Table 1: Bruce Treadmill Protocol

Effects of VO_2 Max Test on Short Term Memory

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Introduction

Exercise in healthy adults has been shown to small but positive effects on cognitive function. Short term or working memory is a limited storage system in which a memory is lost or decays rapidly. Short term memory is believed to support an array of complex cognitive behaviors such as reading comprehension and mathematical problem solving (Beilock & Carr, 2005). The effects of exercise intensity on short term memory is varied, although submaximal and moderate exercise bouts have been shown to have a positive effect on memory. Exercise causes changes in cardiorespiratory, hormonal and metabolic processes that may increase the availability of oxygen, nutrients and glucose to the brain. The VO_2 max test measures aerobic power. Every graded exercise test does not necessarily yield a true maximal oxygen consumption but will always result in a peak oxygen consumption. The Bruce Protocol, one of the earliest standard treadmill protocols developed, was used. (Table 1).

Time (min)	Stage	Speed (mph)	Grade (%)
0:00 - 3:00	1	1.7	10
3:00 - 6:00	2	2.5	12
6:00 - 9:00	3	3.4	14
9:00 - 12:00	4	4.2	16
12:00 - 15:00	5	5.0	18
15:00 - 18:00	6	5.5	20
18:00 - 21:00	7	6.0	22

Table 1: Bruce Treadmill protocol

Purpose

The purpose of this study was to determine if a VO_2 max test using the BRUCE protocol would affect short term memory.

Methods

Five active, healthy subjects (2 female, 3 male) participated in this study. (age 23.6 ± 0.8 years, ht 66.4 ± 4.22 in, wt 164.6 ± 27.65 lbs). Participants were given a variant of the Rey Auditory-Verbal Learning Test prior to exercise and asked to recall as many words as possible after 5 minutes. This supraspan list-learning test contains.

Methods (cont'd)

15 concrete nouns. Participants were given 5 min to memorize as many words as possible and then asked to recall as many words as possible. Participants were then prepped for the exercise test on the treadmill. The speed and grade of the treadmill increased according to the Bruce Protocol. The Bruce protocol increases intensity approximately 8.5 $ml/kg \cdot min^{-1}$ every 3 minutes. Upon arriving at the lab, a Polar heart rate (HR) monitor was attached to the subject to allow for measurement of heart rate, as well as the headgear, mouth piece and nose clip to ensure that exhaled air would be collected in the Parvo metabolic cart during exercise. Heart rate was taken during each minute, as well as workload and rate of perceived exertion score (RPE) with ratings from 6 (rest) to 20 (maximal exercise) during the last minute of each stage (min 3). Participants communicated with hand signals. A "thumbs up" indicated to continue exercise, a "waggle" of the hand indicated not much longer. The exercise was only continued until the participant reached exhaustion. Following a 10 min recovery, participants were given another list of words to memorize in 5 min. Then, their recall of as many words as possible was assessed.

LIST 1	LIST 2	LIST 3	LIST 4	LIST 5	LIST 6	LIST 7	LIST 8
Drum	Desk	Doll	Dish	Violin	Orange	Book	Window
Curtain	Ranger	Mirror	Jester	Tree	Armchair	Flower	Barn
Bell	Bird	Nail	Hill	Scarf	Toad	Train	Hand
Coffee	Shoe	Sailor	Coat	Ham	Cork	Rug	Weather
School	Stove	Heart	Tool	Suitcase	Bus	Meadow	Home
Parent	Mountain	Desert	Forest	Cousin	Chin	Harp	Hot
Moon	Glasses	Face	Water	Earth	Beach	Salt	Balloon
Garden	Towel	Letter	Ladder	Knife	Soap	Finger	Mouse
Hat	Cloud	Bed	Girl	Stair	Hotel	Apple	Crayon
Farmer	Boat	Machine	Foot	Dog	Donkey	Chimney	Fountain
Nose	Lamb	Milk	Shield	Banana	Spider	Button	Rose
Turkey	Gun	Helmet	Pie	Radio	Bathroom	Log	Stranger
Color	Pencil	Music	Insect	Hunter	Casserole	Key	Stocking
House	Church	Horse	Ball	Bucket	Soldier	Rattle	Teacher
River	Fish	Road	Car	Field	Lock	Gold	Toffee

Table 1 Word Lists Used in Modified Auditory-Verbal Learning Test
* Only lists 6 & 7 were used

Results

There was no significant difference found between pre and post exercise short term memory recall ($p>0.05$). Subjects were able to

Results (cont'd)

memorize 10 ± 3 words in pre exercise and 11.8 ± 2.28 words post exercise. Subjects had a relative VO_2 of 41.28 ± 8.22 ml/min, an absolute VO_2 of 3.05 ± 0.73 L/min, a max heart rate of 178.2 ± 13.99 bt/min and exercised for 10:11 ± 1.06 minutes.

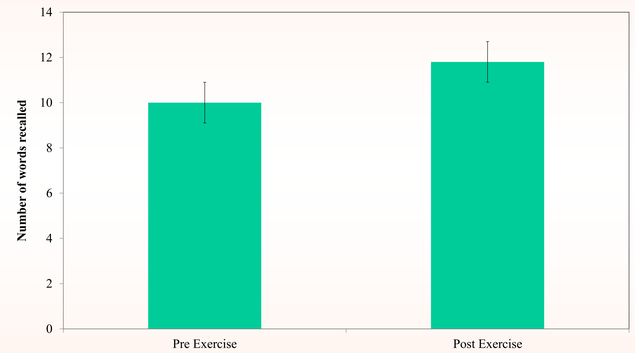

Figure 1: Relationship between Short Term Memory Recall Pre and Post VO_2 Max Test

Conclusions

Although short term memory did increase post VO_2 max test, compared to pre exercise there is no significant difference between memory recall following a VO_2 max test. Short term memory has been shown to improve following moderate exercise (Potter & Keeling, 2005) but future research should be done to find the upper limits in memory recall in relation to exercise intensity. This study could be improved by having a larger pool of participants. Time to recall words should also be recorded in order to determine if max exercise increases recall time.