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Relationships between Extraversion and Measures of Counter Movement Jump Performance

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Abstract Previous research has identified a positive relationship between athletic performance and the personality trait of extraversion. In addition, previous research has demonstrated that a higher degree of extraversion has been associated with a faster movement time during reactionary tasks. To date, previous research has not examined if these observed relationships occur during a sport-related movement, such as a counter movement jump (CMJ). If a relationship between extraversion and CMJ performance were to exist, this may provide mechanistic reasoning for the previously identified relationship to athletic performance. Accordingly, the purpose of this study was to examine the relationship between extraversion and CMJ performance. Twenty-nine (22.6 ± 2.3 yrs) recreationally-active females volunteered to participate in this study (63.7 ± 8.2 kg; 166.4 ± 6.6 cm). The degree of extraversion was measured via the Eysenck Personality Inventory (EPI) and CMJ performance was measured using a Myotest® Sport unit. Bivariate Pearson correlations were utilized to examine the relationship between extraversion and CMJ performance. Extraversion was not significantly correlated with any measures of CMJ performance ($p > .05$). These results suggest that the previously observed relationship between extraversion and athletic performance is not attributed to a relationship between extraversion and CMJ performance. Rather, it is possible that individuals who exhibit a high degree of extraversion may utilize different coping skills or motivational sources in order to achieve greater athletic performance than individuals who exhibit a lower degree of extraversion. In addition, a different underlying physiological mechanism may still remain unidentified.

Keywords Personality, Power Output

1. Introduction

Physical ability and human performance have long been studied by researchers in order to predict and/or maximize the sport performance of athletes. Researchers have attempted to do so by investigating several different aspects of sport performance. Two of these avenues include sport psychology and sport physiology. As such, both of these areas of research have identified various predictors of sport performance.

In the sport psychology literature, a relationship between the personality trait of extraversion and sport performance has been previously hypothesized [1-2]. Specifically, research has demonstrated that highly successful athletes exhibit a high degree of extraversion when compared to less proficient athletes [3-5]. An individual who exhibits a high degree of extraversion is generally considered to be impulsive, active, outgoing, and responsive [6].

In addition, a relationship between the personality trait of neuroticism and sport performance has also been demonstrated in the sport psychology literature where highly successful athletes exhibit a lower degree of neuroticism than their less successful counterparts [5, 7-8]. An individual who exhibits a high degree of neuroticism is generally considered to more emotionally over-responsive and has difficulty coping with emotional experiences [6]. Subsequently, it has been previously hypothesized that highly successful athletes may exhibit a high degree of extraversion and a low degree of neuroticism, which in turn may be advantageous to their given sport [1, 2, 9].

The sport physiology literature has also demonstrated a link between extraversion and physiological performance. Specifically, a positive relationship between extraversion and central cognitive processing speed has been previously identified [10-12]. This implies that if an individual exhibits a greater degree of extraversion, the central processing speed of that individual during a reaction-related task increases as

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well. In addition, previous research has also demonstrated that if an individual exhibits a greater degree of extraversion, the movement time of that individual decreases during a reaction test and their peripheral motoneuron excitability increases [13-16]. In short, individuals who exhibit a greater degree of extraversion seem to display an enhanced movement ability.

Based on these identified relationship between extraversion and movement ability, the relationships between extraversion and athletic performance could in turn be theoretically be related to the enhanced movement ability of highly extraverted persons. Specifically, the ability to react and move quickly and explosively is considered to be an important factor in many different sports and athletic events [17]. For example, the sport of volleyball requires quick, explosive, and powerful dynamic movements. Since previous research suggests that a greater degree of extraversion may be related to an enhanced neuromuscular function and a faster movement time, if similar relationships were identified in an athletic context, it would provide mechanistic reasoning to the relationships between extraversion and sport performance. Furthermore, if relationships between extraversion and a sport-specific movement ability were identified, it would provide further evidence for the use of personality measures when examining potential athletic ability and the enhancement of sport performance.

However, previous research has only examined the relationship between extraversion and movement ability during fine motor movements, such as single joint, reactionary tasks. To the knowledge of the authors, no previous research has examined this relationship during a gross motor movement that is commonly utilized in athletic tasks and events, and thus, would have a greater potential of translation into enhancing sport performance.

A counter movement jump (CMJ) is a gross motor movement task that requires dynamic and explosive movements from the lower body in order to achieve maximal jump height. Specifically, this task involves a downward counter movement followed by an explosive upward phase that results in a maximal vertical jump. The CMJ is commonly utilized by athletes in various sports, such as basketball, volleyball, etc. Accordingly, the CMJ is also a task that is routinely critiqued by talent scouts and sport coaches when examining an individual's athletic ability, such as during the National Football League testing combine [18]. Furthermore, the CMJ is commonly utilized by both sport physiologists [19-20] and practitioners [17] to assess an individual's maximal power output. As such, if a relationship between extraversion and a sport specific, gross motor movement were to be identified, it may provide mechanistic reasoning for the personality differences identified in the sport psychology literature.

Accordingly, the purpose of this study was to investigate the relationships between the personality trait of extraversion and CMJ performance measures of peak height (cm), peak power output (W/kg), peak force output (N/kg), and peak velocity (cm/sec) achieved during the CMJ task. Preliminary results of this study have only been previously presented in abstract form [21].

2. Materials and Methods

2.1. Participants

Thirty-four females between 18-29 years of age (22.6 ± 2.3) volunteered to participate in this study (height = 166.4 ± 6.6 cm; weight = 63.7 ± 8.2 kg). Due to previously reported gender differences in extraversion and neuroticism [22], only females were included into this study. All females were in good health, not pregnant, free from cardiovascular or neurological pathologies or symptoms, and reported no musculoskeletal injuries within the last three months, or surgeries within the last year.

In order to recruit a homogenous study sample in regards to health and physical ability, all participants were recreationally-active and reported engaging in regular exercise meeting the minimum recommendations of the American College of Sports Medicine (ACSM) for at least six months [23]. In addition, none of the participants were currently training for an elite-level competitive sport or event, nor were they members of an elite-level athletic team (e.g., a professional or National Collegiate Athletic Association sports team). This study was approved by the Institutional Review Board and all participants gave informed consent before participation.

2.2. Procedures

The testing procedures were divided into two separate testing sessions. Participants provided informed consent, completed all personality tests, and all anthropometric data were collected during the first testing session. In addition, participants completed several practice CMJ trials during the first testing session in order to familiarize themselves to the CMJ protocol [24]. However, all CMJ trials used in the statistical analyses were collected during the second testing session (48-96 hours later). All data were collected in the Human Performance and Sport Physiology Laboratory located on the University of Wisconsin-Milwaukee campus.

2.2.1. Personality Measurement

The personality measures of extraversion and neuroticism were assessed through the use of the Eysenck Personality Inventory (EPI) Form B [25]. Since various versions of the EPI have been previously utilized to examine relationships between extraversion and neuroticism and sport performance [3-5, 7], as well as neuromuscular factors [10-11, 13-15], the EPI was also utilized in the current study. The EPI is a valid and reliable 57-question survey that assesses the degree of extraversion and neuroticism an individual exhibits. Based on this questionnaire, the degree of extraversion and neuroticism is quantified (i.e., totalled) on scale of 1-24 (low-high) [25-26]. The mean ± SD measures of extraversion and neuroticism of the sample

population were 16.9 ± 3.8 and 9.8 ± 3.2, respectively, which are similar to previously reported normative values (15.2 ± 3.5; 11.4 ± 4.8, respectively) [25].

Due to the previous identified inverse relationship between athletic performance and neuroticism [5, 7-8], the current study attempted to control for the potential impact of neuroticism on CMJ performance. As such, in order to be included in the study, participants must have scored within one standard deviation (±4.8) of the published normative value of neuroticism (11.4) as measured by the EPI Form B [25]. This created an acceptable window of neuroticism scores ranging from 6-17 and allowed for an accurate examination of the relationship between extraversion and CMJ performance. Accordingly, five participants scored outside of this acceptable window of neuroticism, and thus, were removed from the study. This resulted in a total of 29 participants included in all statistical analyses.

2.2.2. Counter Movement Jump Procedures

CMJ performance was measured using the Myotest® Sport Unit (Myotest Inc., Durango, CO). The Myotest® Sport unit is an electronic, three-dimensional accelerometry-based device that measures peak height (cm), peak power output (W/kg), peak force output (N/kg), and peak velocity (cm/sec) of a vertical jump movement. Previous research has verified the reliability and validity of the Myotest® Sport unit in measuring CMJ performance [27-29]. Furthermore, in order to account for the previously identified influence of body mass on vertical jump performance [30], the Myotest® Sport unit automatically normalizes all CMJ performance measures to bodyweight.

Due to the previously observed benefits of including an arm swing during a CMJ reported in the literature [31-32], participants were not allowed to perform an arm swing during the CMJ trial. This was an attempt to eliminate the possible confounding factors of an increased potential energy of the arms or the increased upward momentum from the upward motion of the arm [32]. As such, participants were instructed to keep their hands on their hips during the entirety of the trial (Figure 1).

A neoprene belt was fitted around the waist of each participant with the Myotest® Sport unit fastened to the belt and positioned over their left hip. Participants were then instructed to squat down and propel themselves upwards, jumping as high and as explosive as possible, after hearing the sound of a beep from the Myotest® Sport unit. The depth of the counter movement was not controlled and the participant was simply instructed to squat down to whatever level felt comfortable and that they believed would achieve maximum CMJ performance.

Prior to the CMJ trials, each participant performed a light, five-minute warm-up Monark® Ergomedic 828E bicycle ergometer (Monark Exercise, Vansbro, Sweden) at a self-selected resistance and a cadence of 50 rpm. In addition, each participant was also allowed several practice CMJ trials to ensure proper technique and measurement of the CMJs by the Myotest® Sport unit.

Figure 1. Example of counter movement jump protocol

Each participant performed three successful CMJ trials with 30-60 seconds of rest between each trial. A CMJ trial was considered unsuccessful if: (a) the Myotest® Sport unit did properly measure the CMJ trial, (b) the participant started her movement before the beep stimulus, or (c) if the participant removed her hands from her hips. All unsuccessful CMJ data were discarded and only the CMJ resulting in the greatest peak height was utilized for all statistical analyses.

2.3. Statistical Analyses

Bivariate Pearson correlations were utilized to examine the relationships between the personality trait of extraversion and the measures of CMJ performance (peak height, peak power output, peak force output, & peak velocity). It was hypothesized that extraversion would be positively correlated with the CMJ performance measures. An alpha level of .05 determined statistical significance. All statistical analyses were conducted using IBM SPSS version 20 statistical software (IBM Corp., Armonk, NY). Achieved statistical power ($1–\beta$) was calculated *post hoc* for each correlation [33].

3. Results

3.1. Counter Movement Jump Performance

Table 1. Group Mean CMJ Performance Measures

CMJ Variable	Mean (±SD)
Peak Height (cm)	30.0 ± 4.5
Peak Power Output (W/kg)	30.4 ± 8.4
Peak Force Output (N/kg)	19.4 ± 2.0
Peak Velocity (cm/sec)	183.7 ± 38.8

Group mean CMJ performance measures are provided in Table 1. Overall group performance during the CMJ task was comparable to other similar recreationally-active female sample populations previously reported in the literature [29].

3.2. Extraversion and Counter Movement Performance

The bivariate Pearson correlations (r) between extraversion and measures of CMJ performance, as well as achieved statistical power ($1–\beta$), are provided in Table 2. No measures of CMJ performance were significantly correlated with extraversion ($p > .05$).

Table 2. Correlations between Extraversion and CMJ Performance

CMJ Variable	Extraversion	Significance	Power
Peak Height (cm)	$r = .063$	$p = .746$	$1–\beta = .063$
Peak Power Output (W/kg)	$r = .161$	$p = .404$	$1–\beta = .215$
Peak Force Output (N/kg)	$r = .202$	$p = .294$	$1–\beta = .287$
Peak Velocity (cm/sec)	$r = .091$	$p = .637$	$1–\beta = .122$

4. Discussion

4.1. Extraversion

The purpose of this study was to examine the relationships between extraversion and the CMJ performance measures of peak height, peak power output, peak force output, and peak velocity. Based on the results of this study, no statistically significant relationships were identified ($p > .05$). Although relationships between extraversion and athletic performance have been previously identified in the sport psychology literature [3-5], this relationship was not identified with the sport-specific task of a CMJ. However, it should be noted that this does not necessarily imply that the personality trait of extraversion is not related athletic performance. Since previous research has demonstrated that female athletes who perform at an elite level are generally more extraverted than female athletes who do not perform at an elite level [5], the link between extraversion and athletic performance may only be identified when investigating a sample of female athletes who perform at an elite level (e.g., professional athletes).

Furthermore, it has also been hypothesized by researchers that a lack of introversion (i.e., the opposite of extraversion), is more important for achieving a high level of athletic performance than the degree of extraversion they exhibit [9]. Based on this hypothesis, it may simply be advantageous for an athlete to exhibit a certain degree of extraversion in order to be successful. In other words, it is possible that after an athlete exhibits a certain "threshold" of extraversion, it may no longer be advantageous to exhibit a greater amount of extraversion.

4.2. Confounding Psychological Factors

4.2.1. Coping Strategies

Although a CMJ is a sport-specific task required in many athletic events, solely examining the degree of extraversion an individual exhibits alone omits the "in game" nature of competitive sport. During a competitive event, an athlete must react and cope to the different incidents (both positive & negative) and stressors that occur throughout the given event. How an individual copes with stress has also been linked to personality traits [8, 34-36]. For example, Allen et al. [8] demonstrated that extraversion was significantly related to problem-focused coping among athletes. Therefore, it is possible that focusing on the source of the stress, rather than choosing to employ other coping strategies, may result in greater performance during an athletic event. As such, when examining an acute athletic movement, such as a CMJ, a significant relationship may not be observed without the other important contextual factors that comprise performance during an athletic event.

4.2.2. Neuroticism

While the personality trait of extraversion does not appear to be related to CMJ performance, a relationship between other personality traits may still be exist. For example, previous research has identified a statistically significant negative relationship between neuroticism and sport performance [2, 7]. While the current study attempted to control for the potential impact of neuroticism on CMJ performance, this personality trait (or others) may in fact be the personality trait of most interest.

4.2.3. Motivation

Finally, the level of motivation among the participants may have influenced CMJ performance based on the source of verbal encouragement they received. Previous research has demonstrated significantly different torque outputs based on personality type and the source of verbal encouragement among during isokinetic [37] and isometric knee extension tests [38]. Specifically, extraverts exhibited significantly greater torque output (Nm) than introverts when they received both peer and tester verbal encouragement during isokinetic [37] and isometric knee extension tests [38]. In addition, introverts exhibited a significantly greater torque output (Nm) when they receive no verbal encouragement compared to when they receive only tester verbal encouragement, or both peer and tester verbal encouragement, during isokinetic [37] and isometric knee extension tests [38].

The current study attempted to standardize the source of verbal encouragement by providing the same positive verbal encouragement to all participants. Specifically, all positive verbal encouragement was provided solely by the researchers and not by any other third party (e.g., peers, family, etc.). In addition, the results of McWhorter et al. [37-38] are obtained from a single-joint, non-dynamic, and non-explosive task. This type of task is primarily utilized to assess strength (i.e., force output), and unlike the CMJ, is not a measure of explosive power output. However, the source of verbal encouragement may be a potential confounding factor on the motivation level of the participants and future research is warranted.

4.3. Neuromuscular Factors

Previous research has identified a faster central processing speed [10-12] and a faster movement time [13-16] during reactionary-type tests among individuals who exhibit a high degree of extraversion. Due to this, it was hypothesized that a significant relationship between extraversion and a high velocity, explosive movement task, such as a CMJ, would be identified. Although there was not an identified relationship between extraversion and CMJ performance in the current study, there have been identified relationships between other personality traits and various neuromuscular mechanisms during other gross movement tasks.

Two such personality traits include the Type A and Type B personality traits. In general, an individual with a Type A personality exhibits extremely competitive and aggressive behaviour (e.g., impatient, hard-driving, irritable, etc.) and an individual with a Type B personality exhibits the opposite [39]. Glasscock et al. [39] demonstrated that individuals with a Type A personality exhibit a significantly higher muscle activation level in the antagonist muscle group (i.e., triceps) than individuals with a Type B personality during an isometric and isokinetic elbow flexion task. As such, the potential relationship between personality and muscle activation patterns during a gross movement task, such as the CMJ, should be further investigated.

In addition, Marras et al. [40] demonstrated higher spinal compression forces and shear forces during repetitive loading tasks among individuals who exhibit a high degree of introversion (or a low degree of extraversion). These authors also attributed these increases in spinal compression forces to an altered neuromuscular activation pattern of the antagonist muscle group. Marras et al. [40] suggested that introverts may have greater levels of antagonist activation during a gross movement task. It is possible that the observed altered neuromuscular activation patterns may affect performance during these repetitive loading tasks. In addition, it remains unclear how this potential altered muscle activation affects performance during other gross movement tasks, such as sport-specific movements of a CMJ, sprinting, or balance ability.

Finally, although the relationship between extraversion and force output during the CMJ was not significant, this CMJ performance measure demonstrated the strongest correlation value (r = .202). In addition, Lukaszewski and Roney [41] demonstrated that isometric physical strength accounted for a significant portion of the variance when predicting extraversion among young men and women university students. Specifically, Lukaszewski and Roney [41] reported a zero-order correlation of r = .17 between extraversion and physical strength among young women. This correlation is similar to the findings in the current study as well. As such, it is possible that the previously identified differences in neuromuscular activation patterns in literature may only influence physical strength (i.e., force output) and not explosive power output as hypothesized in the current study. Therefore, future research should investigated the influence of personality on the expression of force output and the neuromuscular factors associated with it.

4.4. Limitations

This study only examined the relationship between extraversion and CMJ performance among females between the ages of 18-29. Therefore, the results of the current study are not generalizable outside of this sample population and it is possible that a significant relationship may have been identified among a sample population of other age ranges or the male gender. In addition, the small sample size of this study (N = 29) should be taken into account as the achieved statistical power for the four correlations ranged from $1–\beta$ = .063 to $1–\beta$ = .287.

Furthermore, although the Myotest® Sport unit normalizes measures of CMJ performance to bodyweight in an attempt to account for the influence of body mass on vertical jump performance, previous research has suggested this ratio method of normalization may not be the most appropriate method [42]. Specifically, allometric scaling may be a more accurate method of accounting for the influence of body mass on vertical jump performance [18]. Since the Myotest® Sport unit automatically performs these normalization analyses, the allometric scaling method of normalization was not possible, and as such, is a limitation in the current study.

4.5. Future Research

Based on the results of this study, future research should examine the potential relationships between other personality traits that have been linked to athletic performance (e.g. neuroticism) and CMJ performance. Furthermore, since the previous research has predominantly identified relationships between personality and sport performance among elite-level athletes, future research should also examine the relationships between personality traits and CMJ performance among a sample of elite-level athletes. In addition, future research should examine the potential impact of different sources of motivation on the relationship between personality and CMJ performance.

Future research should also investigate the potential relationship between personality and neuromuscular factors such as agonist and antagonist muscle activation during a sport-specific task, such as the CMJ. Finally, although no significant relationship was identified between extraversion and CMJ performance, this potential relationship should be examined among other sport-specific movements, such as sprinting or balance ability. In addition, the potential relationships between personality and the expression of strength is warranted.

5. Conclusions

The results of the current study indicated that extraversion was not significantly related to any of the measures of CMJ performance ($p > .05$). These results suggest that the previously observed relationship between extraversion and athletic performance in the literature may not be due to the ability to generate more physiological power output during the sport-specific task of the CMJ. Rather, athletes who exhibit a high degree of extraversion may utilize different coping skills or motivational sources in order to achieve a greater athletic performance. Furthermore, a different underlying physiological mechanism, or a different sport-related task that potentially explains this previously observed relationship, may still remain unidentified.

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