and the mean value was considered as the data for the period. The mean value of total 10 minutes snatch practice in weightlifting was taken as During-test data. One way ANOVA was used for comparative analysis (F-value) of the data and the significance level was set at 0.05 level.

Result

This study was designed to answers 3 specific questions. First, does weightlifting practice (snatch) affect peripheral sympathetic neural activity? Second, does peripheral sympathetic neural activity comes immediately to its near to basal level after weightlifting practice (snatch)? Third, does variation in load (50%, 60% and 70% of 1RM) affect the level of peripheral sympathetic neural activity? To answer these specific questions, following results are given below-

Table 2: 1st day skin conductance value - 50% of 1RM

Test duration	Mean ± SD (µS)	F-Value	P-Value	Table Value (df= 2,9)	Level of Confidence (0.05 level)
Pre-test	4.34 ± 5.90	2.07	0.21	4.26	NS
During-test	6.42 ± 5.67				
Post-test	11.95 ± 5.63				

1st day's data of skin conductance before, during and after weightlifting (snatch) practice is shown in table no. 2 and figure no. 2. SC value increased from pre to during test and from during to post test. The increase in SC value from pre to during test was 47.93% while from during to post was 86.14%.

Table 3: 2nd day skin conductance value - 60% of 1RM

Test duration	Mean ± SD (µS)	F-Value	P-Value	Table Value (df= 2,9)	Level of Confidence (0.05 level)
Pre-test	4.34 ± 7.50	0.36	0.71	4.26	NS
During-test	6.87 ± 9.38				
Post-test	10.81 ± 14.60				

Skin conductance data before, during and after weightlifting (snatch) practice for 2nd day is presented in table no. 3 and figure no. 2. SC value increased from pre to during test and from during to post test. The increase in SC from pre to during test was 58.29% whereas from during to post was 57.35%.

Table 4: 3rd day skin conductance value - 70% of 1 RM

Test duration	Mean ± SD (µS)	F-Value	P-Value	Table Value (df= 2,9)	Level of Confidence (0.05 level)
Pre-test	1.41 ± 0.34	3.32	0.83	4.26	NS
During-test	2.75 ± 1.99				
Post-test	5.21 ± 3.05				

3rd day's data of skin conductance before, during and after weightlifting (snatch) practice is shown in table no. 4 and figure no. 2. SC value increased from pre to during test and from during to post test. The increase in SC from pre to during test was 95.05% while from during to post was 89.45%.

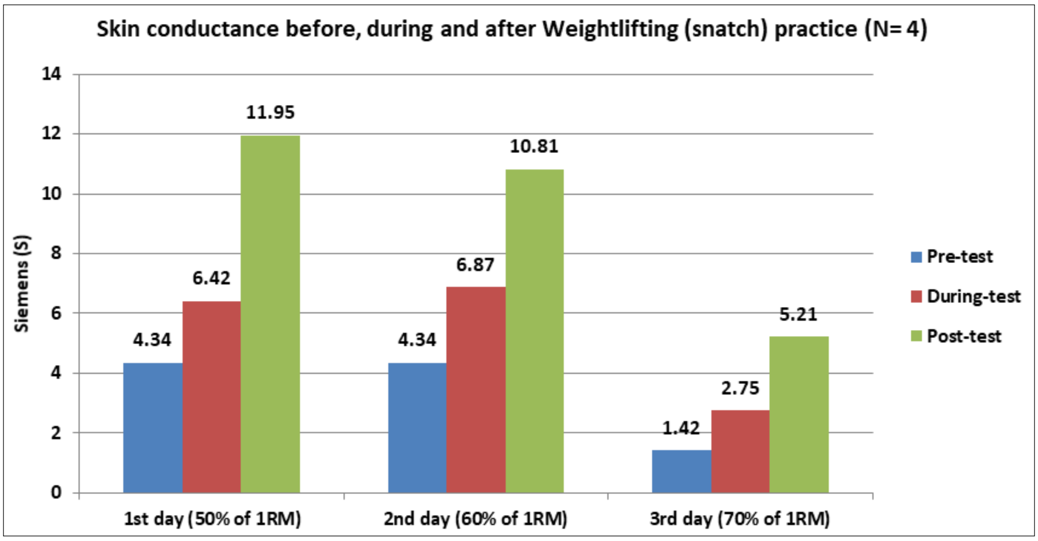

Fig 2: Skin conductance before, during and after weightlifting (snatch) practice on 1st, 2nd and 3rd day.

The result showed that increase of weightlifting load (50%; 60%; 70%) influence the decrease of SC level (Fig. 2). However, the SC level express increasing tendency after completing weightlifting practice.

Discussion

Weightlifting practice (Snatch) increases the skin conductance level in all three experimental days (50, 60 and 70% load). As electrodermal activity (SC) is controlled by sympathetic nerve, so the increase of SC may be due to the increase of peripheral sympathetic neural activity.

Peripheral sympathetic neural activity (measured by SC) did not come to it's near to basal level after weightlifting practice may be due to higher peripheral neural arousal.

Increase in SC also relates to increase in sympathetic tone or decrease in parasympathetic tone or both. The mechanism behind the increase in sympathetic tone or decrease in parasympathetic tone or both involves the activation of vagal tone, baroreflex sensitivity and tissue oxygenation (Turankar *et al*. 2013) [2]. Cholinergic terminals of sympathetic nerve releases acetylcholine which influences sweating (Shibasaki & Crandall, 2010; Sato, 1977; Randall & Kimura, 1955) [4, 5, 6]. It might be possible that the weightlifting (snatch) practice increases the release of acetylcholine which increases the sweating and SC.

Calcitonin gene-related peptide (CGRP) and Vasoactive intestinal polypeptide (VIP) immunoreative nerve fibers enhance sweat secretion (Shibasaki & Crandall, 2010; Schlereth *et al*. 2006; Kumazawa *et al*., 1994; Eedy *et al*., 1990; Kummer *et al*., 1990) [4, 7, 8, 9, 10]. This might be another mechanism to increase skin conductance. The impulses of motor cortex irradiates by central nervous system (Krogh & Lindhard, 1913) [11] and sweating increases as the activity of motor cortex increases (Shibasaki & Crandall, 2010) [4], thus may increases skin conductance.

Sweating has a positive relation with exercise pressure reflex which originates from the stimulation of afferent nerve endings (Shibasaki & Crandall, 2010; Alam & Smirk, 1937) [4, 12], increase in skin conductance might be due to increase in exercise pressure reflex.

Muscle metaboreceptors and sweating remains elevated after exercise due to the ischemic condition of the body (Shibasaki & Crandall, 2010; Shibasaki *et al*. 2001) [4, 13]. As weightlifting is an anaerobic activity so the body stays in ischemic condition. Also after the completion of weightlifting the muscle metaboreceptor still in elevated condition and support to increase sweating and SC response.

Increase of weightlifting load (50% → 60% → 70%) may attenuate peripheral sympathetic neural activity which decreases the SC, reported first time in this study. The mechanism may be speculated that when weightlifting load is increased central sympathetic arousal increased and to neutralize it, probably, the peripheral sympathetic arousal decreased.

The change in SC depends upon sweating through eccrine sweat glands. The eccrine sweating get affected by the sympathetic neural activity (Turankar *et al*. 2013) [2] which is controlled by hypothalamus, brainstem, amygdale, hippocampus, basal ganglia and prefrontal cortex of the brain region (Figner & Murphy, 2011) [1]. It might be possible that these brain regions inhibited peripheral sympathetic neural activity to adjust central arousal due to weightlifting load that decreases sweating and SC. Axon reflex terminates the release of acetylcholine which influences the sweating (Shibasaki & Crandall, 2010; Low, 2003) [4, 14]. It might be possible that with the increasing load the response during weightlifting (snatch) practice comes from axon reflex due to its quick execution and it terminates the release of acetylcholine which decreases the sweating and so the skin conductance.

Conclusion

Peripheral sympathetic neural activity increases from pre to during and from during to post weightlifting practice as observed in this research by the increase of SC. However, it was also observed in the present study that after the increase of load intensity in weightlifting, peripheral sympathetic neural function gradually decreases as reflected by SC result, may be to counter the central sympathetic arousal.

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