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## Proceedings from the First Annual Society for NeuroSports Conference

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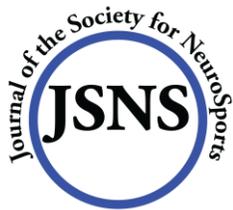
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# Greater occurrences of the “warrior” COMT Val/Met genotype in mixed martial arts fighters compared to controls; however, it does not relate to winning percentage.

*Proceedings of the First Society for NeuroSports (SNS) Conference*

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## Abstract

**Introduction:** A functional single-nucleotide polymorphism (SNP) in the catechol-O-methyltransferase (COMT) gene (rs4680) shows promise as a gene variant that can predict the ability to maintain alertness (e.g. sustained attention and processing speed) during combat and competition (i.e., the warrior/worrier gene). The COMT enzyme works to catabolize catecholamines in the central and peripheral nervous systems. We predicted that elite MMA fighters would be more likely than controls to carry the GG (warrior) genotype. We also predicted that elite MMA fighters carrying the warrior genotype would have better winning percentages than elite MMA fighters not carrying the warrior genotype would.

**Methods:** 25 MMA fighters (mean age = 28.96, SD = 4.6), 41 non-athlete controls (mean age = 22.66, SD = 4.14) were genotyped for the COMT 4680 polymorphism. The study only included male participants. Genomic DNA was extracted in a QIAcube instrument following the manufacturer’s standard protocol for saliva nucleic acid extraction (QIAGEN, Valencia, CA, USA). After isolation, allelic discrimination for the COMT gene was determined via real-time polymerase chain reaction (PCR) using a TaqMan SNP genotyping assay using fluorogenic probes (Applied Biosystems, CA, USA). Genotypes were determined automatically.

**Results:** A 2 (group) X 2 (COMT) analyses showed an overall significant ( $p=0.003$ ) difference in genotype frequencies between the MMA fighters and the non-athlete control group. However, independent samples t-test analysis revealed a non-significant ( $p=0.696$ ,  $r=.082$ ) effect of genotype on winning percentage in MMA fighters.

**Conclusions:** The data shows a significant difference frequency increase in the warrior (GG) genotype in MMA fighters when compared to a non-athlete control group. Our data also demonstrated a non-significant relationship between genotype and winning percentage when compared in MMA fighters only. The findings suggest that The “Warrior” genotype may be a factor in those participating in professional MMA.

# Creatine and Cognitive Functioning: Part 1 – Body Composition

*Proceedings of the First Society for NeuroSports (SNS) Conference*

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## Abstract

**Introduction:** Creatine is linked to a variety of beneficial effects in trained athletes including increased performance on high intensity exercise (Cornish, Chilibeck, Burke, 2006; Dawson, Vladich, Blanksby, 2002), increased tolerance to exercise in heat (Kidluff et al., 2004), and improved recovery from exercise induced muscle damage (Cooke et al., 2009). Additionally, a growing body of work suggests that creatine may have benefits outside of the exercise domain. Creatine may have protective effects for cognitive processes under conditions of stress specifically during cognitive tasks with high demand, such as executive functioning tasks (McMorris et al., 2006; McMorris et al. 2017) and following sleep deprivation (McMorris et al, 2006). Of interest, creatine appears to improve memory functioning in vegetarians (Benton & Donohoe, 2011) and in older adults (McMorris et al, 2007). The purpose of the current study was to examine the impact of a 6-week creatine supplementation in a healthy college student population.

**Methods:** We tested 35 undergraduate students over a 6-week period. Subjects were assigned to either a creatine condition ( $n=18$ ), in which they consumed 5 grams of creatine per day for the 6-week period, or a wait-list control condition ( $n=17$ ), in which they did not consume creatine. Subjects were assessed for body composition (i.e., fat mass, fat-free mass, percent body fat, trunk lean body mass, trunk fat mass and trunk percent fat) via the dual-energy x-ray absorptiometry (DXA) prior to the start of the 6-week period and at the end of the 6-week period. We conducted an ANOVA to assess changes within- and between-groups.

**Results:** We found no significant differences within or between groups for any of the body composition assessments (i.e., body mass, fat mass, fat-free mass, percent body fat, trunk fat mass, trunk fat-free mass, trunk percentage fat). However, there was trend in the creatine group for a decrease in trunk fat percent (creatine pre  $27.3\pm 8.4$ , creatine post  $25.3\pm 7.3$ ; control pre  $28.7\pm 8.6$ , control post  $28.1\pm 8.6$ ).

**Conclusions:** Our findings suggest that creatine supplementation may be beneficial to young males and females vis a vis trunk percent fat.

## Creatine and Cognitive Functioning: Part 2

*Proceedings of the First Society for NeuroSports (SNS) Conference*

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### Abstract

**Introduction:** Creatine is linked to a variety of beneficial effects in trained athletes including increased performance on high intensity exercise (Cornish, Chilibeck, Burke, 2006; Dawson, Vladich, Blanksby, 2002), increased tolerance to exercise in heat (Kidluff et al., 2004), and improved recovery from exercise induced muscle damage (Cooke et al., 2009). Additionally, a growing body of work suggests that creatine may have benefits outside of the exercise domain. Creatine may have protective effects for cognitive processes under conditions of stress specifically during cognitive tasks with high demand, such as executive functioning tasks (McMorris et al., 2006; McMorris et al. 2017) and following sleep deprivation (McMorris et al, 2006). Of interest, creatine appears to improve memory functioning in vegetarians (Benton & Donohoe, 2011) and in older adults (McMorris et al, 2007). The purpose of the current study was to examine the impact of a 6-week creatine supplementation in a healthy college student population.

**Methods:** We tested 35 undergraduate students over a 6-week period. Subjects were assigned to either a creatine condition ( $n=18$ ), in which they consumed 5 grams of creatine per day for the 6-week period, or a wait-list control condition ( $n=17$ ), in which they did not consume creatine. Subjects completed measures of working memory, sustained attention, speed of processing, and mind wandering and measures of body composition via the dual-energy x-ray absorptiometry (DXA) prior to the start of the 6-week period and at the end of the 6-week period.

**Results:** We conducted a mixed model ANOVA to examine changes between Time 1 and Time 2 by condition on working memory, sustained attention, mind wandering, and speed of processing. We did not find a significant interaction between condition and time on any of the cognitive measures, all  $p$ 's  $> .05$ . However, the effects of creatine on sustained attention measures were in the expected direction. For subjects that consumed at least 3 grams of creatine per day ( $n=9$ ), a trend for an increase in sustained attention performance as indicated by increased dprime (T1  $M = 1.22$   $SD = .91$  and T2  $M = 1.62$   $SD = .91$ ,  $t(8) = 1.90$ ,  $p = .09$ ,  $d = .44$ ), increased target accuracy (T1  $M = 29.88$   $SD = 12.96$  and T2  $M = 37.33$   $SD = 15.63$ ,  $t(8) = 2.05$ ,  $p = .07$ ,  $d = .52$ ), decreased reaction time variability (T1  $M = 234.54$   $SD = 135.99$  and T2  $M = 201.99$   $SD = 93.48$ ,  $t(8) = 1.88$ ,  $p = .09$ ,  $d = .28$ ), and decreased percentage of negatively valenced mind wandering (T1  $M = 20.74\%$   $SD = 15.88$  and T2  $M = 9.26\%$   $SD = 15.80$ ,  $t(8) = 1.90$ ,  $p = .09$ ,  $d = .73$ ) were observed. These changes were not observed in the control condition, all  $p$ 's  $> .14$ .

**Conclusions:** Our findings suggest that creatine supplementation may be beneficial to cognitive functioning; however, the effects may be smaller than our current sample allows us to detect. Further research should determine if physical training alters the impact of creatine on cognitive functioning.

# The effects of exercise on the encoding and recall of information

*Proceedings of the First Society for NeuroSports (SNS) Conference*

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## Abstract

**Introduction:** Acute bouts of aerobic exercise have been shown to improve memory for words encoded during (Coles & Tomporowski, 2008) and the exercise. The present study examines the impact of exercise on memory during encoding and on word recall 48 hours later.

**Methods:** Eighty-six participants were randomly assigned to a running, walking, or control group. Participants initially completed the Physical Activity Readiness Questionnaire and (PAR-Q) and the State Trait Anxiety Inventory (STAI). Participants then either jogged or walked on a treadmill or watched a film for 30 minutes. Following this, participants completed a Paired Associate Learning (PAL) task with 40 cue-target word pairs and were instructed to remember the target word associated with each cue. After each of the 40 pairs were presented, participants were given a cue word and were instructed to recall the target word. This was repeated 10 times. We recorded how many pairs they got correct each time they went through the PAL to measure learning rate. Forty-eight hours later, participants completed the STAI, Pittsburgh Sleep Quality Assessment (PSQI), and a demographic survey. Participants then completed a surprise recall task of the words they previously learned to measure retention, along with a shortened version of the Automated Operation Span (AOSPAN) task to measure working memory capacity.

**Results:** To determine if learning rate was affected by condition, we first fit each participant's learning rate to the formula,  $Y = a - b/X$ , where  $Y$  = number pairs correctly recalled,  $X$  = trial number,  $a$  is defined as the best theoretical score achieved and  $b/a$  is defined as the learning rate (Feldman et al., 2009). We conducted a one-way ANOVA on both the best theoretical score and learning rate across conditions. Learning rate was fastest and the theoretical highest number of correct pairs was highest in the walking condition, followed by the running condition, with the control condition being the slowest and lowest, although these were not significant ( $p > .05$ ). We next conducted a one-way ANOVA on the surprise recall task across conditions and found a significant difference ( $F(2, 81) = 4.63; p = .012$ ). Follow up tests revealed that the number recalled correctly was the same in the walking ( $34 \pm 7$ ) and jogging ( $33 \pm 7$ ) conditions, both of which were greater than the control ( $28 \pm 10$ ) condition ( $p < .05$ ).

**Conclusions:** Our findings indicate that exercise does not improve learning rate, but it does improve retention of information.

# Concussion risk in the National Football League is highest during the biological afternoon and is independent of the mandated concussion protocol

*Proceedings of the First Society for NeuroSports (SNS) Conference*

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## Abstract

**Introduction:** Here, we developed a metric known as a human performance response curve (hPRC) to demonstrate advantages and disadvantages during the field-of-play during the NFL regular season schedule. The hPRC relies on the principles of the human circadian timing system such that the nadir of wakefulness/alertness occurs during the biological afternoon when a majority of NFL regular season games are scheduled. Recently, we showed that NFL teams playing during the biological afternoon are at a distinct disadvantage, decreasing winning percentage and increasing time that starting players spend on injury reserve, particularly linemen (Brager and Mistovich, 2017).

**Methods:** For each team and game of a NFL regular season, we plotted risk for concussion with respect to each team's home biological time. Our hypothesis was that risk for concussion would be higher during the predicted circadian nadir of wakefulness/alertness (biological afternoon) compared to optimal zones of circadian-regulated wakefulness/alertness in the late morning and night games. We also hypothesized that circadian regulation of risk for concussion would be independent of implementing a concussion assessment and return-to-play protocol fully implemented in 2014. To support our hypotheses, we examined timestamps of concussions (based on each team's biological time) across the regular season pre-implementation of the NFL concussion protocol (2013) and post-implementation (2015).

**Results:** There were 140 documented concussions across the 2013 regular season prior to implementation of the NFL concussion protocol. In 2015, there were 215 documented concussions after implementation of the NFL concussion protocol. Despite implementation of the NFL concussion protocol, we discovered that the biological afternoon was a danger zone for concussions. In 2013, 75% of concussions (103/140) occurred during the biological afternoon. In 2015, this number increased to 82% (177/218) during the early biological afternoon.

**Conclusions:** Moreover, time of day of play matters for concussion risk management. These data are sufficient and necessary for developing effective countermeasures to monitor, predict, and mitigate risks for short-term and chronic impact of head injuries, particularly chronic traumatic encephalitis (CTE), in professional football players.

# Cognitive phenotypes in elite e-gaming athletes

*Proceedings of the First Society for NeuroSports (SNS) Conference*

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## Abstract

**Introduction:** E-gaming is rapidly expanding in participation and has salient public and financial support. Recent clinical evidence has shown that e-gamers are prone to skeletomuscular injury, behavioral health problems, and fatigue similar to traditional sport athletes that manifest from time at play and performance pressure, increasing its legitimacy as a competitive sport. Here, we characterize simple and complex cognitive performance of elite e-gaming athletes undergoing a multi-day regimen of neurocognitive and physical training assessments. Cognitive performances were additionally collected in elite traditional sport athletes in order to determine the extent to which e-gamers have a cognitive overmatch compared to traditional sport athletes.

**Methods:** Elite functional fitness (n = 2) and e-gaming (n = 5) athletes of the US Army traveled to MAMBA Sports Venture Lab to undergo a four-day regimen (2 h daily; 1 h morning; 1 h afternoon) of cognitive assessments of increasing cognitive load.

**Results:** Baseline reaction time between e-gamers and a cohort of professional football and basketball players did not differ. Under increasing cognitive load, e-gamers were > 100 milliseconds faster compared to professional traditional sports athletes. E-gamers outperformed functional fitness athletes on all tasks. Overall, a four-day regimen of cognitive assessment improved initial, baseline performance in all athletes.

**Conclusions:** Independently of gaming platforms, cognitive training tools of reaction time and dual-processing are capable of further enhancing performance in elite e-gaming athletes. In general, e-gaming athletes demonstrate cognitive overmatch compared to elite traditional sports athletes.

# A brief, personalized intervention increases physical activity in sedentary older adults with memory complaints.

*Proceedings of the First Society for NeuroSports (SNS) Conference*

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## Abstract

**Introduction:** Despite the evidence supporting a multitude of positive health outcomes from being physically active (including improved cognition), a large proportion of older adults remain insufficiently active. Older adults regularly cite low motivation and low health/exercise literacy as important barriers to the participation in physical activity. In this context, personalized interventions offer the advantage of being customizable to each individual's life and needs. Such a precision medicine approach may improve engagement in physical activity. The primary aim of this study was to compare participation in physical activity in sedentary older adults following a personalized intervention or after a control group. The secondary aim was to compare changes in cognitive performance between the groups. We hypothesized that the personalized intervention group would demonstrate greater improvements in physical activity and cognitive performance, when compared with the control group over a 4-week period.

**Methods:** This was a parallel, two-arm, randomized controlled trial. The inclusion criteria were: 1) aged  $\geq 60$  years; 2) sedentary (less than 150 min of moderate exercise per week); 3) subjective memory complaints or mild cognitive impairment (Mini-Mental State Examination  $\geq 18$  and  $\leq 28$ ). The intervention was delivered over 3 days (12 hours total) and included group-based theoretic-practical sessions focusing on: evidence on exercise and brain health, nutrition, and exercise demonstrations and individually tailored sessions on identifying barriers/motivators and increasing confidence, and goal setting. The control group did not participate in the intervention.

All participants received a pedometer (Power Walker<sup>OBJ:OBJ</sup>). This was a parallel, two-arm, randomized controlled trial. The inclusion criteria were: 1) a Walker and given a step count diary for 4 weeks. Participants randomized into the intervention group received smart phone based motivational messaging throughout the for weeks tailored to the individual needs and preferences. The primary outcome was the number of steps walked over a period of 4 weeks. The secondary outcome was cognitive performance assessed by a multi-domain neuropsychological test battery designed to assess executive function, verbal learning and processing speed (Stroop Test, Rey Verbal Auditory Learning Test and the Trail Making Test (TMS) A and B), performed before and after the 4 week period (post testing 1-2 weeks after the 4 week period of collecting steps data). <sup>OBJ:OBJ</sup> and given a step count diary for 4 weeks. Participants randomized into the intervention group received smart phone based motivational messaging throughout the for weeks tailored to the individual needs and preferences. The primary outcome was the number of steps walked over a period of 4 weeks. The secondary outcome was cognitive performance assessed by a multi-domain neuropsychological

test battery designed to assess executive function, verbal learning and processing speed (Stroop Test, Rey Verbal Auditory Learning Test and the Trail Making Test (TMS) A and B), performed before and after the 4 week period (post testing 1-2 weeks after the 4 week period of collecting steps data). PW-610) and given a step count diary for 4 weeks. Participants randomized into the intervention group received smart phone based motivational messaging throughout the for weeks tailored to the individual needs and preferences. The primary outcome was the number of steps walked over a period of 4 weeks. The secondary outcome was cognitive performance assessed by a multi-domain neuropsychological test battery designed to assess executive function, verbal learning and processing speed (Stroop Test, Rey Verbal Auditory Learning Test and the Trail Making Test (TMS) A and B), performed before and after the 4 week period (post testing 1-2 weeks after the 4 week period of collecting steps data).

**Results:** Twenty-six participants (age=65.3±5.3) completed the study (intervention=13, control=13). We found between-group differences in the average steps ( $M_{\text{intervention}}=10,040\pm1158$ ,  $M_{\text{control}}=8,198\pm2845$ ,  $p=.041$ ,  $d=.85$ ), and TMT A ( $p=.049$ ,  $d=-.81$ ), with the intervention group demonstrating both greater number of steps (approximately 2000 more steps per day) and improved processing speed when compared with the control group.

**Conclusions:** These findings demonstrate that a 3-day individually tailored intervention and smart-phone based motivational messaging can: 1) increase physical activity participation and 2) lead to modest improvements in cognition (processing speed), in individuals with memory complaints. This study demonstrates that even brief, individually tailored interventions can be effective at improving physical activity participation in individuals with memory complaints.

# The Drug Policy of the European Union- Quo vadis?

*Proceedings of the First Society for NeuroSports (SNS) Conference*

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## Abstract

**Introduction:** Due to its international dimension, drug policy intersects several political junctions, including crime, freedom, health, science, security and justice. As such, it appears to be the perfect contender for European cooperation of the highest order. Its current classification as a shared-cum-supportive competence limits the scope of actions available to the European actors, with a principal focus placed on bringing added value to national policies. Consequently, European Union Drug Policy has a narrow legal basis in the treaties, probing the EU decision makers to squeeze out every last drop of legitimacy available to them. The purpose of this investigation was to explore how this area of policy could evolve, with particular focus on potential ramifications any advancements in the EU Drug Policy could have for the member states, the European Union as well as global partners in the ‘fight against the drugs’.

**Methods:** A state-of-the-art review was conducted in order to highlight the challenges faced by the European Drug Policy Makers at a global as well as intra-European level. Purposive sampling aimed to represent the voices of the principal policy-making actors but also those who are not directly engaged in the decision-making process: general public, academic researchers and scientists. Thematic analysis was used to evaluate the prospect of integration of further powers into the European Union’s Drug Policy in light of key theories underpinning the European integration: intergovernmentalism, neofunctionalism and multi-level governance model.

**Results:** Main challenges identified include: Static policy area, limited scope of competence granted to the EU institutions vis-à-vis member states’ governments, political expediency, discord between science and politics on the issue of drug classification, the improbability of pan-EU consensus and harmonised approach, law-enforcement centric approach to supply reduction.

**Conclusions:** Under the existing paradigms of decision-making, the EU Drug Governance will likely have limited capacity to prompt the policy-makers to engage fully with some of the more uncomfortable issues, such as predominately prohibition-based drug-policy recipes. The research on harms associated with drug use undermines the validity of the existing European drug classification schedule and resultant punitive measures in a policy area touted as ‘evidence-based’- the uptake of neuroscientific findings appears to be limited by politicised agendas and moralistic discourse. Any further advancements in the field will be a function of political will to address the drug issue beyond what is now within the remit of shared and supporting competence. Even if moderately desirable, the prospect of integration of further powers into the European Union’s Drug Policy legal-toolkit seems rather slender at the time when Europe is grappling with a disintegration challenge for the first time in its history.

# How to make a winner: how hormones and experience shape the brain of the victor

*Proceedings of the First Society for NeuroSports (SNS) Conference*

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## Abstract

**Introduction:** Winning competitions increases self-esteem, morale, status, access to resources, and sometimes safety. Because of the obvious value of winning, we are interested in the effects and predictors of victory. Scientists who study how the brain and hormones contribute to behavior and how experience alters the brain and hormones have already learned quite a lot about competition, which we will review here.

**Methods:** A literature search was conducted to determine the most well-replicated findings concerning the effects of winning on behavior, hormones, and the brain. Data that exemplify the state of the field concerning our knowledge about effects of winning on future performance and testosterone were identified for inclusion. Whenever possible, data from men, women, and rodents were included.

**Results:** Among the most well-studied phenomena is the “Winner Effect,” which shows that a history of winning increases the odds of future victory. This is a hormone-dependent effect. In addition to the intuitive effects of winning mentioned above, winning also briefly increases hormones that can further strengthen performance, including testosterone. This effect is well-replicated in field studies looking at athletes and in experiments looking at nonhuman animals. Winning is rewarding not only because it quite literally secures rewards for the victor, including social status and/or material resources, but also because it causes release of various pleasant neurochemicals, including testosterone. Not only is testosterone acutely increased following ecologically relevant victories, but also its signaling is strengthened long-term because of increased expression of the androgen receptor in various reward centers within the brain. In addition to hormone signaling in the brain and body, external factors also contribute to the Winner Effect. For example, the location of past and present competitions also plays a role: the winner effect is stronger for home teams and for nonhuman animals tested in their home cage, suggesting that territoriality is a key factor.

**Conclusions:** Research in this field has many applications for sports programs. For example, planning preseason competitions against inferior opponents on a team’s home field will increase the odds of winning future competitions. Unfortunately, a large gap still exists in the literature about the neuroendocrinology of competition: women are underrepresented in this research largely because there are no data from other female animals on which to base hypotheses. Ongoing work in our lab will study the winner effect in women and female rats.

# Intranasal Zinc treatment ameliorates behavioral deficits caused by Chronic Stress and Traumatic Brain Injury in mice

*Proceedings of the First Society for NeuroSports (SNS) Conference*

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## Abstract

**Introduction:** Traumatic Brain Injuries (TBI) are a leading cause of morbidity and mortality across ages. Most TBIs are mild TBIs (mTBI) which are identified by minor loss of consciousness (if any) and no fracturing of the skull. Accumulating evidence indicates that the effects of stress alter the pathology seen following TBI. This is especially relevant in military populations, where post-traumatic stress disorder (PTSD) and chronic stress are hallmark problems seen in personnel returning from combat. Zinc (Zn) supplementation prior to TBI has been shown to mitigate the damage seen following injury. This experiment examined the efficacy of acute intranasal Zn therapy following repetitive mild TBI in both stressed and unstressed mice.

**Methods:** Six-week old C57BL/6J mice received chronic variable stress for one week which was followed by two days of behavioral testing including burrowing, nesting, forced swim, and elevated zero maze. Following behavioral testing, mice endured a second week of stress during which four mild TBIs were administered with a 48-hour inter-injury interval. Immediately following each injury, mice received either intranasal Zn or vehicle. The same four behavioral tests were then conducted followed by Morris Water Maze and Circadian Rhythm (CR) testing. Following CR, mice were euthanized and western blots were ran doublecortin, pro and mature BDNF, TrkB, PhosphoTrkB, and GFAP.

**Results:** In the Elevated Zero Maze: for number of head dips, there was a significant effect of TBI  $F(1, 40) = 5.234, p = 0.028$ , and a significant effect of Stress  $F(1, 40) = 4.154, p = 0.048$  with both causing an increase in number of head dips. For time spent in the open quadrants of the maze, there was a significant interaction of TBI, Stress, and Zinc  $F(1, 40) = 4.579, p = 0.039$ . For forced swim: there was a significant effect of stress,  $F(1, 40) = 43.642, p < 0.001$  and a significant effect of TBI  $F(1, 40) = 69.520, p < 0.001$  with both causing an increase in amount of time spent immobile. A trending interaction effect of Zinc and TBI was noted,  $F(1, 40) = 2.993, p = 0.091$  with zinc causing a decrease in immobility. There was a significant effect of stress with stress causing a reduction in GFAP  $F(1, 12) = 6.193, p = .029$ . There was a significant effect of stress reducing doublecortin  $F(1, 12) = 9.556, p = .009$ . Additionally, there was a significant effect of zinc increasing levels of doublecortin  $F(1, 12) = 6.070, p = .030$ . Stress significantly lowered the ratio of mature to proBDNF  $F(1, 12) = 5.039, p = 0.044$ . There was a significant effect of treatment with zinc increasing the relative amount of Phosphorylated Receptors  $F(1, 12) = 11.540, p = .005$

**Conclusions:** These findings add to the literature showing that stress modulates TBI and should be included in animal experiments to increase translation. Further, these results indicate that Zn may be a strong candidate for use in an acute therapeutic intervention following TBI.

# Musculoskeletal injury risk in college athletes is linked to movement patterns and body fat, but not ImpACT performance

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## Abstract

**Introduction:** Musculoskeletal injuries (MSI) in collegiate athletes are common with a reported rate of occurrence of 63.1 injuries per 1,000 athletic exposures. Initial injury risk is thought to be multifactorial in nature and to include neurocognitive as well as physical sources. However, many researchers and clinicians lack the resources to assess these multiple factors in large groups of athletes. Identifying modifiable risk factors associated with initial MSI could prove useful in injury prevention initiatives in the collegiate athletics setting. Therefore, the purpose of this prospective study was to determine if reaction time, visual motor speed, body fat percentage and presence of dysfunctional movement patterns were predictors of MSI in collegiate athletes without history of MSI.

**Methods:** We tested 151 male and female NCAA Division II athletes ages 18-24 that represented 13 university teams. Participants were part of a larger cohort of 279 student-athletes who underwent pre-participation physical examinations. Reaction time (RT) and visual motor speed (VMS) were obtained from the visual reaction time composite and visual motor speed composite scores via ImpACT testing by a credentialed ImpACT consultant. Body fat was assessed via air displacement plethysmography using a BodPod and results were dichotomized using 25% as the cut-point for females ( $\leq 25$  vs  $> 25$ ), and 15% ( $\leq 15$  vs  $> 15$ ) for males. Movement patterns were assessed using the Functional Movement Screen (FMS) by Level I certified personnel. FMS test results were dichotomized by examining scores for the presence of a “1” (yes vs no) indicating dysfunction. MSI were tracked via computer using SportsWare software over an academic year by each team’s certified athletic trainer. We conducted a binary logistic regression to investigate the effects of the four independent variables on the likelihood athletes would have an MSI,  $p < .05$ .

**Results:** Eighty-two (54%) athletes sustained an injury during the study period. Ninety-six (63%) athletes had a score of “1” on at least one of the FMS tests, and 61 (40.4%) had body fat above the cut-points for their sex. Mean RT and VMS were  $59.93 \pm 7.33$  ms and  $40.39 \pm 5.95$ , respectively. The logistic regression model was statistically significant,  $\chi^2(4) = 13.320$ ,  $p = 0.01$ . The model explained 11.4% (Nagelkerke  $R^2$ ) of the variance in MSI occurrence and correctly classified 64.4% of cases. Athletes with FMS movement dysfunction (presence of a score of “1”) or high body fat were 2.5 and 2.3 times more likely to get injured, respectively. RT and VMS did not significantly elevate relative risk of injury,  $p > .05$ .

**Conclusions:** Athletes may be at risk for MSI if they have poor movement patterns as measured by the FMS and possess high body fat percent. Since these factors are modifiable, clinicians may justify their assessment during the pre-participation physical examination. RT or VMS as measured from computerized testing test may not affect the risk of MSI in this group. However, baseline ImpACT assessment is still warranted for athlete monitoring because of the relevancy to mild traumatic brain injury.

# Closed kinetic chain ankle dorsiflexion motion influences dynamic balance in NCAA Division II male soccer players

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## Abstract

**Introduction:** Limited ankle dorsiflexion range of motion (ROM) has been identified as a risk factor for ankle injuries in soccer players. The closed kinetic chain dorsiflexion (CKD) is a clinical tool used to measure ankle ROM in a weight-bearing position. The Y-balance test is a valid and reliable tool for assessing dynamic balance of the stance limb while the contralateral limb reaches in anterior, posteromedial and posterolateral directions. Asymmetries have been linked to lower extremity injuries in athletes. Limited CKD may influence Y-balance performance as well as show contralateral asymmetries. Therefore, the purpose of this study was to examine the relationship of ankle dorsiflexion ROM and dynamic balance between limbs in a healthy group of male division II collegiate soccer players. These results will assist clinicians on identifying the relationship between lower extremity joint kinematics and dynamic balance.

**Methods:** Twenty-seven male NCAA Division II college athletes ages 18-24 (mass, 71.84±7.22, height, 1.79±0.06) took part in this study. Twenty-five were right leg dominant. We assessed ankle ROM in a weight-bearing position utilizing the CKD test and dynamic balance was measured via the Y-balance test in the anterior, posteromedial, and posterolateral directions for both limbs. Testing occurred during the athletes' pre-participation physical examination. All participants performed 3 trials for both limbs of the CKD and the Y-balance. Y-balance reach scores were normalized to right leg length for comparison purposes. Means of the trials for each variable were used for analysis. Separate linear regressions for right and left sides were used to determine the relationship between CKD and Y-balance measures,  $p < .05$ . Paired t-tests were used to determine the significant difference in CKD and Y-balance measures between left and right limbs.

**Results:** Mean CKD values were similar between left and right ankles at 8.7±3.2 and 8.0±2.8 cm., respectively,  $p > .05$ . Left and right Y-balance values for anterior (64.2±6.1 vs 63.0±5.6%) and posterolateral (113.7±8.5 vs. 112.5±11.6%) directions were similar,  $p > .05$ . Left posteromedial was significantly greater than right [(116.4±9.2 vs. 113.0±9.8%) ( $t(26) = -3.59$ ,  $p = .001$ )]. Left limb Y-balance composite score was significantly greater than the right [(98.1±6.5 vs. 96.2±7.1)] ( $t(26) = -3.16$ ,  $p = 0.004$ ). For the left limb there were moderate, positive correlations between CKD and the anterior reach direction ( $r = 0.50$ ,  $p = 0.008$ ) and the composite score ( $r = 0.47$ ,  $p = 0.013$ ), and a weak, positive correlation between CKD and the posterolateral direction ( $r = 0.39$ ,  $p = 0.046$ ). There were no significant relationships between CKD and Y-balance scores for the right limb,  $p > .05$ .

**Conclusion:** While ankle dorsiflexion ROM and anterior and posterolateral reach directions of the Y-balance were similar between limbs, dynamic balance was positively related to Y-balance performance for the left limb only. This may demonstrate that dynamic balance of the planted (non-dominant; left) limb in male collegiate soccer players is influenced by ankle ROM, but the kicking (dominant; right) limb is not. This warrants further investigation.

# Do low force isometric contractions performed to exhaustion recruit high threshold motor units similar to non-fatiguing high force isometric tasks?

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## Abstract

**Introduction:** During fatigue, skeletal muscle fibers display a decrease in their twitch force. In order to maintain a given absolute force level, compensatory adjustments in motor unit control are thought to occur. It is still unclear, however, if recruitment of motor units is similar for low force tasks performed until exhaustion versus non-fatigued contractions performed at high force levels. Therefore, the purpose of this study was to determine whether isometric fatigue at 30% maximal voluntary contraction (MVC) force performed to exhaustion recruits high threshold motor units similar to non-fatigued 50% or 80% MVC force tasks.

**Methods:** Eleven untrained men (mean  $\pm$  SD age = 24  $\pm$  5 years) participated. After determining isometric MVC of the dominant knee extensors, participants performed trapezoidal contractions at 50% and 80% MVC. Following  $\geq$  10-minute rest, participants performed an isometric fatiguing protocol which required them to complete contractions at 30% MVC force until exhaustion. For each contraction, force was increased from 0% to 30% over three seconds, held constant for 33 seconds, and then decreased from 30% to 0% over three seconds. This protocol concluded when force dropped below 25% MVC. Bipolar surface electromyographic (EMG) signals were detected from the vastus lateralis during each contraction. A surface EMG signal decomposition algorithm was used to determine the shapes of individual motor unit action potentials (MUAPs). A custom LabVIEW program was used to quantify each MUAP's peak-to-peak amplitude. MUAP amplitude was quantified for each motor unit from the 50% and 80% MVC tests, as well as the beginning, middle, and end of the fatiguing protocol. We analyzed differences in MUAP amplitude on an individual participant basis by performing one-way analyses of variance (ANOVAs) across conditions (50% MVC, 80% MVC, 30% MVC beginning, middle, and end). Significant ANOVAs were followed up with Bonferroni pairwise comparisons.

**Results:** The mean number of analyzed motor units was: 30% MVC beginning = 23; 30% MVC middle = 22; 30% MVC end = 14; 50% MVC = 15; 80% MVC = 10. All ANOVAs were statistically significant ( $p \leq .001$ ) with large effect sizes ( $\eta_p^2 \geq 0.278$ ), suggesting differences in MUAP amplitude across conditions. Our main findings can be summarized as follows: 1) Under non-fatigued conditions, MUAP amplitude was greater at high forces (30% MVC beginning mean range = .020-.293 mV; 50% MVC mean range = .033-.691 mV; 80% MVC mean range = .049-.551 mV). 2) Six participants showed clear increases in MUAP amplitude throughout the fatiguing protocol. 3) MUAP amplitude was similar at the end of the fatiguing protocol compared to the 80% MVC test for six participants.

**Conclusions:** Although findings varied among participants, these data suggest that as the vastus lateralis fatigues, recruitment of high threshold motor units results in comparable MUAP amplitude to that observed during a high force contraction. Therefore, it is reasonable to suspect that low force exercise performed to exhaustion

has the potential to result in similar motor unit recruitment pattern to that activated during high force activity.

# MMA Fighters and Epigenetics: An Analysis of miRNA Expression and DNA Methylation

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## Abstract

**Introduction:** Psychological and physical stress can induce dysregulation of gene expression via changes in methylation and miRNA expression. Such epigenetic modifications are yet to be investigated in professional MMA fighters who are subject to highly stressful training involving repeated head trauma. The fighters tested in the current study train at the highest level of striking and grappling, often following hypocaloric diets in preparation for professional competition in front of a global viewing audience. This study examines differences in expression of miRNAs associated with inflammatory disease in elite MMA fighters compared to active controls

**Methods:** PCR array was used to estimate differential expression in pooled samples of 21 fighters and 15 controls for 192 different miRNAs. Real time qPCR was then employed to quantify the expression of miR-15a and miR-134 in individuals of both groups. Global methylation differences between groups were also assessed via a LINE-1 assay (surrogate global DNA analysis).

**Results:** Independent samples t-tests found no significant differences in miRNA expression or LINE-1 methylation between group

**Conclusions:** These results suggest no dysregulation of these specific epigenetic mechanisms with professional level MMA training.

# Motor Skill Consolidation During Sleep

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## Abstract

**Introduction:** A large and growing body of evidence suggests that sleep plays a critical role in the consolidation of memory. More specifically, REM sleep has been implicated in the consolidation of procedural memory (i.e. learned movement sequences); whereby, consolidation not only stabilizes a memory, but as well enhances performance. Despite the strong associations between REM sleep and procedural memory consolidation, there fails to be a consensus in the literature. Previous work linking an electroencephalographic (EEG)- based sleep study to procedural memory consolidation is limited and showed disparate results, indicating consolidation in slow wave sleep (SWS) and not REM. Despite these disparate results, no previous study has assessed the role of REM sleep in memory consolidation with participants sleeping in their own home. In order to address the gap in the literature, this study used an ambulatory EEG device to assess the hypothesis that procedural memory is consolidated during REM sleep. Our findings suggest that a night of sleep is sufficient in providing performance enhancements on a procedural motor task, however the mechanism associated with sleep-dependent consolidation remains unknown.

**Methods:** Thirty-one participants (mean age = 19, SD = 2.50, 19 females and 12 males) were tested within 4-day periods using a validated 5-digit span finger tapping task. All subjects were provided a Single channel EEG headband to wear for three consecutive nights (4 days) to record sleep data. The first two nights consisted of baseline measures of sleep. Following the 2<sup>nd</sup> night of sleep (i.e. the 3<sup>rd</sup> day), subjects were given the initial finger tapping “learning” task. After a subsequent night of sleep (4<sup>th</sup> day), the participants were retested with the “post training” and “generalized-untrained-post” finger tapping task.

**Results:** Findings depicted a significant increase in speed and accuracy of the finger tapping task after a subsequent night of sleep. A repeated measure analysis of variance (ANOVA) revealed a main effect  $F(2, 97) = 14.38$   $p < .05$ . The follow up Tukey post hoc tests showed that there was a significant difference between baseline and post-sleep ( $p = .0006$ ). In addition, a significant difference between the post-sleep task and a new task introduced during post-sleep testing ( $p = .000041$ ) were noted. Critically, there was no significant difference between the baseline task and the new task introduced post sleep.

**Conclusions:** In this EEG-based sleep study to evaluate procedural memory, our findings suggest that procedural memory is consolidated during sleep. After one night of sleep, it is shown that sequential motor skills are enhanced by speed and accuracy. Furthermore, performance on a similar, novel sequence is significantly different than that of the post-sleep performance and not different than the original sequence learning performance, indicating that the improved performance was related to memory consolidation of the motor sequence and not due to task familiarity. This suggests that similar tasks learned subsequent to a newly introduced task may be attributed to interference during learning. These results can lead to substantial performance benefits in athletes and novel sleep-based training paradigms by optimally increasing athlete performance with a regimen consistent of training followed by sleep.

# “Winning the Challenge”: The Interaction of Conscientiousness and Perceived Autonomy

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## Abstract

**Introduction:** Understanding determinants for weight-loss is a national priority. Obesity is an epidemic with serious health consequences. Most of today’s obesity and overweight problems are being attributed to poor diets and not enough physical activity. These problems show no signs of slowing down with the behaviors of most Americans. The phenomenon of “The Biggest Loser” (different variants of weight-loss programs that consist of group exercise participation and nutrition therapy to elicit weight-loss, and hopefully behavior change has spawned many variants in commercial health clubs. This prospectus study examined the additive and interactive effects of known determinants of healthy behaviors. The purpose of this study was to examine the psychosocial determinants of adhering to a variant of a twelve week weight-loss challenge and how it affects weight loss in the participants.

**Methods:** Participants were 64 overweight and obese adults who completed measures of conscientiousness and autonomy prior to beginning the 12-week weight-loss program. Participants’ attendance was also kept based on showing up to the regular weight and body fat percentage measurements time points. At final weigh-in, the participants completed measures of conscientiousness, autonomy and autonomy support.

**Results:** Descriptive statistics and Pearson Correlations show that conscientiousness correlates with Autonomy ( $r=.26$ ,  $M=11.36$ ,  $SD=6.43$ ), Autonomy Support ( $r=.08$ ,  $M=5.32$ ,  $SD=1.58$ ,  $\alpha=.97$ ), Attendance ( $r=.14$ ,  $M=3.84$ ,  $SD=1.31$ ), and Change in Weight ( $r=-.09$ ,  $M=-15.26$ ,  $SD=29.06$ ).

**Conclusions:** Participants with high autonomy support scored high in attendance to the program and buffered out the effects of conscientiousness. The combination of high autonomy support and high conscientiousness yielded the greatest amount of weight loss. In both groups of positive and negative autonomy support, the groups with high conscientiousness showed increases in weight loss (negative score in the change in weight).

# The Validity and Reliability of Game-based Exercise on Fall-risk Assessment, Balance, and Muscular Performance

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## Abstract

**Introduction:** Exercise programs that challenge balance have been shown to reduce the risk of fall among older adults. Game-based exercise modalities (e.g., Wii, Trazer) are a growing topic as an alternative intervention to improve balance in older adults. In addition, the Sensory Organization Test (SOT) and Vestibular Ocular-Motor Sensory tests have been used, mainly, for balance and concussion assessments in much younger populations.

**Methods:** This ten-week study investigated if the Trazer, a game-based video system, could be used to assess balance and at-risk status for falls in an older adult population in comparison with other currently accepted fall-risk assessments by questionnaire and physical assessments.

Approval for the study was given by Florida Atlantic University's IRB committee. Each participant completed an informed consent, health history, physical activity questionnaire, three Trazer assessments (focused on dynamic/agility balance with these assessments, Get back, Mini-t, and linear speed), and FES-I questionnaire. Height (cm) and weight (kg) measurements were taken. Other physical assessments were the SOT, VOMS, Timed Up and Go (TUG), and Sit to Stand (STS). All assessments were repeated at the end of the ten weeks.

The participants were randomly selected to be in the Trazer or the control group. Each group participated in the same exercise sessions, three days a week for ten weeks. The Trazer group completed the three assessments each day.

**Results:** Twenty-one subjects were assessed for this study (controls=10; training=11; 3 males and 18 females). Average age, 77.46 (+7.83); height 163.98 (+5.31) cm; weight, 77.46 (+14.70) kg. They were retested after 10 weeks. No significant differences ( $p>0.05$ ) were seen in weight, timed up and go, sit to stand, Trazer skills (Get Back, mini-t, and linear speed) or Fall Efficacy Scale in any of the subjects. Significant differences were in VOMS training group's overall score from pre to post ( $P<.01$ ) and convergence, but not in the control group.

**Conclusions:** All of the participants in both groups did participate in their regular activity three days a week during the ten weeks. Since this study was the first to access VOMS, and nothing else was significant, except the VOMS, the small n may contribute to explain this significance.