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Physical Fitness and Mental Muscle: The Relationship Between Exercise Frequency, Intensity, and Cognitive Functioning

Proceedings of the Second Society for NeuroSports (SNS) Conference

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Abstract

Introduction:

The benefits of exercise extend beyond health benefits and appear to include benefits to some cognitive functions. The cognitive benefits may be due to functional and structural alterations, including but not limited to increasing blood flow to the brain and increasing brain plasticity. Additionally, these benefits may occur due to changes in mood. Exercise frequency appears to be positively correlated with working memory and attentional control, but less is known about the effect of exercise intensity. The purpose of the current study is to examine the relationship between both exercise frequency and intensity and the cognitive functions of working memory and attentional control in a healthy college population.

Methods:

In Study 1, forty-two participants completed the Symmetry Span Task, Sustained Attention to Response Task with thought probes, the Pattern Comparison Task, Daily Inventory of Stressful Events, Perceived Stress Scale, State Trait Anxiety Inventory, and supplied a saliva sample.

In Study 2, one hundred and forty participants completed working memory tasks (Reading Span, Symmetry span, and Updating Counters), attentional control measures (Semantic Sustained Attention to Response Task with thought probes, Antisaccade Letters and Antisaccade Arrows tasks), and questionnaires (Positive and Negative Affect Schedule, Mind Wandering Questionnaire, Five Facet Mindfulness Questionnaire, Ruminative Response Scale and a demographic questionnaire).

Results:

We examined the relationships between exercise indices of frequency and intensity and psychological measures of working memory, attention, and mood. Exercise frequency was positively correlated with working memory performance in Study 1, $r(44) = .42, p < .01$, and in Study 2, $r(134) = 0.19, p < .05$. However, exercise frequency was not related to measures of sustained attention (Study 1, $p > .05$), attentional control (Study 2, $p > .05$), or speed of processing (Study 1, $p > .05$). Exercise frequency was negatively related to negative affect (Study 2, $r(138) = -.18, p < .05$), but not state anxiety or perceived stress (Study 1, $p > .05$). Critically, exercise intensity was related to working memory performance in Study 1, $r(45) = 0.32, p < .01$, and Study 2, $r(134) = 0.26, p < .01$, and attentional control in Study 2, $r(134) = 0.22, p < .01$. In Study 1, we found a significant negative correlation between exercise intensity and trait anxiety, $r(47) = -0.33, p < .05$.

Conclusions:

We examined the impact of both exercise frequency and intensity on mood, working memory, and attention. Exercise frequency and exercise intensity appear to be predictive of working

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from lab bench to weight bench

memory capacity. Exercise intensity, but not frequency was related to attentional control at the latent level (Study 2). Interestingly, the impact of exercise on mood and anxiety differed, such that exercise frequency appears to reduce negative affect, but exercise intensity appears to reduce trait anxiety. These findings suggest that both frequency and intensity of exercise need to be examined to understand the impact of exercise on cognition and mood.

34 mg Dose of Caffeine on Maximum Heart Rate and Time to Exhaustion Performance Testing

Proceedings of the Second Society for NeuroSports (SNS) Conference

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Abstract

Introduction:

Caffeine is the world's most common substance used, as it is found in many foods and beverages including coffee, soda, chocolate, etc. Previous research involving caffeine supplementation has shown improvements in aerobic performance, anaerobic performance, cognitive functioning, and metabolism. Previous research has also analyzed roles of caffeine on improving cardiovascular variables, particularly in women (Hartley, T.R., Lovallo, W.R., Whitsett, T.L., 2004). Much of the previous research has been conducted using high dosages of caffeine. However, minimal research exists examining the effects of low dosage caffeine and performance. Therefore, we propose to test low dosage caffeine supplementation on cardiovascular treadmill testing. We hypothesize that supplementation of 34 mg of caffeine, 90 minutes prior to treadmill testing will have a significant effect on performance when compared to a placebo.

Methods:

The double-blind study included twenty-four physically active males and females participated in the study. Individuals were separated into two groups; caffeine group (CAF), supplementing 34 mg of caffeine prior to treadmill testing, and a placebo group (PLA), supplementing 0 mg of caffeine prior to testing. For CAF, (n=12; age 27.83±7.98; height 174.14±11.48; weight 68.11±10.21; body fat 22.78±7.83) and PLA (n=12; age 30.33±8.87; height 181.94±23.47; weight 62.6±16.91; body fat 21.73±9.91). After dosing either caffeine or the placebo, participants waited 90 minutes before executing the time to exhaustion (TTE) treadmill test. All participants were provided a standardized warm-up on the testing treadmill. Following the warm-up, participants began the TTE test. Females were to begin at 6.0 MPH with 0% incline. Incline increased by 1% every 1 minute until the participant could no longer maintain pace, thus resulting in exhaustion. Males began at 7.0 MPH and also increased incline by 1% every 1 minute. The time at cessation of the test in seconds was recorded as the TTE score. Maximum heart rate (HR) was recorded as well, using a heart rate chest monitor (Polar H10, Polar USA) at the end of the testing trial. Instruction and procedures were explained to participants before beginning the treadmill testing.

Results:

Independent samples T tests were performed on raw score TTE times and maximum HR in beats per minute. There were no significant within or between group differences ($p \geq 0.05$).

Conclusions:

Contrary to previous caffeine research and our hypothesis, the data shows a non-significant difference in both TTE and maximum HR performance when comparing the caffeine and placebo groups. However, previous research has examined higher dosages of caffeine (~150 mg-300 mg) and different dosage timing relative to physical testing (~0-120 min). The findings suggest that low dosage caffeine (34 mg), 90 minutes prior to physical testing has no significant effects when compared to a placebo.

Brain Plasticity is Associated with Cardiovascular Function in Aging Adults

Proceedings of the Second Society for NeuroSports (SNS) Conference

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Abstract

Introduction:

Brain-heart pathways linking cardiovascular responses and neuroplasticity measured with non-invasive brain stimulation have been reported, but no studies have investigated these relationships in response to exercise in aging. The purpose of this study was to assess the relationship between neuroplasticity assessed by TMS/iTBS and well-established metrics of cardiovascular fitness in sedentary aging adults. Our primary hypothesis was that greater neuroplasticity response would be associated with better cardiovascular fitness.

Methods:

In this study, we included thirty-one individuals (age 61.5 ± 6.0 y; 65% female; 48% Hispanic) with sedentary status and no clinically detectable cognitive impairment (low level as per the International Physical Activity Questionnaire, and Montreal Cognitive Assessment score ≥ 24). All participants underwent a neuroplasticity and a cardiovascular fitness assessment. Transcranial Magnetic Stimulation/intermittent Theta-Burst (TMS/iTBS) neuroplasticity targeted the hand representation of the primary motor cortex in the dominant hemisphere and MEPs were recorded using surface electrodes applied to the first dorsal interosseous muscle. The neuroplasticity assessment was measured by the change in amplitude of MEPs elicited by single-pulse TMS at baseline and following iTBS at regular intervals (Post5, Post10, Post20, Post30) and expressed in percent change (% Δ). Cardiovascular fitness measures were derived from the Incremental Shuttle Walk Test including resting Rate-Pressure Product (RPP), and Heart Rate Recovery (HRR) at 1-min and 2-min after test cessation.

Results:

The neuroplasticity assessment demonstrated, as expected, an overall facilitation of MEPs post-iTBS. Specifically, MEP amplitudes showed a mean increase of 17.7% at Post20-30 and an overall 11.8% at Post0-30. The sample on average exhibited cardiovascular outcomes within normal ranges for the aging adult population (HRR-1min [27.4 ± 12.1], HRR-2min [40.5 ± 14.7], and RPP [9119 ± 1863]). Pearson product-moment correlations between neuroplasticity and cardiovascular outcomes revealed that greater neuroplasticity (Post20-30% Δ) was significantly associated with lower resting RPP ($r=-.49$, $p=.0089$), and greater Post0-30% Δ neuroplasticity was significantly associated with higher HRR-1min ($r=.48$, $p=.01$) and HRR-2min ($r=.39$, $p=.04$).

Conclusions:

Our preliminary results demonstrated that neuroplasticity as assessed by TMS/ITBS was moderately correlated with cardiovascular fitness measures (HRR and RPP). These preliminary data build on existing data demonstrating that TMS may provide insight into neuroplasticity and the role that exercise, and cardiovascular function appears to have on it.

State and Trait Anxiety in Mixed Martial Artists

Proceedings of the Second Society for NeuroSports (SNS) Conference

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Abstract**Introduction:**

Mixed martial arts (MMA), is a hybrid combat sport incorporating techniques from boxing, wrestling, judo, jujitsu, karate, Muay Thai (Thai boxing), and other disciplines. Having only been formed as a sport in 1993 by the Ultimate Fighting Championship (UFC) not a lot of research has been done on these competitors. Research done so far has shown that personality traits can predict various cognitive, affective, and behavioral outcomes (e.g., Laborde, Guillén, Watson, & Allen, 2017). Furthermore, elevated levels of trait anxiety have been shown to deteriorate non-MMA athlete's overall performance in high pressure situations (Horikowa, 2012). The present study aims to, first, investigate the association of Trait Anxiety in professional fighters and Mixed Martial Artists versus our control (non-Mixed Martial Artists). We hypothesize that MMA fighters will have significantly lower scores on the STAI overall and on key subsections such as trait anger and trait depression than the control population of college aged non-mixed martial artists.

Methods:

Thirty-Four professional Mixed Martial Artists and professional fighters were recruited as well as twenty-six aged-matched non-MMA athletes. Participants were recruited utilizing flyers across a university campus and MMA gyms, and social media posts linking to the survey. Participants completed a demographic questionnaire, professional win-loss record, self-efficacy questionnaire, the State-Trait Anxiety Inventory (STAI-Y) as well as other mental health assessments as part of the battery. The State-Trait Anxiety Inventory (STAI) is a psychological inventory based on a 4-point Likert scale and consists of 40 questions on a self-report basis. For the present study, we will utilize Independent Sample T-Tests to examine mean differences in State-Trait Anxiety Inventory (STAI-Y) scores between professional Mixed Martial Artists and aged-matched non-fighters.

Results:

Preliminary results from the data analysis indicate that the control population of mostly college-aged students had significantly higher trait anxiety ($p=.002$), trait anger ($p=.002$) and trait depression levels ($p=.05$) than the professional fighters. The professional fighters had significantly higher trait curiosity ($p=.010$) scores than the population of majority college students.

Conclusions:

These findings suggest that professional fighters' personality traits lead them to having individual differences in the way that they present state anxiety specially in the areas of anxiety, anger and depression as compared to our control of non-mixed martial artist. The professional fighters displayed significantly higher levels of curiosity compared to

the control as well. More research needs to be done in this area however the data seems to suggest the fighters have either learned or born with a more natural inclination to be able to regulate and keep their emotions at a balance specifically anxiety.

The Impact of Bilingualism on Athletes: A Comparison Between Monolinguals and Bilinguals on Verbal Ability

Proceedings of the Second Society for NeuroSports (SNS) Conference

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Abstract

Introduction:

The impact of speaking two or more languages on behavior has been the topic of ongoing debate for the past couple of years. Indeed, some research links bilingualism to enhanced performance on computer tasks, working memory, and even athletic performance. However, other studies argue against such advantage. Additionally, assessment of linguistic abilities shows a bilingual disadvantage on language tests. One important limitation of some of these studies is that the language groups differ on educational attainment, socio-economic status (SES), and parental education, which impact overall cognitive functioning and linguistic abilities. Our goal was to assess linguistic abilities in a group of bilinguals and monolinguals matched on extraneous variables.

Methods:

We tested English monolingual (n=109) and Spanish/English bilingual (n=152) college students with similar educational attainment, SES and parental education on the Bilingual Verbal Ability Test (BVAT). This battery contains three subtests and generates an index of second language proficiency and of general verbal ability. Language proficiency refers to a person's mastery of their second language, and general verbal ability refers to mastery across both languages. In bilinguals, items failed in English are administered in the person's native language (Spanish in our sample) and scores are combined to determine their true, overall language ability. In monolinguals, performance on the English subtests is used to determine overall language ability.

Results:

Our findings revealed that when bilinguals are compared to monolinguals on overall verbal abilities, there are no linguistic differences between groups on overall verbal ability.

Conclusions:

To accurately capture potential differences between bilinguals and monolinguals in linguistic as well as on non-linguistic abilities, it is important to obtain verbal abilities across all spoken languages and to match groups on extraneous variables such as SES, education and parental education. This will permit a more accurate representation of verbal abilities in bilinguals and it is more likely to reveal differences between linguistically diverse populations if differences exist.

Single Channel EEG Shows Stability Across Cognitive Performance Testing Sessions in eGamers

Proceedings of the Second Society for NeuroSports (SNS) Conference

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Abstract

Introduction:

Wearable single channel electroencephalographic (EEG) holds great promise as an objective measure of cognitive performance and neural fatigue (Balanou et al., 2013; Casson, 2019; Lin et al., 2014). However, the use of single channel EEG as a performance measure requires that band frequencies are consistent across testing sessions in the absence of intervention or performance training (Casson, 2019). In order to address this concern, we tested the stability of multiple EEG band frequencies using a single channel EEG in an e-gamer population while they performed a series of cognitive tasks. We hypothesized that task-related single channel EEG band power would show stability across multiple testing sessions.

Methods:

Thirty-seven male participants (mean age = 20.57, SD = 2.11) were tested once a week for three weeks using NIH Toolbox and Joggle iPad cognitive tests while EEG was recorded using a single channel EEG band (Enchanted Wave LLC, Miami, FL). EEG electrode placement was at the FP1 site. Recordings were carried out for approximately 15-minutes while participants performed 4 cognition tasks on an iPad: Flanker Inhibitory Control and Attention Task (inhibitory Control), Pattern Comparison Processing Speed Test (Processing Speed), Dimensional Change Card Sort Task (Executive Functioning), and the Psychomotor Vigilance Task (PVT. Attentional Control and Alertness). EEG data were automatically decomposed using Fast Fourier Transformation (FFT) through the Enchanted Wave software. EEG power data are presented as $(\mu V^2/Hz)/.048$.

Results:

A 3 x 8 (session x EEG) omnibus analysis showed that band frequencies were consistent across recording sessions. There was not a main effect of session $F(2,72) = 0.07$, $p = 0.93$ or a session x band frequency interaction $F(14,504) = 0.07$, $p = 0.93$. As expected, there was a significant main effect of band frequency $F(7,252) = 89.10$, $p < 0.001$.

Conclusions:

EEG has been shown to be able to detect neural fatigue which can assist with the timing for the implementation of countermeasures and recovery (Huang et al., 2016). However, EEG application can be challenging due to the time and resources involved in multiple channel EEG protocols. Our findings suggest that single channel EEG represent an easy-to-use application that shows stability during performance measures. This study is ongoing, but we aim to replicate these findings in a population of female e-gamers. Future work should also carry out test-retest stability of single channel EEG across other performance tasks.

Better Processing Speed in eGamers Compared to Controls

Proceedings of the Second Society for NeuroSports (SNS) Conference

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Abstract

Introduction:

A growing body of literature suggests that video games can benefit cognitive processing (Campbell, 2018). The specific cognitive benefits are related to the skills that are being challenged in the games; however, some studies also suggest a general improvement in executive functioning (Parong, 2017; Eichenbaum, 2014). Although video games appear to benefit overall executive functioning, other areas of cognition have been less studied in eGamers. In order to address this gap in the literature, we compared eGamers to a control group on three cognitive tasks. Results indicated that 10+ hours/week of first-person video game exposure is related to increased processing speed in comparison to controls.

Methods:

The study included 125 male participants collected through convenience sampling on Nova Southeastern University's campus (mean age = 27.75) that were split into two groups- those playing video games >10 hours/week (N=35, M=20.66, SD=2.3) and those that did not (N=90, M=31.45, SD=9.9). Participants completed a battery of cognitive tasks from the NIH Toolbox. These tasks included the Flanker Inhibitory Control and Attention Task, Dimensional Change card Sorting Task & Pattern Comparison Processing Speed Task. After data collection, three independent samples *t*-test were performed to identify differences in means.

Results:

An independent samples *t*-Test of PCPS scores revealed a significant difference in means ($t=6.32$, $p < 0.001$). 10+ hours/week of first-person video game exposure appears to be related to increased processing speed in comparison to controls. However, here is no significant difference seen in eGamers compared to controls when observing executive functioning or executive functioning and attention.

Conclusions:

Consistent with previous research, it has been demonstrated that 10+ hours/week of first-person video games is related to increased processing speed. Future studies should aim to relate the specific game skills challenged with improvements in cognitive domains in a longitudinal study. Additionally, they could explore whether individuals with higher processing speed are choosing to play video games or if the games are causing these improvements.

The Impact of Fidgeting on Memory for a Lecture

Proceedings of the Second Society for NeuroSports (SNS) Conference

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Abstract

Introduction:

Memory retention of recently learned information decreases as a function of a person's fidgeting behavior; the more a person fidgets during a lecture, the less they tend to remember (Farley et al., 2013). In addition, Seli et al. (2013) propose that fidgeting behavior may be an external indicator of mind wandering which is associated with decreases in immediate attention and memory. This study further examined the relationship between fidgeting and memory in a learning setting.

Methods:

Participants were placed in either the fidget condition (tapping their feet while seated), the no movement condition, or the control condition while watching and answering multiple choice questions about three videos. Movbands strapped to participants' ankles recorded participants' fidgeting movements while they were watching the videos. Participants also completed two fidgeting surveys about their self-reported fidgeting.

Results:

Results thus far indicate that condition did not impact memory performance [$F(2, 111) = .12, p = .89$]. Participants answered 58.5% questions correctly in the fidget condition, 58.7% in the no movement condition, and 59.9% in the control condition.

Conclusions:

The findings in this study suggest that fidgeting during a lecture did not significantly hurt or help memory for the material. Furthermore, forcing people to stay still also did not significantly impact their memory for the lecture material compared to the control condition.

The Relationship Between Proactive Semantic Interference and Gait Speed in Aging Individuals – Preliminary Results of an Ongoing Trial

Proceedings of the Second Society for NeuroSports (SNS) Conference

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Abstract

Introduction:

Reductions in gait speed not only precede cognitive changes but may predict cognitive decline years before most traditional neuropsychological assessments detect these changes. The Loewenstein-Acevedo Scales for Semantic Interference and Learning (LASSI-L) is a novel cognitive outcome measure that has been shown to be sensitive in detecting early cognitive changes in both preclinical and prodromal AD. Specifically, performance on the LASSI-L List B Cued Recall-2 designed to assess proactive semantic interference has shown to be related to total amyloid load, a risk factor for Alzheimer disease.

Methods:

We explored the relationship between performance on the Timed up-and-go (TUG), a widely used clinical assessment of functional mobility, and the failure to recover from proactive semantic interference as measured in the LASSI-L List B Cued Recall-2. Twenty-five healthy participants over the age of 55 were administered the LASSI-L as part of a cognitive test for an 8-week exercise study. Participants completed two trials of the TUG test at their normal walking pace and two trials at a fast walking pace.

Results:

Results showed a positive correlation between the average time to complete the fast walking condition and (M=7.27 SD=1.69) and the number of intrusions during the LASSI-L Cued Recall B (M=1.18 SD=1.14), $r=.623$, $p=.004$.

Conclusions:

Implementing walking measures such as the TUG in the point of care setting can be an inexpensive and accessible tool to cast a net to help determine who may need further evaluation. As the study progresses, an increased sample size will improve statistical power and allow further analyses to be conducted.

The Relationship Between Biomarkers of Stress and Psychomotor Vigilance in eGamers

Proceedings of the Second Society for NeuroSports (SNS) Conference

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Abstract

Introduction:

The Psychomotor Vigilance Task (PVT) is a widely used neurobehavioral test and is a sensitive measure of fatigue and attention deficits in clinical and experimental contexts (Drummond et al., 2007; Yang et al., 2018). Performance on a psychomotor vigilance attention task generally improves with increased physiological arousal (Diamond et al., 2007). Persistent usage of videogames has been shown to be a correlate of fine motor skill enhancement and vigilant attention (Borecki et al., 2013). However, it is currently unclear the extent to which physiological measures of arousal during a baseline (non-stressed) condition are related to psychomotor vigilance in eGamers. This study investigated the relationship between two measures of physiological arousal and performance on the PVT in eGamers.

Methods:

The study included thirty-five male amateur e-gamers (mean age = 20.57, SD = 2.13). Participants provided baseline saliva samples and underwent a mood and sleep survey (MAPS) as a way to determine a stable emotional state. Individuals were tested on the Psychomotor Vigilance Task (PVT) through the iPad-based NIH Toolbox and Joggle Cognition platform while having an EEG band attached. Participants provided post-PVT-pre-supplement saliva samples and were then dosed with the supplement. Following the hour-long incubation period, participants provided post-supplement saliva samples, and underwent MAPS. Participants then performed the same psychomotor vigilance tasks as mentioned above, and once done, provided post-PVT-post-supplement saliva samples. Salivary Alpha Amylase increases in response to stress and is a validated measure of autonomic nervous system arousal. Cortisol is the end-product of the hypothalamic pituitary adrenal (HPA) axis and levels of cortisol rise in response to stress. Salivary Cortisol and alpha amylase were quantified through a competitive immunoassay (cortisol) or kinetic reaction (sAA) according to the instructions of the protocol manual (Salimetrics LLC).

Results:

A Pearson correlation analysis of sAA and PVT reaction time revealed a significant correlation ($r = .68, p < 0.001$). There was also a significant correlation between sAA and PVT error ($r = .43, p < 0.01$). Unfortunately, there were no significant relationships found between cortisol and PVT reaction time or cortisol and PVT error ($p > 0.05$).

Conclusions:

Autonomic arousal (sAA) is related to a speed-accuracy tradeoff (SAT) in PVT performance. Higher autonomic arousal is significantly associated with slower reaction times, but is also significantly associated with fewer errors. While we see a similar trend for cortisol (higher cortisol relates to slower reaction time), this relationship is not statistically significant. Future work should aim to examine the neural underpinnings that relate autonomic arousal to speed-accuracy tradeoff in regions of the brain such

as the dorsolateral prefrontal cortex (as it pertains to working memory) and vigilant attention in eGamers (Curtis & D'Esposito, 2003).

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