Effect of spotters on state anxiety and self-confidence during maximal squatting among male high school athletes

Drew Rykert [1], Chad Harris [2], Kent J. Adams [3], Mark DeBeliso [1,*]

[1] *Southern Utah University, Cedar City, UT, USA.*
[2] *Metropolitan State University of Denver, Denver, CO, USA.*
[3] *California State University Monterey Bay, Seaside, CA, USA.*

Abstract. The ideal performance state is manifested by psychological and physiological efficiency. The psychological effects of anxiety and self-confidence has been shown to alter the efficiency of performance. This study attempted to identify the state anxiety and self-confidence of high school athletes just prior to a one repetition maximum (1-RM) back squat and determine if the number of spotters affects an athlete's level of state anxiety and/or self-confidence. Male high school athletes (10th and 11th grades) were randomly separated into two experimental groups who performed the 1-RM back squat (BSQ) with either 1 spotter (1SG: n=52) or 3 spotters (3SG: n=54). Following a dynamic warm-up period and several progressive BSQ warm-up sets, and just prior to attempts at a 1-RM BSQ, the participants completed the revised Competitive State Anxiety Inventory-2 (CSAI-2R). The CSAI-2R included the number of spotters (1 or 3) that would be present during the subsequent 1-RM BSQ attempts. The CSAI-2R is a17-question instrument with three subscales (self-confidence, somatic anxiety, and cognitive anxiety). The subscale scores were compared between the 1SG and 3SG with an independent t-test (alpha≤0.05). None of the subscales (self-confidence, somatic anxiety, and cognitive anxiety) were significantly different between the 1SG and 3SG experimental groups (p>0.05). Within the parameters of this study, the number of spotters present during the execution of the 1-RM BSQ had no practical or statistical impact on self-confidence, somatic anxiety, and cognitive anxiety. Coaches and athletes could use this information in the training environment in order to make best use of personnel (assigned to spotting tasks), physical resources (ex. squat racks), and time management.

Keywords. Cognitive, CSAI-2, somatic, state anxiety.

Introduction

Athletic performance is dependent on a variety of physiological and psychological factors, such as genetics, skill, fitness, arousal and anxiety. Performance can have a high level of variation from event to event, with stable, high level performance being a sign of personal excellence (Brody & Hatfield, 2008). Setbacks can occur in athletic performances due to factors such as more skilled competitors, poor fitness, illness, anxiety, stress, and environmental conditions. When performance in lacking, often one hears the saying "he just didn't play to his potential". Whether it is a bad day, the weather, or a lack of preparation, many athletes simply do not perform at their full skill level often attributing it to "their nerves".

The field of sport psychology looks at how psychological factors affect performance and often sport's psychologists study the impact of state anxiety on the athlete's achievements (Brody & Hatfield, 2008). State anxiety can be described as a subjective feeling of apprehension or tension that makes one feel uncomfortable in a given situation (Statler & DuBois, 2016; Spielberger, 1979). Different than optimal arousal, this anxious state of anticipation elicits both neurological and endocrine responses that often lead to uncertainty or fear, thereby lowering performance (Statler & DuBois, 2016; Spielberger, 1979). Hence, state anxiety includes the components of cognitive and somatic state anxiety (Brody & Hatfield, 2008). Cognitive state anxiety refers to one's negative thoughts or worries that often fluctuate moment to moment (Statler & DuBois, 2016; Weinberg, & Gould, 2014); whereas somatic state anxiety refers to rapid changes in physiological arousal (Statler & DuBois, 2016; Weinberg & Gould, 2014). Overall, when athletes are in an anxious state, both mental and physiological arousal may be somewhat uncontrolled or inefficient leading to tense muscles, rapid heartbeat, negative thoughts, and ultimately poor performance (Statler & DuBois, 2016).

Corresponding Author: M. DeBeliso, e-mail; markdebeliso@suu.edu

In an attempt to explain this relationship, the Inverted-U Theory introduced by Yerkes & Dodson (1908) suggests that performance is enhanced by arousal levels until an optimal level is achieved, beyond that point, higher arousal levels leads to degraded performance. Given the relationship between state anxiety (cognitive & somatic) and arousal, it is important to reduce stressful stimuli that lead to ineffective state anxiety and the associated excessive arousal levels that lead to degraded performance. Hackfort & Schwenkmezger (1989) suggest that the level of stressful stimuli and the athlete's individual subjective response to this competitive stress impacts the intensity and duration of the negative response. However, testing an athlete's stress response during a significant sporting event is nearly impossible (Martens, 1990).

Maximal strength is a key part of many sports and is specifically assessed in competitively in sports such as powerlifting and strongman competitions. In training, maximal strength (i.e., one repetition maximum; 1-RM) testing is routinely used to help develop an individualized exercise prescription, monitor training outcomes, and assess individual abilities (Harman, 2008). Reducing stressful stimuli that lead to ineffective state anxiety is important for athletic competition requiring maximal strength and for the valid assessment of 1-RM in training. Exercise modalities frequently tested include the clean and jerk, power clean, bench press and the back squat (BSQ). Of these exercises the bench press and the BSQ rely upon spotters to ensure safety of the athlete in the event of a failed attempt. This same reliance upon spotters extends to sports such as powerlifting, where athletes attempt maximal attempts in both the bench press and the BSQ. Based upon feedback from practitioners and personal observations, it is presumed that the athlete's ability to rely upon the safety extended via the spotters reduces stressful stimuli that could lead to ineffective state anxiety and poor performance. However, a review of the literature revealed no such studies.

With that said, this study focused upon state anxiety and self-confidence just prior to 1-RM BSQ attempts in the controlled environment of a weight room. The premise of this study was to create a controlled atmosphere in which the stressful stimuli that athletes encounter during 1-RM testing or during competition could be tested. This study assessed the cognitive state and somatic state anxiety as well as self-confidence levels of male high school athletes just prior to a 1-RM BSQ with one or three spotters as measured by the Competitive State Anxiety Inventory-2R (CSAI-2R) (Cox et al., 2003). It was hypothesized that there would be lower self-confidence and higher state anxiety for the participants performing the 1-RM BSQ with one spotter when compared to those whom had three spotters during the 1-RM BSQ.

Methods

Participants

Participants in this study were male student athletes in the 10th and 11th grades who were enrolled in a resistance training (RT) class. During the RT course participants were taught the proper mechanics and form of the BSQ and other exercises such as the bench press and dead lift over the duration of three semesters. Student athletes were asked if they wanted to participate in the study and later volunteered to do so. Authorization by a University Institutional Review Board was obtained before conducting any assessments and participants and their parents signed an informed assent/consent form that had been approved by the same University Institutional Review Board.

Instruments and apparatus

Testing sessions were conducted during a RT class in the weight room of the High School. Equipment employed to conduct the study included: squat racks, 20.45 kg Olympic style barbell, and weighted plates (1.14 – 20.45 kg). The revised Competitive State Anxiety Inventory-2 (CSAI-2R) was used in order to assess the state anxiety and self-confidence of the participants (Cox et al., 2003). The CSAI-2R is a17-question instrument with three subscales (self-confidence, somatic anxiety, and cognitive anxiety). The CSAI-2R has a scoring key for the sub-scales. Somatic anxiety consisted of questions 1, 4, 6, 9, 12, 15, and 17; cognitive anxiety consisted of questions 2, 5, 8, 11, and 14; and self-confidence consisted of questions 3, 7, 10, 13, and 16. Each question was scored via a 4 point Likert system. The following process was required in order to calculate the sub-scale scores. First, the individual question scores (range 1-4 pts/question) for each subscale were added together and divided by the number of questions in the given subscale. The resultant was then multiplied by a factor of 10. Sub-scale scores ranged from 10-40 for each subscale. Higher scores on the subscales are considered indicative of a higher degree of the construct.

Procedures

The study commenced with a briefing session regarding the protocol to be employed and addressed any questions or concerns posed by the participants (see figure 1). Afterwards, age, height and mass were recorded. Next 3-RM BSQ scores were collected and recorded of all of the participants in the manner prescribed by McGuigan (2008). The 3-RM BSQ scores were preceded by the same dynamic warm-up described below.
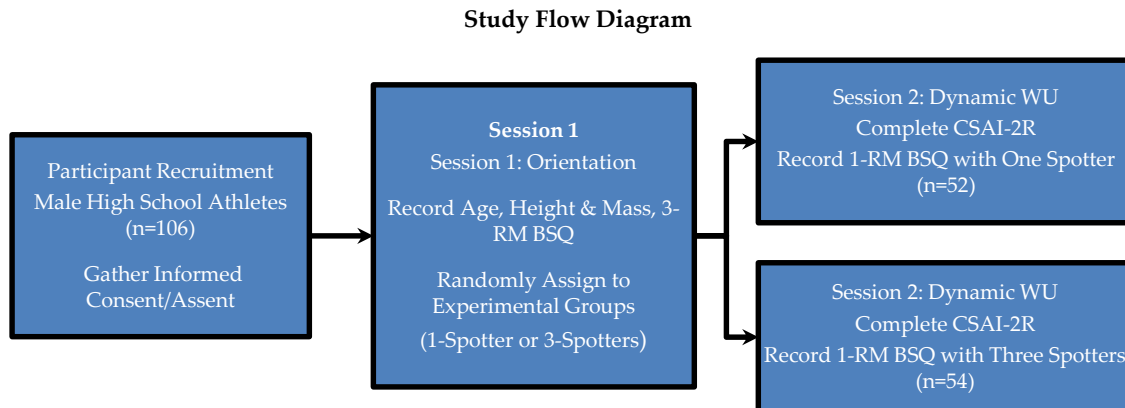
Study Flow Diagram

Figure 1. Study time line of events and procedures. Note: BSQ-back squat, 1-RM-one repetition maximum, CSAI-2R-revised Competitive State Anxiety Inventory-2.

Following the collection of the 3-RM BSQ scores, experimental groups were randomly formed based on rankings on 3-RM BSQ scores. Specifically, the participants with the two highest ranking in 3-RM BSQ scores were randomly assigned to two experimental groups (1SG-one spotter group or 3SG-three spotter group). Next, the participants with the ensuing two highest rankings in 3-RM BSQ scores were again randomly assigned to the two experimental groups. This process continued until all participants were assigned to an experimental group: 1SG (n=52) and 3SG (n=54). This assignment procedure assured that the experimental groups were essentially equal with respect to BSQ strength scores. This group assignment procedure was based on a similar procedure used in the Thompson et al. (2017) study.

The second study session occurred one week following the briefing session. The second session was initiated with a dynamic warm-up consisting of exercises such as high knees, butt kickers, and karaoke (≈10 minutes), noting that no static stretching was allowed. Following the dynamic warm-up period and several progressive BSQ warm-up sets, and just prior to attempts at a 1-RM BSQ, participants completed the revised Competitive State Anxiety Inventory-2 (CSAI-2R). The CSAI-2R included the number of spotters (1 or 3 spotters) that would be present during the subsequent 1-RM BSQ attempts. Participants then completed the CSAI-2R and proceeded to the 1-RM BSQ attempts. Participants were allowed as many as three 1-RM BSQ attempts. The highest BSQ score was recorded (although not considered relevant to the study). The 1-RM BSQ scores were collected in the manner as prescribed by McGuigan (2008). The spotter stood behind the athlete when the 1-RM BSQ attempts required only one spotter. The spotters stood, one behind, and one on

each side of the bar, when the athlete was performing the 1-RM BSQ attempts requiring three spotters. The principal investigator supervised all of the study sessions.

Reliability

The 1-RM BSQ and CSAI-2R were collected during this study. The National Strength and Conditioning Association (NSCA) recognizes 1-RM measures of exercises such as the BSQ to be reliable assessments of muscular strength McGuigan (2008). Reported reliability coefficients of r≥0.90 and ICC≥0.90 suggest that 1-RMs and 3-RMs are highly reliable measures of muscle strength (McCurdy et al., 2004; Tagesson & Kvist, 2007). The CSAI-2R was validated by Cox et al. (2003) who conducted a confirmatory factor analysis using a validation sample of high school and collegiate athletes. The internal reliability coefficients for the subscales of cognitive anxiety, somatic anxiety, and self-confidence were 0.83, 0.88, and 0.91, respectively.

Statistical analysis

The dependent variables (DVs) in this study were the subscales of the CSAI-2R (self-confidence, cognitive anxiety, and somatic anxiety). The DV's were to be compared between two levels of the independent variable of number of spotters (1 spotter vs. 3 spotters). In order to analyze the data, histograms of the DV's were explored for the assumptions of normality and equal variance. If the assumptions of normality and equal variance are met, the DVs will be compared between the experimental groups (1SG, 3SP) with an independent t-test. Where the tests of assumptions of normality and equal variance be in question, a Welch's t-test was employed to compare the DV's between experimental

groups. For the purpose of this study alpha was established *a priori* at $\alpha \leq 0.05$ as the critical value for statistical significance. However, there is a growing lack of agreement surrounding "statistical significance" and replication of study results (Amrhein et al., 2017). Hence, we also discuss the results in terms of a practical applied setting. Data management and statistical calculations were conducted with Microsoft Excel (2013).

Results

High school athletes (n=106) with prior RT experience participated in this study and where randomly assigned to two experimental groups (1SG and 3SG). Table 1 provides participant descriptive information of height, body mass and age. Likewise, Table 1 provides the participant's 1-RM BSQ score and 1-RM BSQ score normalized to body mass. All of the participants completed the study without incident.

After reviewing histograms of the subscale scores, we were concerned that the assumptions of normality and equal variance might be in question, noting that the independent t-test is robust regarding these assumptions McDonald (2014). Hence, additional statistical analyses (Welch's t-test) that accommodate for the aforementioned violation of assumptions were carried out as suggested by McDonald (2014). Table 2 provides the CSAI-2R subscale scores for self-confidence, somatic anxiety, and cognitive anxiety. Table 2 also provides the statistical test summary for the comparisons of the subscales between the experimental groups. There was not a statistical difference between the subscales as assessed for the two experimental groups (p>0.05). There was also not a statistical difference in the 1-RM BSQ and 1-RM BSQ/Body Mass scores between the experimental groups (p>0.05).

Discussion

The purpose of this study was to determine if the number of spotters (1 or 3) in support of an athlete during the execution of a 1-RM BSQ has an impact on measures of state anxiety and self-confidence as measured by the CSAI-2R. Contrary to our research hypothesis, there was no difference in any of the subscale scores (cognitive/somatic anxiety and self-confidence) of the CSAI-2R between conditions (1 or 3 spotters).

The ideal performance state occurs when the athlete is both psychologically and physiologically efficient; this means that the athlete is optimally aroused to effectively perform the task at hand (Brody & Hatfield, 2008). When an athlete experiences ineffective state anxiety or too much arousal, ideal performance may suffer and the unnecessary expenditure of nervous energy may also impact future performances. This degraded level of psychological and physiological efficiency is typically associated with negative (or anxious) anticipation of an event marked by three factors (Statler & DuBois, 2016):

"1. A high degree of ego involvement, in which the athlete may perceive a threat to self-esteem,

2. A perceived discrepancy between one's ability and the demands for athletic success, and

3. A fear of the consequences of failure (such as a loss of approval from teammates, coach, family, or peers)."

Table 1

Participant descriptive information.

Group	N	Height (cm)	Mass (kg)	1-RM BSQ (kg)	1-RM BSQ (kg)/Body Mass
One Spotter	52	175.2±7.5	74.9±14.7	121.4±34.6	1.6±0.5
Three Spotters	54	176.4±7.2	73.6±9.5	125.5±30.7	1.7±0.4

Participant mean and standard deviations for descriptive information (mean ± sd). 1-RM-one repetition maximum, BSQ-back squat.

Table 2

Confidence and anxiety scores.

Group	N	Self Confidence	Cognitive Anxiety	Somatic Anxiety
One Spotter (1SG)	52	30.2±6.1	20.1±5.6	17.0±4.7
Three Spotters (3SG)	54	28.4±6.8	19.0±5.7	16.5±5.1
Independent t-test p-value		0.07	0.16	0.37
Welches t-test p-value		0.14	0.31	0.62

CSAI-2R subscale scores (mean ± SD). No significant differences in subscale scores between groups (p>0.05).

While contemplating the study design we felt that a number of the aforementioned factors would be present in the controlled environment of a weight room of competitive athletes engaging in maximal attempts. Also, we hypothesized that the number of spotters could impact state anxiety and self-confidence. For example, it is difficult to imagine that any athlete would not experience reduced self-confidence and adverse state anxiety if they were required to attempt a 1-RM BSQ with no spotter(s) when not in a power a rack. Hence, we were interested to determine if having three spotters as opposed to one spotter during the execution of the 1-RM BSQ might reduce adverse state anxiety and potentially yield a scenario that approached the ideal performance state. Likewise, given the relationship between arousal and anxiety, we presumed that the added state anxiety of one spotter would place the athlete somewhere to the right of the apex of the inverted-U curve of the arousal performance relationship (Yerkes & Dodson, 1908). Our hypothesis was that the addition of two spotters (total of three spotters) would reduce non-beneficial arousal levels and return the athlete towards the apex of the inverted-U curve of the arousal performance relationship (Yerkes & Dodson, 1908). As mentioned above, the data did not support our notion that additional spotters would lead to a scenario more closely aligned with the ideal performance state.

One potential explanation for the results of this study is that the athletes did not perceive an additional threat while performing the 1-RM BSQ with only one spotter (1SG) when compared to those athletes who were assigned three spotters (3SG). Conversely, it is possible that while there was added levels of ineffective state anxiety and lower self-confidence for those in the 1SG group but that they were performing is what Hanin (1989) refers to as the "individual zones of optimal functioning" (IZOFs). Hanin (1989) contends that optimal performance does not occur at a specific arousal level but that optimal performance occurs within a small arousal window. So, while it may have been possible that there was added levels of ineffective state anxiety and lower self-confidence for those in the 1SG group (but not captured by the CSAI-2R), the participants may have been performing in Hanin's (1989) "IZOFs" or within the arousal window that leads to optimal performance.

Strengths of the current study were the relatively large sample of high school athletes as well as their training status. All of the athletes had at least three semesters of RT classes and the study was conducted at the end of a semester long course of periodized RT leading to the synchronized 1-RM testing of the course and this study. The data collected in the current study (1-RM BSQ and CSAI-2R) appeared relatively consistent with previous research that has assessed the 1-RM BSQ or CSAI-2R in populations of male high school athletes.

For example, the CSAI-2R subscale scores collected in the current study were reasonably close to those reported by Cox et al. (2003) where subscale scores of male high school track and field athletes were 20.5 ± 5.2, 18.4 ± 4.7, and 24.0 ± 4.9 for cognitive anxiety, somatic anxiety, and self-confidence respectively. The slightly higher self-confidence subscale scores reported in the current study are likely due to the controlled environment of the study (weight room) and the lack of a true competitive scenario as in the Cox study (Illinois High School Track and Field State Championship meet). Likewise, the mean 1-RM BSQ scores for both experimental groups in the current study were 121.4 ± 34.6 and 125.5 ± 30.7 kg for the 1SG and 3SG respectively, which is comparable to 40th percentile 1-RM BSQ scores for 14-15 year old male North American football players (Hoffman, 2006). The 1-RM BSQ/body mass ratios for the 1SG and 3SG were 1.6 and 1.7 respectively. Both 1-RM BSQ and 1-RM BSQ/body mass ratios reported in this study were slightly higher than those reported by Todd et al. (2017) of: 1-RM BSQ=107.3kgs and 1-RM BSQ/body mass ratios ranging from 1.45-1.47 for the experimental groups comprised of high school male athletes.

If future research were to be conducted in this area, we would recommend the addition of collegiate level athletes and include both genders. It would also be of interest to determine what the CSAI-2R subscale scores would be if no spotters were present during the 1-RM BSQ attempts (albeit ethically problematic to attain). Further, it would be of interest to determine if athletes with 1-RM BSQs that approach twice or three times body mass would have similar responses (self-confidence & anxiety) to the spotter conditions posed in the current study. Finally, the CSAI-2R attempts to capture state anxiety (somatic and cognitive) and self-confidence just prior competition. Given the advances in wearable biometric technology, it may be possible to capture real time somatic physiologic data (blood pressure, heart rate, body temperature, etc.) during competition.

Conclusions

Within the parameters of this study, the number of spotters present during the execution of the 1-RM BSQ had no practical or statistical impact on self-confidence, somatic anxiety, and cognitive anxiety. Coaches and athletes could use this information in the training environment in order to make best use of personnel (assigned to spotting tasks), physical resources (ex. squat racks), and time management. However, there are times when an athlete will be executing a heavy loaded BSQ which is beyond the capacity of one spotter to safely handle in the event of a missed attempt. In such cases, from a safety standpoint it would be advisable to have three spotters present for the attempt.

Acknowledgment

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