The Effect of Acute Anxiety on Lower Extremity Neuromuscular Function of NCAA D3 Athletes

Noah Emanuel and Justin Byers, MS

The Department of Human Kinetics and Applied Health Science
The Biokinetics Program

Abstract

Purpose: Acute anxiety can have a variety of effects on performance; can be a determinant on neuromuscular activation by producing somatic (Som) or cognitive (Cog) stress effects. The aim of this study is to analyze neuromuscular function (NMF) of the lower extremity during counter movement jumps (CMJ) and a squat jump (SJ) to determine if anxiety affects the NMF. The Competitive State Anxiety Inventory (CSAI-2) measures Som or Cog. Neuromuscular function was measured by examining power, speed and eccentric force using a 2-jump test 3D accelerometer Myotest.

Methods: Twenty-two NCAA D3 athletes (M 11, F 11) (age 20 ± 3) participated in this study. The subjects completed three separate data collection periods: baseline (BL), pre-competition game day (GD), and an academic exam day (ED). Subjects completed a familiarization session consisting of CMJ and SJ before data was collected and then the CSAI-2 was administered with the five-jump sequence.

Results: Paired samples t-tests revealed a significant difference for power output and anxiety levels between CMJ and SJ at BL ($\bar{x}$ BLCMJ= 43.77W± 8.45, $\bar{x}$ BLSJ= 40.69W ±7.75, p=.049) and GD ($\bar{x}$ GDCMJ=41.72W± 6.38, $\bar{x}$ GDSJ= 38.02W±6.26, p=.029),however there was no significance for ED ($\bar{x}$ EDCMJ=39.05w±7.85, $\bar{x}$ EDSJ= 36.79W± 7.63 p=.244). Significant differences were also found in power between of BL and ED CMJ ($\bar{x}$ BL= 43.77W±8.45, $\bar{x}$ ED= 39.04W ± 7.85, p= .002), EDSJ ($\bar{x}$ BL= 40.69W±7.75, $\bar{x}$ ED= 36.79W± 7.63, p= .018), and BL CMJ to ED SJ ($\bar{x}$ BL= 43.77W± 8.45, $\bar{x}$ ED= 36.79W ± 7.63, p= .003). Significant difference for anxiety levels for BL ($\bar{x}$ BL=12.09±4.18,p=.000) and GD ($\bar{x}$ GD=17.32±5.59, p=.000) ED ($\bar{x}$ ED=18.68 ± 6.44, p=.000),however, no significance was found for GD and ED anxiety (p=.167).

Conclusion: The results of the present study displays significant difference for CMJ and SJ in pretest and GD. However, no significant difference in ED therefore, leading to the potential that there may be a physiological effect from a higher cognitive activity (HC) or environmental factors on an exam day, which leads to a lower power output. This is further supported by the lack of significance determined between anxiety level of GD and ED. These findings implicate that CMJ performance, is decreased as a result of psychological anxiety. Further research needs to be done to determine what physiological factor from acute anxiety suppresses the reflexive nature of NMF and causes HC during performance.

Methods

Participants

The Institutional Review Board of Bethel University approved this protocol and all participants signed informed consent. Twenty-two NCAA D3 college athletes participated in this study (11 males, 11 females) (age 20 ± 3) from Bethel University. Inclusion criteria included being a winter sport NCAA varsity athlete. If an athlete had an athletic injury they were prohibited to continue in the study.

Interventions

On three separate data collection periods participants completed an anxiety trait inventory (Competitive State Anxiety Inventory-2 "CSAI-2") followed by two series of five jumps, one series as a counter movement jump (CMJ) and the other series as a squat jump (SJ). Jumps were measured by a 3D accelerometer (Myotest, Switzerland). The Myotest is considered to have acceptable accuracy and reliability when used to evaluate the velocity maximum of squat jumps (CMJ,SJ) [11]. Participants would come in to the lab before the start of their respective sport season for a baseline test followed by a pre-competition game day test (GD) and an academic exam day (ED) test in anticipation of varying anxiety levels. First subjects complete a familiarization session using proper Myotest protocol consisting of a CMJ and SJ before data collection occurs. After the familiarization process is complete the CSAI-2 is administered to the individual. Immediately after inventory completion the participant jump sequence is administered. Again, this process is repeated two separate occasions after the baseline data is collected. The participants are participating in a single blind study meaning the scores from the CSAI-2 and the Myotest are not shared with the participants.

Acknowledgement

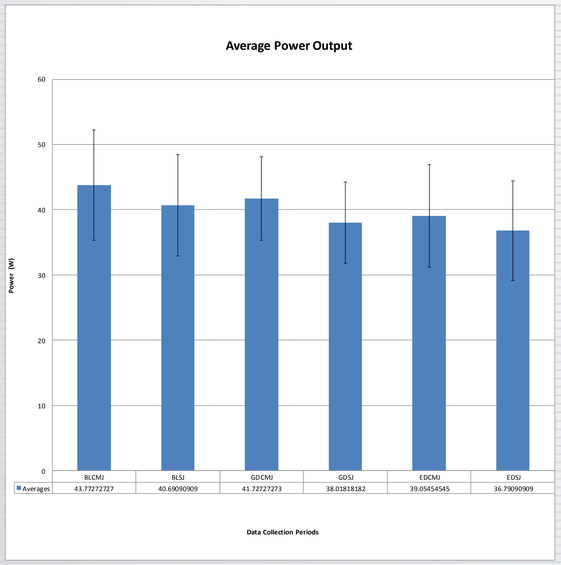
Special thanks to the Bethel Royals basketball and hockey teams for their participation. I would also like to thank Justin Byers for advising this project.

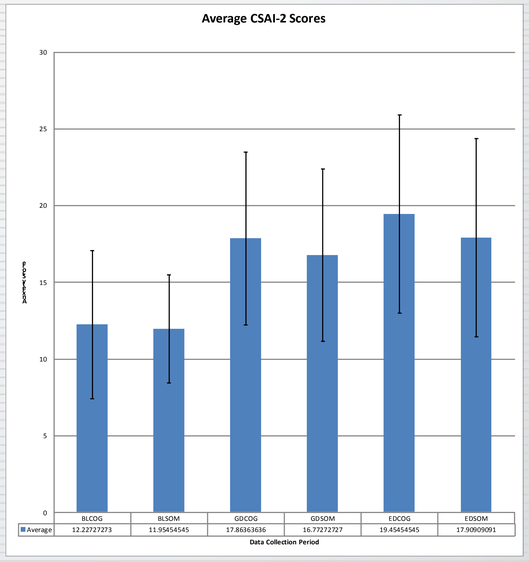
Introduction

The relationship between somatic and cognitive arousal and power output of the lower extremities is an area of human performance that has not been fully researched. Studies show that arousal strategies enhance maximal motor performance, however these results are up for interpretation[1]. It is known that the more anxiety an individual experiences; focused cognitive abilities or faster motor response may be experienced. This is known as the Inverted-U-hypothesis or optimal arousal perspective. These views communicate that optimal athletic performance will increase due to the moderate levels of increased arousal in a curvilinear fashion [1]. This brings a unidimensional approach of arousal to sport psychology as well as other realms of arousal influenced performances [2]. Levels of moderate arousal showed association with better performance where low and high levels showed a decrease in performance [3]. This has been supported with studies that show that individuals perform better in neutral mood conditions[4]. It is important to note that the inverted-U hypothesis has been mistaken tendency to equate high levels anxiety with the outcome of a decrease in performance [5]. Also, it is important to note the reversal theory. This theory notes that current motivation and arousal of the individual can determine their emotional state [1]. The reversal theory would explain the idea that an athlete will enter a telic state and would feel anxious and vise versa if they enter a paratelic state[1].

There are a few psychophysiological studies that have analyzed strength performance in relation to HR as the measure of arousal which produced no relationship to increase in strength performance [6].These have been deemed problematic due to the fact that HR is an oversimplified indicator of arousal due to how the sympathetic (SNS) and parasympathetic (PNS) branches of the autonomic nervous system (ANS) influence the HR[1,7]. This is supported because a withdrawal has been identified in vagal tones, a reduction in PNS, which can contribute to stress related cardiac activity[8]. Contrary to the current research, this study uses power output from the lower extremities rather than HR. If an increase of power is observed from a high somatic state it will possibly driven by the ANS a physiological effect. The SNS system triggers the fight or flight response of the ANS. During time of acute anxiety and arousal the SNS will start to activate. Physiological response to the SNS stated previously are a higher HR, raised BP, higher vasomotor activity, raised perspiration as well as greater muscle tension. It has already been established that previous research has shown a lack of significance when using HR as variable when observing this topic[1].

The present study focused on the physiological factor of increased muscle tension and neural muscular response to anxiety. With this being said the power output will be examined by identifying a difference between a Counter Movement Jump (CMJ) and Squat Jump (SJ). A CMJ exemplifies an indicator that the Stretch Shortening Cycle (SSC) where an active muscle is stretched prior to shortening is physiologically present. Studies show that concentric torque production is enhanced after prestrech (continuous movement associated with CMJ) as compared to a pre-isometric condition (pause associated with SJ) [9].When the SSC is active there is a greater energy stored in the muscle recoil compared to a normal movement. In the SSC the greater the eccentric contraction the greater the accompanying concentric reaction will occur [10]. With that being said, a SJ will show a lesser power output compared to a CMJ due to the pause that occurs during an SJ. The pause in the SJ creates higher cognitive response to occur rather than a spinal cord reflex that occurs in the CMJ. Since the CMJ produces a faster eccentric contraction reflex it will produce a higher power output. This is how the measurement of whether power output and anxiety are correlated. If the CMJ is consistently higher than the SJ it is demonstrating that the power output stimulus does not go to a higher cognitive region but rather is observed as a spinal cord reaction. Also, the behavior of the intact neuromuscular system is more complex in its influence on the muscle-tendon interaction, which could lead to consequences in the concentric phase and overall performance [9]. The implications lead to movement is coordinated without the use of higher cognitive centers. However, if the SJ equals or becomes higher than the CMJ after an increase in anxiety, it can be assumed that a longer neural response is occurring, thus taking the neural input to a higher cognitive center instead of the spinal cord. This could be attributed to the effect anxiety has on the muscle and motor units. The physiological effects are unknown, however, they can range from a consequence of anxiety or other immeasurable physiological and environmental variable.





Results

Paired samples t-tests revealed a significant difference for power output and anxiety levels between CMJ and SJ at BL ($\bar{x}$ BLCMJ= 43.77W± 8.45, $\bar{x}$ BLSJ= 40.69W ±7.75, p=.049) and GD ($\bar{x}$ GDCMJ=41.72W± 6.38, $\bar{x}$ GDSJ= 38.02W±6.26, p=.029),however there was no significance for ED ($\bar{x}$ EDCMJ=39.05w±7.85, $\bar{x}$ EDSJ= 36.79W± 7.63 p=.244). Significant differences were also found in power between of BL and ED CMJ ($\bar{x}$ BL= 43.77W±8.45, $\bar{x}$ ED= 39.04W ± 7.85, p= .002), EDSJ ($\bar{x}$ BL= 40.69W±7.75, $\bar{x}$ ED= 36.79W± 7.63, p= .018), and BL CMJ to ED SJ ($\bar{x}$ BL= 43.77W± 8.45, $\bar{x}$ ED= 36.79W ± 7.63, p= .003). Significant difference for anxiety levels for BL ($\bar{x}$ BL=12.09±4.18,p=.000) and GD ($\bar{x}$ GD=17.32±5.59, p=.000) ED ($\bar{x}$

Conclusion

Conclusion: The results of this study displays significant difference for the power output and anxiety comparing the CMJ to SJ in the BL and GD testing ($\bar{x}$ BLCMJ= 43.77W± 8.45, $\bar{x}$ BLSJ= 40.69W ±7.75, p=.049) ($\bar{x}$ GDCMJ=41.72W± 6.38, $\bar{x}$ GDSJ= 38.02W±6.26, p=.029). No significant difference was displayed on ED ($\bar{x}$ EDCMJ=39.05w±7.85, $\bar{x}$ EDSJ= 36.79W± 7.63 p=.244) therefore, leading to the potential that there may be a physiological effect from a higher cognitive activity (HC) or environmental factors, which leads to a lower power output. This is further supported by the lack of significance determined between anxiety level of GD and ED (p=.167). These findings implicate that CMJ performance is decreased and result of psychological anxiety. Further research needs to be conducted to determine what physiological factors from acute anxiety suppresses the reflexive nature of NMF and causes HC during performance. If either physiological an environmental factor can be identified as the cause suppression of the NMF and cause HC during times of anxiety it will allow for manipulation in athletic training, competition and rehabilitation procedures and concepts. The ability to identify and manipulate the anxiety that interrupts normal NMF will allow for athletes and individuals to perform at their highest levels on a consistent basis.

References

1. Perkins D, Wilson GV, Kerr JH. The effects of elevated arousal and mood on maximal strength performance in athletes. *Journal of Applied Sport Psychology*. 2001;13(3):239-259.
2. Gould D, Krane V. The arousal–athletic performance relationship: Current status and future directions. In: Horn TS, ed. Champaign, IL England: Human Kinetics Publishers; 1992:119-142.
3. Craft L, Magyra M, Becker B, Feltz D. The relationship between the competitive state anxiety inventory-2 and sport performance: A meta-analysis. *Journal of Sport & Exercise Psychology*. 2003;25:44-64.
4. Murphy SM, Woolfolk RL, Budney AJ. The effects of emotive imagery on strength performance. *J Sport Exercise Psychol*. 1988;10(3):334-345.
5. Krane V. Conceptual and methodological considerations in sport anxiety research: From the inverted-U hypothesis to catastrophe theory. *Quest*. 1992;44(1):72-87.
6. Dorney L, Goh EKM. The impact of music and imagery on physical performance and arousal: Studies of coordination and.. *J Sport Behav*. 1992;15(1):21.
7. Berntson GG, Cacioppo JT, Quigley KS. Respiratory sinus arrhythmia: Autonomic origins, physiological mechanisms, and psychophysiological implications. *Psychophysiology*. 1993;30(2):183-196.
8. Grossman P, Svebak S. Respiratory sinus arrhythmia as an index of parasympathetic cardiac control during active coping. *Psychophysiology*. 1987;24(2):228-235.
9. Finni T, Ikegawa S, Komi PV. Concentric force enhancement during human movement. *Acta Physiol Scand*. 2001;173(4):369-377.
10. Komi PV. Stretch-shortening cycle: A powerful model to study normal and fatigued muscle. *J Biomech*. 2000;33(10):1197-1206.
11. Houel N, Dinu D, Faury A, Seyfried D. Accuracy and reliability of the myotest pro

Noah Emanuel: nde46236@bethel.edu ▪ The Exercise Medicine and Prevention Center ▪ Justin Byers: jbyers@bethel.edu