Effects of Sensory Deprivation on Upper Extremity Neuromuscular Recruitment in a Closed Kinetic Chain Movement

DuVaughn Schroeder, Rebecca Wesley and Seth Paradis, Ph.D.

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

Abstract

Purpose: Every auditory, visual, olfactory, tactile, and gustatory stimulus that the body interprets may play an important performance role and aid in producing a desired physiological reaction. Some stimuli may be more vital in neuromuscular recruitment (NR). The aim of the current research is to determine the extent to which NR in a closed kinetic chain activity is affected by eliminating the auditory and visual stimuli. NR will be measured by the mean power, force and speed output generated by the bench press profile on a 3D accelerometer (Myotest).

Methods: Twenty active male University students (20.2 yrs+/-2.1 SD) participated in this study. Force, power and speed were assessed in three sessions for each individual participant: 1) a familiarization session, 2) a baseline session (BL) and 3) a sensory deprivation session (SDS). The Myotest bench press profile was used to calculate the participants' force, velocity and power output during BL and SDS. During SDS, participants were deprived of visual and auditory stimuli.

Results: There was found to be no significance between BL and SDS results for power, force and speed when utilizing a two-tailed paired t-test. BL and SDS data for participants' average power, force, and speed were as follows: Power- BL mean 667.548 watts (W) +/- 201.266 standard deviations (SD), SDS mean 652.482 W +/- 190.387 SD (p=0.325). Force- BL mean 590.815 Newtons (N) +/- 147.676 SD, SDS mean 579.433 N +/- 144.021 SD (p=0.139). Speed- BL mean 153.086 cm/s +/- 14.994 SD, SDS mean 153.748 cm/s +/- 11.904 SD (p=0.821).

Methods

Participants completed three sessions, 1) a familiarization session, 2) a baseline testing session (BL), and 3) a sensory deprivation session (SDS). Each session began in a room adjacent to the weight room in order to eliminate the weight room atmosphere and promote professionalism. During the familiarization session, participants signed the informed consent document as well as the health history form. Upon completion, they began a 3 minute warm up on the elliptical, using the arm blaster setting level 10. In this setting, arm motion was emphasized and the researchers observed limited ankle motion which is characteristic of limited lower body muscle recruitment. After completing three minutes on the elliptical, participants were asked to complete 2 sets of 10 explosive pushups with a 30 second rest period between sets. Explosive pushups are characterized by a powerful concentric movement that may result in some participants pushing their body into the air. After the completed warm-up, participants entered the weight room to complete the Myotest's bench press profile which is typically used to calculate the optimal training loads for the pectorals and triceps, as well as calculate one repetition maximums and peak power outputs at specific weights. Once in the weight room, the researchers introduced the participant to the tapping numbers and locations that were utilized during the testing session. A researcher tapped the participant once on the shoulder to indicate that the participant should lift the bar off the rack, twice on the shoulder to indicate that the participant should perform the eccentric movement of the bench press, and once again to perform the explosive concentric movement. The researchers would then assist the participant in placing the bar back on the rack. The participants were asked where their desired hand placement was on the bar to help the researchers monitor their hand placement during SDS. The BL consisted of the warm-up and the Myotest bench press profile. Each consecutive weight that the Myotest suggested during the profile was recorded so that the same profile would be used during SDS. During SDS, participants completed the warm up, and were then asked to wear a blindfold and noise-cancelling headphones transmitting white noise. The participants were then asked to complete the bench press profile using the weights tested during the BL.

Introduction

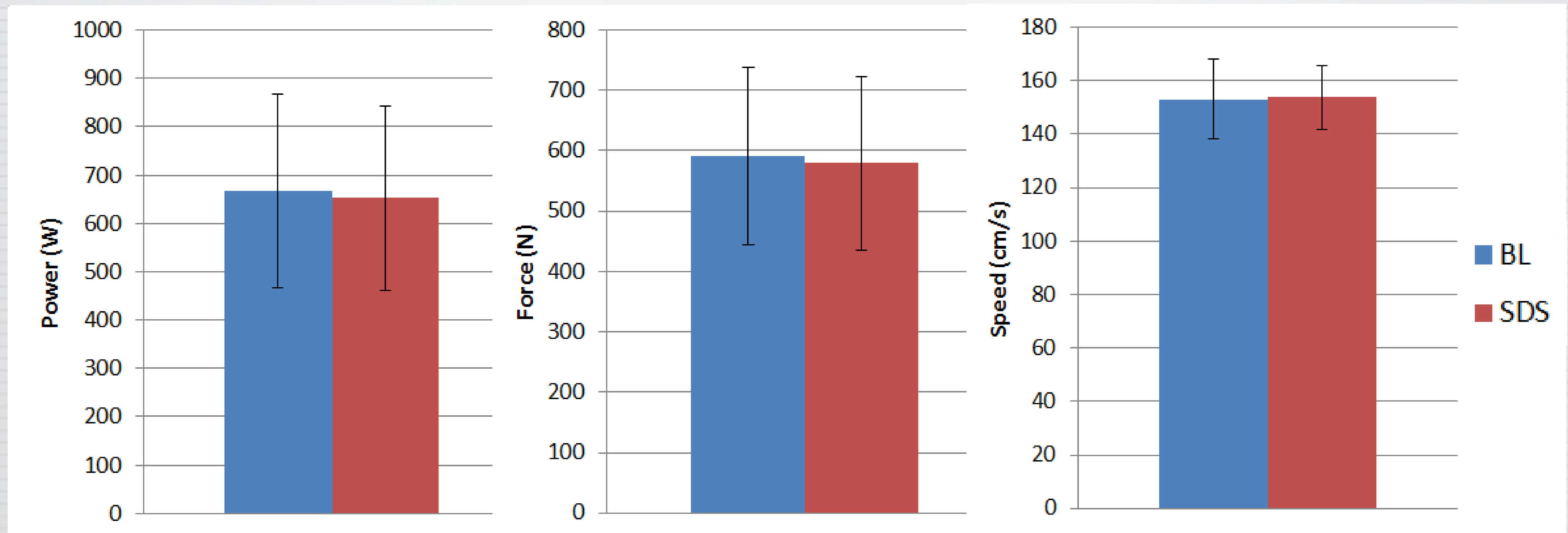
Incoming stimuli is processed in specific areas of the cerebral cortex, this system consists of receptors and neural pathways that exceed the central nervous system (1). These sensory impulses are then processed, providing the necessary information for various bodily systems to maintain homeostasis within our environments. Once the sensory feedback is analyzed, an efferent motor response is produced, where the CNS controls the force output of skeletal muscles by varying the firing sequence (rate coding), as well as the number of motor units recruited in the designated movement (8.) Sensory deprivation, as seen with blind and deaf individuals, has recently been associated with neuroplastic changes within the CNS as other senses and neural pathways are recruited in order to compensate for the missing stimuli, thus proprioceptive function is maintained (5).

The stimuli that the body receives and neural adaptations that the body goes through plays a key roll in exercise therapy. When performing a movement, proprioceptive impulses from receptors within the joint, muscle, and skin create feedback for the higher processing centers, allowing a motor response or modification to the movement (4). Kinesthesia, or awareness of body or limb and motion in space, is based on the sensory information from receptors within joint capsules, tendons, and muscles (7).

Research has shown that proprioception is a key variable in the rehabilitative process (8). When visual and auditory stimuli are inhibited, there is a heightened awareness to an individual's body as kinesthetic pathways are recruited in order to compensate for the lack of sensory stimuli, thus maintaining proprioceptive control. The peripheral receptors involved send impulses to the CNS where motor programs of static or dynamic muscular movements can be processed and then performed. The amplitude and frequency of muscular contractions is affected by the excitability threshold of the neural units involved (2). With less sensory feedback, the potential of excitability is thought to increase to maintain kinesthetic control.

Proprioceptive functions are dependent on the stimuli that the body interprets, and the body may adapt and compensate if any are deprived (5). This principle is what lead to the question of whether or not power, force output and muscle contractile speed will increase with neuromuscular rate coding when sensory deprivation occurs and proprioception is heightened.

Data of Average Power, Force and Speed



Conclusion

There was found to be no significance between BL and SDS data when analyzing each individual's average power, force and speed using a two-tailed paired t-test. There was a negative trend (p=0.139) in force between BL and SDS that suggests that force output of the upper extremity (namely, the pectoralis major) decreases when deprived of auditory and visual stimuli. This may be due to the lack of sensory input required for proprioception, which is necessary for the body to determine the amount of effort it needs to exert for a given motion. However, more research is needed to confirm this finding. There were several limitations and confounders of the study, including the inability to control for the atmosphere in the weight room at the time of each individual test. Other factors affecting the study include the variations in sleep, diet, and activity level in the participants' weekly lifestyle.

Baseline Session | Sensory Deprivation

Note blindfold and headphones

Results

BL and SDS data for participants' average power, force, and speed were:

Power- BL mean 667.548 watts (W) +/- 201.266 standard deviations (SD), SDS mean 652.482 W +/- 190.387 SD (p=0.325).
Force- BL mean 590.815 Newtons (N) +/- 147.676 SD, SDS mean 579.433 N +/- 144.021 SD (p=0.139).
Speed- BL mean 153.086 cm/s +/- 14.994 SD, SDS mean 153.748 cm/s +/- 11.904 SD (p=0.821).

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DuVaughn Schroeder: dss36562@bethel.edu   Rebecca Wesley: raw49396@bethel.edu   ▪ The Exercise Medicine and Prevention Center ▪   Seth Paradis: s-paradis@bethel.edu