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Sight Deprivation and Metabolic Effects During the YMCA Bench Press Test

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SIGHT DEPRIVATION AND METABOLIC EFFECTS DURING THE YMCA BENCH PRESS TEST

By

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Abstract

Several studies have investigated the effect of sensory deprivation, particularly sight. However, very few have demonstrated the impact of sight deprivation while exercising to cadence blindfolded. This study aimed to determine exercise performance during a common muscular endurance evaluation, the YMCA Bench Press Test (YBPT), while blindfolded compared to a sighted condition. Twenty-five healthy participants (11 male, 14 female, 168 ± 7.7cm, 68 ± 11.7kg, 23 ± 7.5% fat mass) were recruited from the University of Nevada, Las Vegas student populations and communities. After a YBPT familiarization session, participants completed testing in a counterbalanced order, following the same procedures. A paired-samples t-test was used to determine whether there was a statistically significant difference between sighted and blindfolded conditions. There was a difference in the number of repetitions performed wearing a blindfold, 31.48 ± 14.08 compared to not wearing a blindfold, 30.6 ± 14.2, ($t(24) = 2.397$, $p = .025$, d= .479). Wearing a blindfold elicited an increase in total kilograms lifted, 753.6 ± 375.4, compared to not wearing a blindfold, 725.7 ± 364.7, $t(24) = 2.514$, $p = .019$, d=0.503. Small ES were noted for heart rate during PRE, INTRA, and POST at d=.21, d=.28, and d=.37, respectively. ES was small for PRE VE, d=.21, PRE RER, d=.29, POST VO_2, d=.25, and POST VCO_2, d=.24. While the blindfold condition did not affect metabolism, performance measures were enhanced. These findings provide evidence that increases in repetitions and overall workload occur while wearing a blindfold during muscular endurance testing (YBPT).

Keywords: blindfold, VO2, weight lifting, muscular endurance

Table of Contents

Abstract iii

Introduction 1

Methods 3

Experimental Approach to the Problem 3

Participants 3

Procedures 3

Statistical Analysis 4

Results 6

Discussion 7

Practical Applications 10

Appendix

Table 1 11

Table 2 12

Table 3 13

Table 4 14

References 15

Curriculum Vitae 16

Introduction

When experiencing sensory deprivation or loss of sensory function, individuals compensate by relying on the remaining senses. When considering only the sense of sight, using blindfolds or a sight-controlled environment requires the other senses to be employed when making decisions, reacting, and coping with risks associated with exercise. Using a blindfold enables individuals to focus on developing other senses, such as hearing, smell, and touch, respectively [3]. Individuals with a congenital vision impairment experience "sensory substitution," where sensitivity to other sensory information (e.g., hearing and touch) is enhanced to compensate for vision loss [13,9]. For example, an individual remains conscious of the surroundings based on the last image of the exercise area. The image implanted in the brain helps people concentrate on the physical environment.

Blindfolding has been shown to promote improved precision [13]. On the contrary, blindfolding disrupts motor activities with a large visual component. Exercising with blindfolds or while in a dark room encourages individuals to remember the degree of muscular tension, joint angles, the amplitude of movement, as well as the movement patterns encountered during exercise [7]. Remembering such factors is critical to enhancing motor sensitivity and self-control, which plays a crucial role in improving skills.

Blindfolds or exercising in a dark room helps individuals avoid competition, allowing one to train uninterrupted from exogenous distractions. Improvement can occur through stimulating commitment to the exercise(s), allowing the participant to maintain interest while keeping the respiration stable despite the intensity of the workout [8]. While such benefits are achieved, calmness reduces heart rate. In addition, the reduced heart rate is associated with a decrease in the depth of breathing [13], resulting in reduced oxygen absorption into the blood

while less carbon monoxide is expelled from the lungs. In this context, physiological changes occur during exercise, but those changes are not understood within a sight-deprived environment.

While sight deprivation has been used in studies on balance, stability, and isokinetic exercises, no systematic investigation has evaluated its effects on resistance training or muscular endurance as obtained from the YBPT. This is important because of the growing popularity of individuals using resistance exercise in their training programs [15]. Additionally, while the metabolic benefits of sight-deprivation training have been suggested, no well-controlled study has been designed to evaluate the effect on VO_2 and VCO_2 during the actual exercise session.

We hypothesize that individuals who perform the YBPT under both sighted (control) and blindfolded (experimental) conditions will perform a significantly greater number of repetitions and produce greater overall power during the test while blindfolded. In addition, there will be a significant difference in the volume of oxygen consumption (VO_2 L/min), the volume of carbon dioxide output (VCO_2 L/min), Respiratory Exchange Ratio (RER), Metabolic Equivalents (METS), and Heart Rate (HR) measured between sessions.

Methods

Experimental Approach to the Problem

A within-subjects experimental approach was used to determine the effect of blindfolding on muscular endurance performance. A common muscular endurance test was utilized (YMCA Bench Press Test). Participants were randomly assigned to an initial condition (no blindfold, wearing a blindfold), and the testing order was counterbalanced. The independent variables were time intervals (PRE, INTRA, POST). The dependent variables were performance (number of repetitions, overall workload), heart rate, and metabolic measures (VO2, VCO2, RER, VE). In addition, 72 hours were required in between test days.

Participants

Twenty-five resistance weight-trained participants (11 male, 14 female, age 25.72 ± 6.34 yrs, 68 ± 12 kg, 168.04 ± 7.75 cm, 23 ± 8 BF%) (Table 1) performed the YBPT over three separate test days with a total time consisting of 30-60 minutes each. Participants were recruited from the University of Nevada, Las Vegas student populations and communities through word of mouth. This study was approved by the University of Nevada, Las Vegas Institutional Review Board (Protocol #1764864-5).

Procedures

Testing took place at the UNLV Exercise Physiology Laboratory. Anthropometric data (height, weight, age, sex, body fat percentage) were measured via self-report, a stadiometer, and bioelectrical impedance analysis (SECA mBCA 515, Hamburg, Germany). A standard flat bench and weighted plates were used. 80lbs/36.2kg for males, 35lbs/15.8kg for females. The metronome was used via a metronome app on the researcher's phone connected to a Bluetooth speaker. Disposable blindfolds were used during the blindfold testing day. Metabolic data were

recorded using the Parvo Truemax 2400 (Salt Lake City, UT). Testing procedures were conducted following The YMCA Bench Press Test [6,12].

Day one of testing consisted of participants completing an informed consent form followed by the ACSM Health Risk Questionnaire to determine eligibility, anthropometrics, explanation of the procedures for all three days, introduction to the equipment used for the test (barbell, bench, equipment used for metabolic sampling), and a non-blindfolded familiarization test. The study consisted of three separate test days, 30-60 minutes for each test day.

Data collection consisted of three intervals: PRE, INTRA, and POST. The PRE interval was the first 10 minutes before exercise with the participant lying on the bench and fitted to the metabolic cart. The INTRA interval consisted of the duration during which the exercise was performed (i.e., performing the YBPT). The POST interval was 10 minutes after completion of the YBPT, with the participant lying on the bench. PRE and POST averages were taken from their respective 10-minute intervals. INTRA averaged the total time required until cessation. Metabolic data (VO_2 L/min, VCO_2 L/min, RER, HR, and VE L/min) were averaged for their respective intervals. Continuous data (number of repetitions) were recorded each test day. Total kilograms lifted was calculated by the weight used and multiplied by the number of repetitions performed.

Protocol for cessation of the test included: (a) the participant chose to stop, (b) the participant could not perform repetitions that matched tempo (60 BPM). This means the subject cannot complete the concentric (up) or eccentric (down) portion of the synchronous movement with tempo.

Statistical Analysis

A paired-samples t-test was used to determine whether there was a statistically significant difference between sighted (control) and blindfolded (experimental) conditions. Data are reported as means and SDs; significance was set at $p < 0.05$. Effect size (ES) statistics were calculated using Cohen's d (small, $d = 0.2$; moderate, $d = 0.5$; large, $d = 0.8$) [2]

Results

Table 2 represents YMCA Bench Press performance variables. There was a difference in the number of repetitions performed wearing a blindfold compared to not wearing a blindfold ($t(24) = 2.397$, $p = .025$, d= .749). Wearing a blindfold elicited an increase in total kilograms lifted compared to not wearing a blindfold, $t(24) = 2.514$, $p = .019$, d=0.503.

Table 3 represents heart rate (bpm) obtained during the YBPT. Small ES were noted for PRE, INTRA, and POST at d=.21, d=.28, and d=.37, respectively.

Table 4 represents metabolic variables during the YBPT. ES was small for PRE VE, d=.21, and RER, d=.29. Small ES was observed for POST VO_2, d=.25, and VCO_2, d=.24.

Discussion

This study evaluated the effect of exercise performance, heart rate, and metabolic output during the YMCA Bench Press Test while blindfolded. It was hypothesized that performing the YBPT under blindfolded conditions would result in greater repetitions and a higher overall workload than in an unsighted condition. In addition, it was hypothesized that there would be a difference in oxygen consumed, carbon dioxide produced, respiratory exchange ratio, ventilation, and heart rate measured between sessions. Our findings indicate that wearing a blindfold increases the number of repetitions performed and consequently the overall workload performed.

We report for the first time that being blindfolded while performing a muscular endurance task increases performance. In comparison to our observations, Reynard and Terrier [11] showed that participants had no destabilizing effects when adopting alternative sensory strategies in treadmill walking. Kim [6] provided evidence that the elderly (≥65 years) show significant improvements in balance ability by blocking visual information. In contrast to a previous intervention [5], our findings suggest that wearing a blindfold increases the overall load performed. Killebrew [5] reported that untrained men and women significantly decreased their power output during a double-leg press when wearing a blindfold. Interestingly, trained individuals showed no significant difference in power output during the blindfolded condition [5]. The trained individuals in the current investigation increased the total number of repetitions and overall load lifted while wearing a blindfold. It is possible that being blindfolded has a greater beneficial influence on muscular endurance (YBPT) than muscular strength [5]. Further investigations are necessary to evaluate this phenomenon.

Small but non-significant effects were noted for heart rate, being slightly higher during each interval of the blindfolded condition compared to the control. The findings of the current

study align with previous literature for heart rate but not metabolic measures. Pinheiro et al. [17] reported no significant difference in heart rate between a light deprived condition (doors and windows covered with thick black plastic and thick black curtains to separate the bicycle from electronic devices) and an illuminated controlled room when performing a time-to-exhaustion cycling test. However, only the last 10 seconds were averaged for heart rate during exercise, comparing pre to post-measures [17]. Although Pinheiro [17] showed significant differences in VO_2 and VE, participants exercised longer to exhaustion or failure (average = 5.0 ± 1.6 min, whereas the current study = 62.08 ± 28.3 sec) during sight-deprived conditions. In the current study, the relatively short duration of the INTRA portion of the YBPT could explain that no significant metabolic findings were observed, contrary to our hypothesis. Thus, future research is needed to determine whether a duration and/or intensity threshold must be met during a muscular endurance exercise to observe changes in metabolic measures while blindfolded.

Heart rate is controlled by the autonomic nervous system (ANS) [4], which includes the sympathetic and parasympathetic nervous branches. Increased heart rate could indicate enhanced sympathetic nervous system activation during the blindfolded condition, which may have resulted in greater repetitions performed in the present study. Future investigations should be designed, allowing for more sensitive ANS measures. For example, Guo [5] demonstrated non-invasive measures during meditation practice by recording ANS activation via heart rate variability (HRV). HRV is strongly associated with heart rate [7] and could be used in future studies to determine the readiness of the cardiovascular system to perform a muscular endurance-based test.

Interestingly, unique invasive measures may also be taken. Stress hormones epinephrine and norepinephrine play a major role in oxygen and energetic substrates to muscles during

exercise [21]. Kox [12] demonstrated a unique technique by activating cytokine production by injecting the endotoxin *Escherichia coli* prior to each training program. Intervention groups were trained in breathing techniques, meditation, and immersions in ice-cold water, which resulted in intermittent respiratory alkalosis and hypoxia, thus increasing plasma epinephrine levels [12]. Future research may dive into other natural means of increased activation of the ANS to increase the ability to perform a muscular endurance test.

One potential limitation inherent to the YBPT is that each sex utilizes the same absolute workload (80lbs/36.2kg for males, 35lbs/15.8kg for females). Individuals who found the load too easy may have performed differently between conditions and ceased the test for reasons other than muscular fatigue. The activity of the exercise could be reflected based on the interests of the individual. Some participants may have found a response that could elicit an undesirable willingness to participate (i.e., boredom) [4]. Future studies should conduct testing based on individual capacity based on a set relative workload. Another limitation is that testing was performed in a lit room, and the blindfold may not have completely blocked all ambient light. Additional measures such as a darkened room and instructing participants to keep their eyes closed may allow future studies to mitigate this potential limitation.

From a biomechanical perspective, it is uncertain whether there were any angular differences in the mechanics of performing a bench press under sighted conditions. Variations in grip width and elbow positioning can affect joint movement throughout the bench press [14]. The current study did not account for grip or elbow positioning, which may have produced different results in the total number of repetitions. A decrease in grip width induces larger elbow joint movement and larger EMG activity of the lateral head of the triceps brachii, anterior deltoid, and clavicular head of the pectoralis major, and an increase in grip width elicited larger

net joint movement and strength [14]. Because of this study [14], future studies may have participants utilize a wider grip to test their potential increase in performance during a muscular endurance

The YBPT is a safer alternative to performing a one-repetition maximum that requires basic training room equipment [6]**.** However, it is uncertain what effect wearing a blindfold may have on more complex exercises such as a barbell squat. This study suggests that acute bouts of muscular endurance exercise enhance performance. Future research is needed to establish the effects of a chronic training regimen incorporating a sight-deprived condition such as wearing a blindfold. Although our findings indicate wearing a blindfold beneficially impacts muscular endurance performance, it is not recommended for all exercises**.** For example, running on a treadmill under sight-deprived conditions could lead to the runner unintentionally stepping off to the side or bumping into the railings, causing a disturbance in proprioception leading to a fall. Other exercises, like plyometrics, could lead to miscalculating how far the ground is when going into the pushup position during a burpee. A training partner or coach should supervise all blindfolded exercises to ensure the safety of the individual.

Practical Applications

While several studies have shown that a sight deprived condition can improve stability and focus [1,6], our findings indicate that implementing sight deprived conditions within a resistance training regimen focused on muscular endurance can elicit positive performance (i.e., overall load output) when exercising. Furthermore, assuming the individual has a training partner or coach to ensure a safe environment, wearing a blindfold may promote an enhanced and unique training experience compared to an unsighted condition.

Appendix

Table 1.

Descriptive characteristics of the participants.

	Female (n=14)	Male (n=11)	Combined (n=25)
Age (y)	25.57 ± 3.96	25.91 ± 8.47	25.72 ± 6.34
Height (cm)	164.07 ± 6.41	173.09 ± 5.80	168.04 ± 7.75
Body Mass (kg)	60.58 ± 8.89	76.53 ± 8.66	68 ± 12
Body Fat %	26.09 ± 6.92	18.06 ± 6.22	23 ± 8

Data are presented as mean ± SD.

Table 2.

Exercise Performance Variables.

	Control	Blindfold	*p (ES)*
Repetitions	30.6 ± 14.2	31.48 ± 14.08	0.025* (0.749)
Total kilograms lifted (kg)	725.7 ± 364.7	753.6 ± 375.4	0.019* (0.503)

Data are presented as mean ± SD. ES = effect size. *Significantly different from control trail, *p <0.05*

Table 3.

Heart Rate (BPM)

	Control	Blindfold	*p (ES)*
PRE	73.87 ± 11.03	75.79 ± 11.81	0.285 (.21)
INTRA	103.03 ± 17.49	106.38 ± 20.62	0.171 (.28)
POST	79.95 ± 12.92	83.6 ± 13.28	0.074 (.17)

Data are presented as mean ± SD. *ES* = effect size

Table 4.

Metabolic Variables

	PRE			INTRA			POST		
	Control	**Blindfold**	***p (ES)***	**Control**	**Blindfold**	***p (ES)***	**Control**	**Blindfold**	***p (ES)***
VO_2 (L/min)	0.33 ± 0.06	0.32 ± 0.06	0.679 (0.08)	0.53 ± 0.17	0.52 ± 0.15	0.793 (0.05)	0.38 ± 0.09	0.40 ± 0.1	0.224 (0.25)
VCO_2 (L/min)	0.28 ± 0.06	0.28 ± 0.07	0.506 (0.01)	0.52 ± 0.22	0.53 ± 0.21	0.742 (0.07)	0.42 ± 0.13	0.44 ± 0.13	0.244 (0.24)
VE (L/min)	8.91 ± 1.28	8.72 ± 1.57	0.529 (0.21)	15.3 ± 5.13	15.5 ± 5.29	0.784 (0.06)	12.19 ± 2.59	12.5 ± 2.86	0.405 (0.17)
RER	0.86 ± 0.07	0.88 ± 0.08	0.160 (0.29)	0.97 ± 0.18	0.99 ± 0.17	0.485 (0.14)	1.08 ± 0.12	1.08 ± 0.11	0.926 (0.19)

Data are presented as mean ± SD. *ES* = effect size

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Curriculum Vitae
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Education

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Information Systems Technician, Petty Officer Second Class, 2009-2015

Professional Research Experience

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Research Assistant, Exercise Physiology Laboratory, 2019-current
Selected skills: metabolic cart, graded exercise testing, body composition, lactate, wearable technology, resistance training

Professional Teaching Experience

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Graduate Teaching Assistant - Department of Kinesiology and Nutrition Sciences, Summer 2021, Fall 2021, Spring 2022
KIN 223 Anatomy and Physiology Laboratory
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Advanced Training Institute (ATI), Las Vegas, NV

Personal Fitness Instructor, 2020-2021.

Courses taught include the following:

PFT 101- Anatomy & Physiology
PFT 102 - Kinesiology
PFT 103 - Sports Nutrition
PFT 104 - Exercise Assessment and Prescription
PFT 105 - Fitness Nutrition
PFT 106 - Exercise Physiology
PFT 107 - Strength and Conditioning
PFT 108 - Corrective Exercise
PFT 109 - Biomechanics,
PFT 110 - Introduction to Business and Sales.

Peer-Reviewed Journal Articles (Published or In Press)

Dustin W. Davis, Bryson Carrier, Brenna Barrios, **Kyle Cruz**, James W. Navalta. *A protocol and novel tool for systematically reviewing the effects of mindful 5 walking on mental and cardiovascular health (2021) PLOS ONE https://doi.org/10.1371/journal.pone.0258424*

Carrier, B., **Cruz, K**., Farmer, H., & Navalta, J. (2021). Validation Of The Lactate Threshold Estimate From The Garmin Fenix 6 Fitness Tracker: 157. *Medicine & Science in Sports & Exercise, 53*(8S), 48. doi:10.1249/01.mss.0000759640.87686.98

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Cruz, K, Navalta, JW, Davis, DW, Carrier, B. Validity of the K5 Wearable Metabolic System during the YMCA Bench Press Test - A Pilot Study. Annual Meeting of the Southwest American College of Sports Medicine, Costa Mesa, CA, 2021. *International Journal of Exercise Science: Conference Proceedings* 14(1): Article 22. Available at: https://digitalcommons.wku.edu/ijesab/vol14/iss1/22

Bodell, NG, Carrier, B, Gil, D, Fullmer, W, **Cruz, K**, Aguilar, CD, Davis, DW, Malek, EM, Montes, J, Manning, JW, Navalta, JW, Lawrence, MM, DeBeliso M. Validity of Average Heart Rate and Energy Expenditure in Polar OH1 and Verity Sense While Self-Paced Walking. Annual Meeting of the Southwest American College of Sports Medicine, Costa Mesa, CA, 2021. *International Journal of Exercise Science: Conference Proceedings* 14(1): Article 69. Available at: https://digitalcommons.wku.edu/ijesab/vol14/iss1/69

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Davis, DW, Carrier, B, **Cruz, K**, Barrios, B, Navalta, JW. The Effects of Meditative and Mindful Walking on Mental and Cardiovascular Health. Annual Meeting of the Southwest American College of Sports Medicine, Costa Mesa, CA, 2021. *International Journal of Exercise Science: Conference Proceedings* 14(1): Article 8. Available at: https://digitalcommons.wku.edu/ijesab/vol14/iss1/8

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Professional Presentations

Kyle Cruz, James W. Navalta (2022) *Blinded by Power is a Good Thing.* UNLV 24th Annual Graduate & Professional Research Forum (Las Vegas, NV)

Cruz, K, Navalta, JW, Davis, DW, Carrier, B. Validity of the K5 Wearable Metabolic System during the YMCA Bench Press Test - A Pilot Study. Annual Meeting of the Southwest American College of Sports Medicine, Costa Mesa, CA, 2021. *International Journal of Exercise Science: Conference Proceedings* 14(1): Article 22. Available at: https://digitalcommons.wku.edu/ijesab/vol14/iss1/22

Cruz, K., Carrier, B., Farmer, H., Navala, J. (2021) *The Validity of VO_2 Max: Treadmill GXT and Wearable Technology.* UNLV 23rd Annual Graduate & Professional Research Forum (Las Vegas, NV)

Cruz, K., Carrier, B., Farmer, H., Navalta, J. (2021)
The Validity of VO_2 Max: Treadmill GXT and Wearable Technology. 2021 American College of Sports Medicine Annual Meeting and World Congresses

Cruz, K., Salatto, R., Davis, D., Carrier, B., Barrios, B., Cater, P., Navalta, J. (2020). *Evaluation of Rating of Perceived Exertion during mountain biking*. Submitted for the 2020 Southwest ACSM Regional Meeting.

Professional Memberships

American College of Sports Medicine Student Member, Southwest Region (2020-Present)

Conferences Attended

2020 Southwest ACSM Regional Meeting
2021 Southwest ACSM Annual Meeting, Costa Mesa, CA

Organizational Involvement

UNLV Grad Rebel Advantage Program Mentor (AUG 2020 - Current)
TESK (Topics in Exercise Science and Kinesiology) Reviewer for abstract submission (2021)

Awards/Grants:

UNLV 23rd Annual Graduate & Professional Research Forum (Las Vegas, NV) - 2nd place, $200.
2021 SWACSM Student Travel Grant - $400
2021 Travel Grant from UNLV - Department of Kinesiology and Nutrition Sciences - $120
2021 UNLV Grad Rebel Slam 3MT, Preliminary Round 1st place, - $300.