National level sprinter’s competitive anxiety and performance success according to ability level and sex: an observational study with a cross-sectional design

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Abstract

The capacity to cope with pre-competition anxiety is a pre-requisite to high level performance (Lazarus, 2000). The first purpose of this investigation was to analyse the relationship between sprinter’s PCSA dimensions and performance. Additionally, ii) to investigate whether elite sprinter’s cognitive-somatic anxiety response and success rate would differ from those of county level athletes, iii) to observe whether sex and ability level had an influence on sprinters competitive anxiety and iv) to observe anxiety distribution response. Sixty-six high level sprinters volunteered in this study. An hour before taking part in an official race, the athletes completed the Competitive State Anxiety Inventory (CSAI-2R) which measured their pre-race anxiety and self-confidence levels and stated their expected chronometric performance. Results indicated a strong positive cognitive-somatic anxiety correlation ($r = .726$, $p < .01$) among county level sprinters corresponding to a 27% of performance success. By contrast elite level athletes, revealed 42% performance success rate matched by a smaller correlation ($r = .437$, $p <.01$) between the anxiety dimensions. Consequently, controlling the pre-race psychophysiological anxiety response could be favourable to performance. Furthermore, it was revealed an interaction effect of sex and status showing that self-confidence was higher both in elite and county level male athletes compared to elite female athletes ($p < .001$ and $p < .05$ respectively). There were no differences in either cognitive anxiety nor in somatic anxiety among males and female’s starters. Status alone (elite vs county level) had no significant effect on any of the anxiety components nor in self-confidence.

Key Words: Pre-competitive state anxiety (PCSA) – Trait anxiety (TA)– Cognitive anxiety (CA) – Somatic anxiety (SA) – Self-Confidence (SC). Multidimensional anxiety theory (MDAT).
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INTRODUCTION

Considering that the capacity to deal with pre-competition anxiety is a requirement to high standard performance (Lazarus, 2000), it is deemed important to investigate the psycho-physiological anxiety components that characterize a successful effort vs those associating to a less successful one. Anxiety is a negative emotional state associated with worry and activation of the body which has largely been considered as damaging to performance (Jones, 1993; Weinberg and Gould, 2006). Pre-race anxiety in elite sprinters has been scarcely investigated with no data available that can indicate neither pre-competition anxiety nor objectively assess race outcome in relation to anxiety; thus, leaving unanswered whether there is or not a particular anxiety response which might be beneficial to sprinters. This manuscript’s intention is to contribute to such understanding in sprinters by considering anxiety, expected performance and race outcome.

In contrast to anxiety, arousal, reflects a physical activation of the body, which can be associated to either a pleasant or un-pleasant situation (Weinberg and Gould, 2006), thus arousal shall also be used to differentiate the terms accordingly. Anxiety can be quantified in intensity and direction; the first parameter measures the strength of the symptoms which signify the presence of anxiety itself, the second, indicates whether anxiety is interpreted as positive or negative (Jones et al., 1993), this depend on athlete’s own appraisal, (Alpert and Haber, 1960; Cerin, 2003). Cerin (2003) described that while a challenge state (positive anxiety) would allow athletes good functionality, a threat state (negative anxiety) can be detrimental to performance (Cerin, 2003; Jones et al., 1993). In-fact, how athletes view anxiety coupled with their confidence level can be key to good performance (Jones et al., 2009; Mellalieu et al., 2004). The concept of how anxiety is interpreted, was described by Jones et al. (1993) as “directional perception”.

Different dimensions can also be identified within anxiety, each affecting athletes both mentally and physically. As explained by Weinberg and Gould (2007) PCSA (pre-competitive state anxiety) refers to the level of two anxiety dimensions: cognitive anxiety (CA), such as negative thinking or worry, and somatic anxiety (SA),
as physical signs (such as increased heart rate or muscles tension) experienced by athletes before and during competition. While CA is measured by quantifying worries about one’s performance, SA symptoms reflect the activation of the sympathetic system that prepare the body for action; hence SA in terms of arousal is not automatically associated with either enjoyable or unpleasant situations (Weinberg and Gould, 2017). Typically, CA symptoms begins several days or weeks before the event while SA symptoms tend to raise markedly nearer to the start of the race (Bull, 2002). Thus, on competition day, is reasonable that athletes need to tune into their desired physical arousal whilst having to deal with pre-existent worries. It is then understandable that athletes need a high degree of control over both the cognitive processing associated with concerns (Eysenck and Calvo, 1992) and optimal level of physical arousal needed to succeed (Hanin, 1980, 1986); thus, a deliberate physical activation rather than a somatic reaction to worries appears a key element to a successful performance.

The third dimension of PCSA is athlete’s self-confidence (SC), level. SC, which can be described as “one’s belief to control himself and his surrounding environment” has consistently been linked to positive effects upon sports outcome (Woodman and Hardy, 2003). Competitive anxiety has been vastly investigated both adopting monodirectional methods (intensity only) and intensity plus interpretation methods, with conflicting results. The majority of research investigating anxiety in a monodirectional model have typically recorded a negative impact of it upon sports execution in both men and women (e.g., Burton, 1988; Kleine, 1990; Weinberg and Hunt, 1976; Weinberg and Gould, 2017; Soo Lim et al., 2016). Conversely multiple studies examining anxiety in both intensity and direction (anxiety interpretation) indicate that some athletes have the capacity to change worries into positive thoughts that can, in turn, support their physical and mental endeavour (e.g., Hanin, 2007; Hardy and Parfitt, 1991; Mellalieu et al., 2004).

The most relevant research of the past 40 years on pre-competitive state anxiety (PCSA) has chronologically nurtured the ideology of the following theories on anxiety and athletic effort: the Individual Zones of Optimal Functioning model
(IZOF) as applied to anxiety (Hanin, 1980, 1986,) the catastrophe model (Hardy, 1990), the MDAT (multidimensional anxiety theory), (Martens et al., 1990), the directional perception approach (Jones, 1995; Jones and Swain, 1992), the reversal theory (Kerr, 1997) and the mental health model (Raglin, 2001). While it is beyond the purpose of this investigation to analyse the above theories and models it will be briefly introduced the concepts of the MDAT and the IZOF model in the contest of this investigation. The MDAT rationale may provide an answer as whether intensities of cognitive and somatic anxiety symptoms raise or diminish in parallel, according to each other changes in intensity only. The MDAT has attracted interest of multiple research (Burton, 1988; Jones and Hardy, 1989; Smith et al., 1990; Smith et al., 2006) that framed pre-competitive state anxiety in a multidimensional perspective.

Martens et al. (1990) multidimensional concept embedded in the MDAT states both anxiety dimensions positively correlate each other, while both CA and SA negatively correlate with SC. Moreover, while CA directly negatively correlates with effort outcome, SA correlates with performance in an “inverted U shape” as extremes on both end of the curve associate with poor performance and best outcome may-be reached with mid-levels of SA; additionally, performance linearly increases with increase in SC (Martens et al., 1990). The approach of the MDAT is monodirectional with the belief that CA can only be detrimental to performance even with a minimal increase (Jones, 1993). Furthermore, according to an extensive review by Craft et al. (2003) the relationship between CA-SA and SC may-be weak and that the best predictor of performance is SC.

The IZOF Model may instead provide individual outcome explanation, emphasising that each competitor has his/her own zone of anxiety for optimal performance (Hanin, 1980, 1986, 2007). Contrary to the MDAT, within the IZOF model, anxiety direction may play a key part in influencing athlete’s results. For example, raised CA may not automatically be detrimental if interpreted as helpful and fit in within the athlete optimal zone of functioning that exist according to emotions (functional or dysfunctional); it is inside “the zone” that an athlete has the best chance to succeed
in performing optimally (Hanin, 1980, 1986, 2007; Robazza et al., 2008). Major differences between the IZOF model and the MDTA rely on anxiety appraisal and their ideal intensities for optimal effort. According to the MDTA cognitive thoughts are negatively correlated to performance, while the IZOF model explains that optimal outcome can be reached even by athletes with different CA levels. Additionally, in the IZOF concept SA does not need common mid-range values but it varies to meet each athlete’s demands for optimal performance (Hanin, 1980, 1988). The above model has not been empirically explored with respect to sprinters during pre-race warm-up.

The impact of gender and ability level on athlete’s PCSA dimensions has been object of many studies (Fernandes et al., 2013; Jones et al., 1993; Jones et al., 1994; Hanton et al., 2000). The following past research illustrate the theoretical principles of the MDAT. Fernandes et al. (2013) found in a sample of 303 athletes, that in accordance with the MDAT, CA and SA were positively moderately correlated (p<.01), while both anxiety dimensions were negatively correlated with SC; additionally, female athletes displayed higher CA and less SC than male athletes.

Burton (1988) found that while SC exhibited a positive linear trend with effort outcome, CA associated with it negatively; CA accounted for 46% of swimming performance variance and SC for 21% of the variance. Zaccagni et al. (2018) studied between sex psychological traits in competitive sprinters adopting a method in which sprinters needed to re-call their anxiety at the time they obtained their personal best time. They observed that women scored 13% higher than men (p < .05) in CA, while there was no significant difference in SA and SC among gender.

Additionally, within the same study, it was observed a significant inverse correlation between PB and CA (in women only), suggesting that the negative correlation between CA and performance as formulated by MDAT applied (within their study) to females but not to males. As explained by Cazenave et al. (2007) males and females may in-fact react to PCSA differently, thus investigating PCSA dimensions among them can be useful to coaching staff when advising athletes in their race preparation. The SC dimension has been largely investigated in both genders
reporting higher SC in males than in females (Weinberg and Gould, 2017; Kotnic et al., 2012); moreover, SC has been generally considered a potential protector of excessive anxiety (Jones and Anton, 2001). Studies in several sports have reported greater SC in males than in females (e.g., Clifton et al., 1994; Martens et al., 1990); overall, multiple studies (Craft et al., 2003; Weinberg and Gould, 2017; Neil et al., 2012) suggested that highly self-confident athletes (regardless of their sex) can achieve better results than less confident one’s.

Martin and Gill (1991) found a significant positive correlation between SC and distance running best times regardless of gender. Additionally, Hardy (1990) within his “catastrophe theory” suggested that high SC can protect high CA athletes from massive drops in athletic outcome which similarly to the MDAT emphasize the importance of the SC factor. However, in pistol shooting Gould et al. (1987) found a negative relationship between score and SC, indicating that when accuracy was determinant SC may not be a key factor influencing results outcome. Nevertheless, overall, high SC appears to be a main component for a positive competition outcome in several disciplines (Martens et al., 1990).

As explained by Mellalieu and Hall (2004) the combined effect of facilitative CA and high SC are paramount to optimize athletic outcome; they observed that highly self-confident competitors were able maximise their effort by directing anxiety at their own advantage and likely to experience CA as facilitating; their results and conceptualization are in agreement with Alpert and Haber (1960) ideology which stated that anxiety is not always debilitating to performance and with the observation of Jones et al. (1993) which noted that CA did not correlate (neither in intensity or direction) to performance and the only execution predictor was SC. Therefore, it may be beneficial that sprinters experiencing high CA could even use it at their own benefit in disagreement with the MDTA (Martens et al., 1990). Why CA may cause beneficial effects to performance has been further investigated within the TCTSA (theory of challenge and treat states in athletes); this explains that the facilitative interpretation of CA is associated with the release of epinephrine, the lowering of total peripheral resistance and greater anaerobic effort which is the
energy system that sprinters rely upon (Jones et al. 2009). Conversely, high anxiety coupled by low SC has often been linked to general sports performance worsening (Weinberg and Gould, 2017). Hence, hypothetically, high SC sprinters with a facilitative appraisal of CA would be endorsed with the ability to enhance their anaerobic output, consequently sprinting faster.

To some extent, the effect of positive thoughts versus negative ones on sprinting times were explored by Rathshlag and Memmert (2015), who analysed the effects of “self-generated emotions” on recreational sprinters. They found that in the happiness condition the participants run faster than in both the anxiety and neutral conditions; it was hypothesised that the anxiety condition could have been detrimental due to debilitative anxiety which can, as explained by the TCTSA, decrease performance. While on ability level (status) anxiety and competitive experience are generally negatively correlated with elite athletes normally less anxious than novice competitors (Mellalieu et al., 2004). Mahoney and Avener’s (1977) found gymnasts who qualified for the 1976 Olympics tended to use anxiety as facilitative whereas those who made it only to the trials experienced anxiety as debilitating. Jones and Swain (1992) found that elite athletes are also more likely to cope with CA by “transforming” negative thoughts (worries) into positive ones (redirecting debilitative anxiety into facilitative). Therefore, potentially, county level sprinters could display greater negative CA than their elite counterpart. Sport type too can influence PCSA (Fernandes et al., 2013); this notion has been documented by multiple studies, mainly involving accuracy and concentration. Example include archery, Soo Lim et al. (2016); penalty kicks Vine et al. (2011) and golf putting, Murphy and Woolfolk (1987), which all strongly correlated best performance with minimal anxiety within a narrow anxiety distribution on the lower end of the scale. It is reasonable that similarly to combat sport athletes which tend to record an elevated anticipatory response (Cintineo and Arent, 2019), sprinters too may exhibit an analogous effect in terms of an increase in cortisol and epinephrine; such reaction rise state anxiety (Cintineo and Arent, 2019), and associate the “fight or flight” mechanism (Cannon, 1929) which may satisfy the demands of sprinting. More-over, rapid rises of epinephrine level serve the purpose
of meeting the quick demands of ATP for the anaerobic effort involved in dash events (Reilly, 1996). However, while an athlete in the fight mode associates the event to a challenge and produce a rapid release of epinephrine, the athlete in the flight mode tend to produce excessive levels on cortisol which can in turn produce a negative vasoconstriction effect, potentially negatively affecting anaerobic effort (Blascovich and Mendes, 2000). Interestingly, the limited research available indicate that, contrary to males, females maybe unaffected by excessive pre-race cortisol level (Van Paridon et al. 2017), which can impair anaerobic performance (Jones et al., 2009).

In a study by Hanton et al. (2000) both CA and SA intensity did not differ between rifle shooters and rugby players, however the latter perceived both anxiety dimensions to be more helpful to their performance, indicating that the nature of the sport may influence anxiety direction. Sprinting requires high concentration coupled with a high level of anticipatory response (Reilly et al., 1996) therefore, it is of interest to explore whether the distribution of PCSA among sprinters indicate that the athletes exhibit a high anticipatory response (high end of PCSA on overall distribution) or a low response as recorded in accuracy discipline (low end of PCSA and narrow distribution). In this study the potentially beneficial performance effect of managing anxiety dimensions is central, as CA-SA independence is expected to match optimal outcome. It is however important to outline that as explained by Morris et al. (1981) worries (CA) and physical feelings of nervousness (SA) are expected to covary in stressful situations (race day) as they both comprise elements related to the arousal of each, yet, remaining conceptually independent. Hence while the ability to control both anxiety dimensions independently is expected to be observed in successful performance, it is also reasonable that to some extent when observing a group of athletes as a whole (for example containing athletes of different abilities) CA and SA should to some extent associate Morris et al. (1981). To the author’s knowledge, there is no information available investigating national level sprinters anxiety just before racing; therefore, this novel study can provide data linking PCSA to race results.
RATIONALE AND AIM

Overall, theories and studies indicate that performance in athletes is not always a function of PCSA rise. CA can be detrimental (Weinberg and Gould, 2006), however, high SC may allow perceiving CA as positive (re-appraisal), optimising performance. CA by itself may even help performance (Eysenck and Calvo, 1992) and anxiety can also differ substantially between athletes (Hanin, 1980, 1986). Although some covariance is normally observed between cognitive and somatic responses (Morris et al., 1981), the athlete’s ability to control psychophysiological reactions appears paramount as studies have shown that elite athletes are mentally better equipped to use their cognitive resources than less proficient ones in important events, Mahoney and Avener’s (1977). By contrast, as conceptualized by the MDTA (Martens et al., 1990) CA and SA cannot be modulated unless both anxiety dimensions follow a parallel decrease or increase. Four purposes aimed to answer as many research questions within a single study. The first purpose analysed the relationship between CA, SA, SC and performance, answering the research question as whether CA-SA are overall positively correlated. The concept of managing worries and arousal independently, to perform optimally is embedded into the second aim of this investigation which is to answer the research question as whether elite sprinters CA-SA response and success rate would differ from those of county level athletes; furthermore to investigate such response in the other subgroups. The third purpose intended to investigate whether sex and ability level had an influence on sprinters competitive anxiety, thus answering research question three. Lastly, examining PCSA distribution among sex and status served the purpose to acquire a general overview as whether sprinters tend to exhibit a low and narrow anxiety response or high level of PCSA thus answering the fourth research question. The first response is commonly reported in sports requiring absolute concentration (parasympathetic response); the second could indicate a fight or flight response. Finally, considering the studies reviewed it is hypothesised that in the sample as a whole CA and SA anxiety in sprinters are correlated (although, as previously explained this response may not be ideal for their optimal performance). The null hypothesis is that there is no CA-SA correlation in the whole sample of sprinters.
METHODS

Participants

The participants were sixty-six high level sprinters, all officially ranked within British Athletics list (Tables 1 and 2). Thirty-six all competed at a minimum of national level, hence, were selected as “Elite”. These included: two para-Olympic athletes, one para-Olympic gold medallist, one Junior World Gold Medallist, one European Gold Medallist and one member of the 4x100m relay team competed at Doha World Athletics Championship 2019. While thirty of lower ability were classified as “County level” having a minimum of 3 years of competitive experience in sprinting within regional events. The participants were initially seventy-five, nine of whom withdrew from the race after their warm-up, therefore only sixty-six sprinters were selected for this investigation, (Tables 1 and 2).

Table 1 Physical characteristics of the athletes

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age (years)</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All athletes [n66]</td>
<td>22.6 ± 5.0</td>
<td>175.9 ± 7.5</td>
<td>70.5 ± 9.2</td>
</tr>
<tr>
<td>Males [n47]</td>
<td>22.8 ± 5.3</td>
<td>178.5 ± 5.9</td>
<td>74.5 ± 6.6</td>
</tr>
<tr>
<td>Females [n19]</td>
<td>22.3 ± 4.1</td>
<td>169.4 ± 6.8</td>
<td>60.5 ± 7.1</td>
</tr>
</tbody>
</table>

Table 2 Performance standard of all athletes by personal best time

<table>
<thead>
<tr>
<th>Status and race type</th>
<th>N</th>
<th>Fastest [Sec.]</th>
<th>Slowest [Sec.]</th>
<th>Mean [Sec.]</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elite Male 100m</td>
<td>18</td>
<td>10.21</td>
<td>11.18</td>
<td>10.65</td>
<td>.28</td>
</tr>
<tr>
<td>Elite Female 100m</td>
<td>5</td>
<td>11.59</td>
<td>12.60</td>
<td>12.16</td>
<td>.39</td>
</tr>
<tr>
<td>County Males 100m</td>
<td>19</td>
<td>10.81</td>
<td>11.69</td>
<td>11.23</td>
<td>.24</td>
</tr>
<tr>
<td>County Females 100m</td>
<td>3</td>
<td>12.64</td>
<td>13.40</td>
<td>13.00</td>
<td>.38</td>
</tr>
<tr>
<td>Elite male 60m</td>
<td>4</td>
<td>6.76</td>
<td>7.07</td>
<td>6.92</td>
<td>.13</td>
</tr>
<tr>
<td>Elite Female 60m</td>
<td>2</td>
<td>7.53</td>
<td>7.56</td>
<td>7.54</td>
<td>.02</td>
</tr>
<tr>
<td>County Females 60m</td>
<td>6</td>
<td>7.88</td>
<td>8.45</td>
<td>8.22</td>
<td>.24</td>
</tr>
<tr>
<td>Elite Male 60 H</td>
<td>4</td>
<td>7.62</td>
<td>8.15</td>
<td>7.92</td>
<td>.24</td>
</tr>
<tr>
<td>Elite Females 60 H</td>
<td>3</td>
<td>8.32</td>
<td>9.17</td>
<td>8.75</td>
<td>.42</td>
</tr>
<tr>
<td>County Males 60H</td>
<td>2</td>
<td>9.12</td>
<td>9.18</td>
<td>9.15</td>
<td>.04</td>
</tr>
</tbody>
</table>
ETHICS

The investigation took place under strict rules which guaranteed all the participants their safety, full anonymity and privacy; these complied with UK law on data protection legislation (both for adults and under 18), with UK government guidelines and with the four ethical principles of the British Psychological Society which are I) Respect ii) Competence iii) Responsibility iv) Integrity. The study also adapted with the ethical guidelines of the Declaration of Helsinki.

Firstly, all athletes between the age of 16 and 17 were only approached in the presence of parent/legal guardian or coach in spite under both UK and EU law minors from the age of 15 upwards are legally allowed to take part in surveys without parental consent. Secondly, all athletes were given a verbal plain language briefing explaining that the study was voluntary without monetary reward. The briefing included the requirement of the study, the purposes of it, the procedure, how data would be collected and stored and their right to withdraw at any time without providing explanation. Athletes were made aware that the investigation was part of the author Master Thesis in Sports Psychology.

Thirdly, all participants were explained that none of their private data would appear in the study and were informed that Mid-Sweden university staff had access to the general overall data (but not to any private individual information); additionally, participants were explained that in the event the study would be published it would not allow the identification of any individual. Fourth, athletes who agreed were required to fill an informed consent form which also stated their right to withdraw at any time, their guarantee to privacy and confidentiality. Athletes were given the opportunity to ask any questions and these were answered.

Neither the physical nor the emotional safety of the participants was put at risk. Participants were given privacy when filling the questionnaire and their data was kept and stored securely. No personal addresses or phone numbers were required by any of the participants. There was no conflict of interest. Additional information is provided in the appendix.
Observational study design using a cross-sectional design, Polit and Beck (2008).

Figure 1. Data collection and analysis plan of the four purposes single investigation performed.

1. PCSA questionnaire is filled 1h before competing. "Expected" race chronometric time is declared.

2. Post-race time is corrected to "zero wind" condition. A plus/minus time differential is obtained for each athlete.

3. Faster versus slower performers are separated. Athletes are split according to ability level and sex.

4. Percentages of success is calculated according to criteria of faster vs slower performers.

5. Testing for normality, linearity, multicollinearity and homogeneity of variance-covariance matrix for each group and sample as whole.

6. PCSA anxiety & SC score dimensions correlations are obtained. CA-SA observed in relation to success percentages for subgroups as well.

7. The reliability of the dimensions of the CSAI-2R was assessed using Cronbach’s alpha calculation.

8. 3 X2 MANOVA general linear model of analyses is carried out to investigate the effect of sex and status.

9. PCSA distribution is observed

End purpose four

Measures of Status (ability level) and selection criteria

Elite sprinters were classified those athletes competing at National/International standard and/or ranked within the top 100 in the UK either at senior, under 23 or under 18 level. County level sprinters were classified as those senior, under 23 or under 18 athletes competing within regional or local championships and ranked outside the top 100 UK sprinters. Athletes were randomly selected among ability level, aiming to reach an equal number among the two in both status and gender.

Instrument and measure of PCSA

The CSAI-2R inventory (Cox et al., 2003) was chosen to measure three variables: SC, CA and SA; each evaluates an aspect of athlete’s PCSA. The inventory has shown
good validity, reliability, and factorial validity to measure PCSA in athletes (Cox, Martens, and Russell, 2003) and (Cox et al., 2003). The CSAI-2R is a 17-item scale that measures CA (5 items), SA (7 items) and SC (5 items) prior competing. Respondents rate their feelings before competition on a scale anchored by 1 = not at all and 4 = very much so. Examples of the statements are: “I am concerned about losing” and “I am concerned about choking under pressure” (CA); “My body feels tense” and “I feel my stomach sinking” (SA); “I’m confident I can meet the challenge” and “I am confident coming through under pressure” (SC). According to Cox et al (2003) the 3 sub-scales total items scores are ranked as follow: CA from lowest of 5 (no CA at all) to highest of 20 (highest CA); SA from lowest of 7 (no SA at all) to highest of 28 (highest SA) and SC from lowest of 5 (no SC at all) to highest of 20 (highest SC) The results of each sub-scale [ranging from the lower to the upper end] provides an indication of the athlete PCSA before racing (Cox et al., 2003).

**Instrument and measure of chronometric performance**

In addition to the inventory PCSA results, other measures were: a) athlete’s set target (expected race time) b) official race results provided by the British Athletics bulletin c) wind-correction software calculator d) time differential obtained [wind corrected-race result/expected time] E) faster and slower performers (according to whether time-differential was within set arbitrary limits).

**Measure of expected time**

Expected chronometric time was deemed suitable as performance measure rather than absolute final race time. The intent was to minimise results variability due to differences in sprinter’s physical preparation into the season and reflect athlete’s current physical preparation as far as possible.

**Measure of race time**

The competition (under IAAF rules) provided official electronic results. Therefore, measurement accuracy was ensured. However, athletes competed with different wind condition, therefore race times needed to be levelled to zero wind.
Measure of wind condition

Mureika (2001) explained that wind condition can greatly affect outdoor sprints results, therefore, all final times were wind-adjusted according to his formula. All calculations were performed using the automated wind calculator provided.

Measure of successful sprint performance

In order to divide athlete’s performance into “good” or “bad” some studies have split athlete’s results by the median (Jones, 1993). For the purpose of this investigation, it was found appropriate to categorise sprinters results according to meaningful and sport specific chronometric ranges. These fitted the participants own expectations and were deemed reasonable in the context of sprinting. Hence, all athletes were asked their accurate expected performance to 1/100 of sec. accuracy.

However, to set rationally thought parameters which allowed to distinguish between a successful versus an unsuccessful race, the following values were chosen.

A] “Faster performers”, sprinters who run in the 60m flat within .05 sec. (or within .1 sec in the 100m or in the 60m Hurdles) from their expected time.

B] “Slower performers”, sprinters who run in the 60m flat slower than .05 sec. (or slower than .1 sec in the 100m or in the 60m Hurdles). A plus time differential indicated a slower than expected performance while a minus time differential indicated a faster than expected race time (as explained in Table 3).

The rationale for the above parameters is based on the following principles: Firstly, both training sessions and hand-timed races are measured to a 1/10th of sec. accuracy, therefore this limit still provide a commonly used cut-off time; secondly, the shorter 60m flat race required smaller cut-off margins because of a shorter distance. Conversely, in the 60m Hurdles race, .1 sec. cut-off was deemed appropriate as the race is particularly technical compared to the 60m flat. Note; in the rare event that a sprinter failed to be categorised in the “faster performance” values but run within the above described set margins off their personal best time,
he/she was still classified as a “faster performer”, see example of athlete “A” in table three below.

**Table 3** example of how faster versus slower performers analysis was carried out in a sample of 3 of the athletes.

<table>
<thead>
<tr>
<th>Sprinter</th>
<th>PB</th>
<th>EXPECTED</th>
<th>TIME DIFF. sought from PB</th>
<th>RUN</th>
<th>WIND m/sec</th>
<th>CORRECTED TIME</th>
<th>TIME DIFFERENCE FROM &quot;EXPECTED&quot;</th>
<th>TIME DIFFERENCE FROM PB</th>
<th>PERFORMANCE LABEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>A) male</td>
<td>10.25</td>
<td>10.10</td>
<td>0.15</td>
<td>10.28</td>
<td>+0.9</td>
<td>10.34</td>
<td>+ 0.14</td>
<td>+ 0.24</td>
<td>“FASTER”</td>
</tr>
<tr>
<td>B) male</td>
<td>10.71</td>
<td>10.70</td>
<td>0.01</td>
<td>10.80</td>
<td>+2.1</td>
<td>10.93</td>
<td>+ 0.23</td>
<td>+ 0.22</td>
<td>“SLOWER”</td>
</tr>
<tr>
<td>C) female</td>
<td>11.59</td>
<td>11.55</td>
<td>0.05</td>
<td>11.69</td>
<td>-2.7</td>
<td>11.44</td>
<td>- 0.11</td>
<td>- 0.15</td>
<td>“FASTER”</td>
</tr>
</tbody>
</table>

**Procedures**

All athletes were not recruited with previous notice but were asked in person by the investigator if they were willing to voluntarily take part in the study directly on competition day. Hence all data collection was obtained directly at pre-selected athletics venues in official races under IAAF regulation to be part of this single investigation. Race organisers were aware and consentient of the study being carried out. The sprinting meetings where athletes were observed and questionnaire were collected included the “London indoor Games” (January 2019) and various open 100m sprints events at Lee Valley Athletics Centre (also in London, UK) during the summer season 2019.

Beginning two hours before the start of the first heat of each sprint event the athletes were approached by the investigator in the warm-up area of the arena and explained in details the purpose and benefits of study which was part of a Master degree thesis in “Optimal performance for elite athletes” of the investigator himself. All those who volunteered to participate (with no money reward) were given both verbal and written detailed instruction on how to fill the CSAI-2R
questionnaire and the additional forms. Anonymity and confidentiality were guaranteed as explained in the ethical section.

Additionally, to standardise the procedure as much as possible, all athletes were asked to fill the questionnaire one hour before their race starting time; this accommodated also the athlete’s warm-up requirements, so not to distract them near the time they needed to wear spikes and attend the call room area. All forms were then collected before and after the race, as soon as the athletes were ready to hand it in directly to the investigator.

Official race time of each athlete with consequent wind condition (for the outdoor races only) was observed in the “Power of 10” website which is in agreement with UK Athletics to publish the official athlete’s results.

**Data analysis**

To achieve the first and second purposes answering the first two research questions, the CSAI-2R inventory data, expected race time (wind unaffected), race corrected time to zero wind condition were all used to calculate (according to arbitrary set value) performance success percentages. Sprinter’s success was used to investigate whether the athlete’s capacity to reach optimal desired performance was possibly due to their ability to regulate cognitive-physical reactions independently as opposed to Martens et al. (1990) MDTA principle. Particularly, it was observed the amount of CA-SA anxiety correlation that sprinters exhibited according to success in the sample as whole (Page 22) and in sub-groups divided by status and/or sex (Table 4). To achieve the third purpose, answering the third research question, PCSA (in each of its dimension using the CSAI-2R) was investigated according to sex and status. The model was created with the 3 dependent variables measuring PCSA dimension: SC, CA and SA and two independent variables (sex and status) each with two levels (males versus females and elite versus county level). This model also investigated differences due to the interaction effect caused by gender plus status. To achieve the fourth purpose, answering the fourth research question, boxplots according to sex and status were created and assessed by distribution and percentiles. The whole observation for all
four purposes was divided into nine stages (Figure. 1). In the first stage, participants (Tables 1 and 2) filled the CSAI-2R inventory (see appendix) one hour before competing. Additionally they declared their current personal best time (PB); the time (performance) that they were aiming to run unaffected by the wind (expected time accurate to 1/100 of a second); their age and anthropometric features as body weight [kg] and body height (cm) as self-measured which were all recorded (Table 1). In stage two, after competing, all athletes official race results were wind corrected using an automated wind calculator provided by Mureika (2001). Thus, a ± time differential (accurate to 1/100 of a sec.) was obtained for each sprinter (as shown in Table 3) by calculating the difference between their expected time (wind unaffected) and the wind adjusted time (for example: - .34 sec. or + .11 sec. off expected time constituted either a fast or slow time differential data for each athlete). Indoor races did not need to be wind corrected as obtained in an official arena with zero wind condition. In the third stage, sprinters were sub-divided into up to eight different groups (according to faster performers versus slower performers and according to sex and status too); faster versus slower performers were categorised depending to their individual post-race wind-adjusted time differential data. The two main groups (Figure.3) were identified as elite (n = 36) and county level (n = 30). In stage four success percentage were calculated according to status and gender (Table 4). Post-race time differential (plus, equal or minus athlete’s expected time) for the sample as whole (Page 21) and for each sub-group were also presented (Table 4); this served the purpose of clearly indicating how faster or slower sprinters run from their expected time and used to calculate rate of success. In the fifth stage, the dependent variables were tested for outliers, then the premises of normality, linearity, multicollinearity and homogeneity of variance-covariance matrix were analysed. using frequency, scatter plots and Box M test, this process was performed both for each sub-group and for the sample as a whole. In stage six, Pearson correlations testing were used on SPSS to investigate PCSA dimensions in order to evaluate whether CA-SA correlations would be found or not within the selected sample. Furth-more CA-SA correlation coefficients were presented as well as the percentage of race success for each sub-group (Table 4); this allowed to discuss how the CA-SA athlete’s reaction was linked to performance.
In stage seven, the reliability of the dimensions of the CSAI-2R was assessed using Cronbach’s alpha calculation. In stage eight, a 3 X 2 MANOVA general linear model of analyses was deemed appropriate and applied in order to investigate the effect of sex and status (independent variables) upon the 3 dependent PCSA dimensions (SC-CA-SA) among the sprinters. The above model, simultaneously tested whether there were differences among sex and status in SC, CA and SA. Similarly, to the statistical test (to investigate the effects gender and performance level) used by Fernandes et.al (2013). The test was performed in SPSS version 25 with a significance level at 5% (p < .05). Finally, in ninth stage the distribution of all PCSA dimensions was observed (Figures 2 and 3).

RESULTS

Assumption testing

The scores dimensions data from the CSAI-2R were examined for possible typing errors, omitted cases and premises for multivariate analysis both in the sample as whole and in each single sub-groups comparison (elite all vs county level all; male’s elite vs males county level; females elite vs females county level). Data entry errors were all corrected. In the whole sample, the Mahalanobis distance score was recorded as 3.537, which was considerably less < 16.27 (Heckert et al., 2002) indicating that there were no outliers; therefore, the significant results of the Shapiro-Wilk test of normality suggested that the dependent variables are non-normally distributed due to skewness of the data. Similarly, the Mahalanobis distances in the other sub-groups were recorded respectively as 2.955 (elite vs county level); 2.917 (males elite vs males county level) and 2.842 (females elite vs females county level) were also < 16.27 (Heckert et al., 2002); additionally to corroborate that there no outliers Mahalanobis distance values were for each of these groups compared against the Chi Square distribution with the same degrees of freedom, no outliers were found. Matrix scatter plots indicated that the linearity assumptions were met both in the whole sample and in each of the described sub-groups. Neither the premises of normality, linearity and multicollinearity or the premises of variance-covariance matrix were violated in the sample as a whole $[F_{(18,}$
according to the recommendations of Tabachnick and Fidell (2019); nor in any of the sub-groups: Elite vs County level, \(F(6, 27087.416) = 1.912, p > .05\); elite male’s vs county males, \(F(6, 8074.390) = .220, p > .05\); elite female’s vs county level females, \(F(6, 2018.597) = .088, p > .05\). Additionally, multicollinearity test showed that the PCSA sub-components (SC-CA-SA) were correlated but not multicollinear (<.9) within the full sample and in each single of the above sub-group. In the whole sample, the box test equality of covariance Alpha was .195, below the required significance of .001, therefore it was assumed that the covariance matrices of the dependent variables are equal across groups; Levene’s test of equality was carried out in order to test the null hypothesis that the error variance of the dependent variable is equal across the all groups, assumptions were met (sig. >.05) across SC, CA and SA (.764, .357, .230). The internal consistency of the dimensions of the CSAI-2R was calculated through Cronbach’s alpha with all the PCSA dimensions recording above the set normal criteria of .70 (Taber, 2017).

Research question one

Intercorrelations between the CSAI-2R dimensions, (Whole sample, \(n = 66\)).

CA showed a moderate positive correlation with SA \((r = .532, p < .01)\), representing approximately 28.3% common variance; thus, rejecting the null hypothesis stating that overall, in the full sample of athletes CA-SA are not positively correlated. SC revealed a negative correlation with both CA \((r = -.395, p < .01)\), revealing about 15.6% common variance and with SA \((r = -.293, p < .05)\), indicating 8.6% common variance. SC was not correlated either positively or negatively with performance \((- .45)\); neither CA not SA revealed a correlation with performance \((- .37 \text{ and } -.27 \text{ respectively})\). The overall success rate was 35%.
Research question two

Intercorrelations between the CSAI-2R dimensions, (Elite all, n = 36).

CA showed a low/moderate positive correlation with SA (r= .437, p < .01), representing approximately 19.1% of common variance. The time difference achieved was .15 ± .17 sec. from expected time. Success rate = 42%.

Intercorrelations between the CSAI-2R dimensions, (County all, n = 30).

CA showed a strong positive correlation with SA (r= .726, p < .01), representing approximately 52.8% of common variance. The time difference achieved was .29 ± .20 sec. from the expected time. Success rate = 27%.

Table 4. CSAI-2R correlations categorised by sex and status, (other sub-groups).

<table>
<thead>
<tr>
<th></th>
<th>Success Rate</th>
<th>CA-SA</th>
<th>CA-SC</th>
<th>SA-SC</th>
<th>Time diff (Sec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males (n47)</td>
<td>34%</td>
<td>.432**</td>
<td>-.336*</td>
<td>-.284</td>
<td>.21 ± .20</td>
</tr>
<tr>
<td>Females (n19)</td>
<td>32%</td>
<td>.659**</td>
<td>-.406</td>
<td>-.167</td>
<td>.22 ± .21</td>
</tr>
<tr>
<td>Elite M (n26)</td>
<td>50%</td>
<td>.266</td>
<td>-.408*</td>
<td>-.226</td>
<td>.12 ± .20</td>
</tr>
<tr>
<td>Elite F (n10)</td>
<td>20%</td>
<td>.692**</td>
<td>-.341</td>
<td>-.091</td>
<td>.22 ± .17</td>
</tr>
<tr>
<td>County M (n21)</td>
<td>14%</td>
<td>.822**</td>
<td>-.389</td>
<td>-.428</td>
<td>.31 ± .19</td>
</tr>
<tr>
<td>County F (n9)</td>
<td>44%</td>
<td>.588</td>
<td>-.438</td>
<td>-.131</td>
<td>.23 ± .25</td>
</tr>
</tbody>
</table>

** Correlation significant at the .01 level (2 tailed) * Correlation significant at the .05 level (2 tailed).

Research question three

Analysis of the effect of sex on PCSA (Main effect)

When all sprinters where split only by sex there was an overall difference in PCSA, with the only dimension significantly differing being SC greater in males than in females. PCSA distribution by sex are shown on figure 2. Wilks’ Lambda was recorded as .043 therefore we reject that the combination of SC-CA-SA are equal in both sexes. By observing the multivariate-analysis it was verified that the variable sex had a significant effect \[ F (3,60) = 2.879, p=.043; \eta^2 = .126; \lambda =.126 \] on pre-competitive anxiety; Indicating that about 12.6% of the difference in PCSA as a whole was due to sex differences alone. The subsequent univariate analysis (Table 7, appendix) indicated that there was a specific difference in SC between gender,
\[ F (1,66) = 7.966, \ p< .01, \ \eta^2 = .114 \] indicating about 11.4% of variability in SC between sex. There were no significant differences in CA between sex \( F (1,66) = 2.015, \ p = .161, \ \eta^2 = .31 \) indicating that sex accounted for only 3.1% of this dimension difference. Similarly, there was no significant difference in SA \( F (1,66) = 2.508, \ p = .118; \ \eta^2 = .039 \); indicating that only 3.9% of the difference in the somatic dimension of PCSA was due to sex.

**Analyses of the effect of status on PCSA (Main effect)**

The PCSA distribution by status (elite sprinters V county level sprinters) are shown on Figure 3. Simply being an elite or a county level sprinter did not count in the level of any dimension of PCSA the athlete experienced. By observing the multivariate-analysis (Table 7, appendix) it was verified that this variable did not have a significant effect \( F (1,60) = .500, \ p=.684; \ \eta^2 = .024; \ \lambda = .24 \) on pre-competitive anxiety; Indicating that about 2.4% of the difference in PCSA as a whole was due to status differences alone. The subsequent between subject’s (univariate) effects (Table 7, appendix) indicates that there was no difference in SC between status, \( F (1,66) = .358, \ p > .5; \ \eta^2 = .006 \); indicating about .6% of variability in SC between status (Table 7). There were no significant differences in CA between status \( F (1,66) = 1.535, \ p = .220; \ \eta^2 = .24 \) indicating that only about 2.4% in PCSA differences between status was due to CA alone (Table 7). Similarly, there was no significant difference in SA either between status \( F (1,66) = 4.06, \ p = .526; \ \eta^2 = .007 \); indicating that only about .7% of the difference in the somatic dimension of PCSA was due to status differences (Table 7).

**Analysis of the combined effect of sex and status on PCSA**

When all sprinters were categorised by both sex and status there was generally no difference in PCSA as a whole. In-fact, the initial Multivariate analysis indicates a general non-significant effect on the combination of sex and status upon PCSA score \( F (1,66) = 2.288, \ p= .897; \ \eta^2 = .103; \ \lambda = .088 \) on pre-competitive anxiety; Indicating that about 10.3% of the difference in PCSA as a whole was due to the combined effect of sex plus status. The subsequent between subject’s effects analysis (Table 7, appendix) identified a specific significant difference in SC on the
combined sex + status variables, \( F(1,66) = 5.541, p < .05; \eta^2_p = .082 \) indicating that about 8.2% of variability in SC is due to the interaction of sex plus status. A Post-Hoc test identified that elite males SC \((M = 16.8, SD = 2.7)\) were higher than elite female’s \((M = 12.6, SD = 3.1; p < .001)\) but not higher of values recorded by county females \((p >.05)\). Similarly, county level males SC \((M = 15.6, SD = 3.2)\) was higher than elite female’s \((M = 12.6, SD = 3.1, p < .05)\), but no higher of that registered by county females \((M = 15.5 SD = 3.6 p >.5)\).

**Research question four**

*Figure 2. Males V Females PCSA distribution.*

*Figure 3. Elite V County level PCSA distribution.*
DISCUSSION

This four purpose’s single investigation embraced a comprehensive analysis of high-level sprinters PCSA and their race performance. The first purpose presented the relationship between CA, SA, SC and performance within the whole sample. Performance accomplishment rationale was based on athlete’s own expectations using an original and sport specific method. The second purpose investigated whether elite sprinter’s cognitive-somatic anxiety response and success rate would differ from those of county level athletes, multiple groups were also observed according to sex and/or status. The rationale was that an athlete’s independent psycho-physiological anxiety response would correspond to an increased performance success; for example, by allowing sprinters re-appraisal and the use of positive arousal. This response was expected to be prominent in elite athletes. However, as some covariance between worries and physical symptoms is normally overall expected (Morris et al., 1981) and because the whole sample embraced sprinters of considerable different ability level It was hypothesised that in the single, whole sample CA-SA would be positively correlated. Further analysis reached the second purpose by grouping sprinters in elite vs county level and observing their success rate. The third purpose observed whether sex and ability level had an influence on sprinters competitive anxiety. Lastly, the fourth purpose observed if PCSA distribution indicated a strong CA-SA psychophysiological response (mostly orientated towards upper values) or a mild response (characterised by a low anxiety response) of the two anxiety dimensions; the first maybe indicative of a fight or flight response Cannon (1929) while the latter may be likely to suggest a controlled para-sympathetic response mostly observed in accuracy sports such as archery (Robazza et al.,1998). The data for analysis was provided by the CSAI-2R pre-race inventory, the sprinters results expectations and ultimately by the actual wind-corrected chronometric race results. The first purpose results indicate that overall, sprinters anxieties to some significant extent either increase or decrease simultaneously in accordance with Marten’s et al. MDTA theory (1990); therefore, accepting the study hypothesis of a positive CA-SA among the full sample.
This first finding matches those of Fernandes et al. (2013) who also observed a low/moderate CA-SA positive correlation in athletes. Despite confirming the hypothesis of a positive CA-SA correlation, when this anxiety response occurred, as expected, race times tended to worsen. The overall percentage of sprinters success rate indicated that about a third of all competitors were able to meet their expected results.

Importantly, the 28.3% of common variance exhibited between CA and SA indicates that overall, most sprinters could still react independently in SA (or arousal) regardless of cognitive worries or vice-versa. Additionally, as explained by Morris et al. (1981) it is normal that some positive correlation exists between the two symptoms. It was revealed that overall, both CA and SA negatively correlated to SC with moderate to low values, respectively. Hence in total, to some extent confirming three of Martens et al. (1990) MDAT concepts. However, when a high SC sprinter display high SA as helpful (voluntary psyched-up) performance could still benefit (Weinberg and Gould, 2007). SC was not positively correlated with performance, in disagreement both with the results of Burton (1988) and those of Martin and Gill (1991), the latter had found a positive correlation between SC and distance runners racing times. Thus, SC alone may not be a sufficient indicator of how well an athlete can meet his/her performance’s expectation unless it did have a positive influence on anxiety appraisal, hence an indirect impact on race outcome as outlined by past papers (Cerin, 2003; Jones; 1993). Again, within the sample as whole, CA was not negatively correlated to performance contrary to Martens et al. (1990) MDAT and in contrast with the finding of Burton (1988) who recorded a direct negative association between CA and performance. Hence overall sprinters were not negatively affected by it. In general, despite that both anxiety dimensions correlated each other and SC negative correlated to both CA and SA, the anxiety-performance association was not obvious if to be explained by Martens et al. (1990) MDAT which does not explains whether CA may be facilitative to performance and the effects of high versus low SC coupled with individual CA appraisal, Jones (1993).

Within the second purpose, in order to focus on performance accomplishment and practically demonstrate the advantages of an independent psychophysiological
response, the CA-SA reaction versus success rate was analysed in the two largest sub-groups (elite vs county level) plus in further sub-groups totalling eight (Table 4). The general trend was that as CA-SA correlation decreases across the different sub-groups, the rate of performance success observed instead increases; highlighting that the MDAT theory of Martens et al. (1990) did not apply as it did in the group as whole and possibly indicating the presence of optimal vs dysfunctional zones where CA and SA can be independent and deliberately modulated to reach an ideal performance (Robazza et al., 2008).

The strong CA-SA correlation recorded in the full county level group (and county level males only) suggests a marked and un-favourable mono-directional anxiety response of the two dimensions, accompanied by success rates of 27% and 14% respectively. Conversely, the results observed in the full elite group (and male elite only) indicate an independent and advantageous response between the two anxiety dimensions coupled with success rates of 42% and 50% respectively.

Conversely, while elite female sprinters recorded a strong CA-SA correlation (.692) they reached only 20% of performance success; by contrast, county level females registered a lower non sig. CA-SA (.588) coupled with a 44% success rate, clearly indicating that even in female athletes the concept of gaining an advantage by independently controlling each anxiety dimensions applied. Two main reasons might explain why county level female, not elite, exhibited such characteristic of CA-SA independence coupled by a much better success rate. Firstly, and interestingly the latter registered lower SC (although no significant) than their regional level counterpart, secondly, elite females were perhaps unable to cope with the increased demands (higher performance requirements; qualifying for major championships) that they might have placed upon themselves in the form of their “expected results”, thus paying in execution efficiency, Eysenck and Calvo (1992). Additionally, elite females significantly lower SC values compared to elite males one might in part explain their relative “failure” at elite level.

Interestingly, the two sub-groups were CA-SA response was not correlated (elite males and county level females) displayed the two highest rates of performance
success (Table 4). Hence, the considerable difference in sprint performance accomplishment especially between the two main and largest groups demonstrate not only that the method implemented for distinguishing between faster and slower race was successful but it also strongly supports the rationale underpinning the second purpose of this study. The favourable athlete’s psycho-physiological response characterized by a much greater race success may be due for instance to a) an ability to be regulate race physical arousal regardless of their worries (or even vice-versa), (Robazza et al., 2007) b) interpreting either (or both) anxieties as facilitative (Jones, 1993; Jones et al., 1992), c) re-appraising worries into positive thoughts as sustained by the TCTSA (Jones et al., 2009) or d) have used CA to aid performance Eysenck’s and Calvo (1992).

In other sports, for example Jones (1992) found that elite swimmers interpreted both anxiety states as being more facilitative to performance than the non-elite swimmers; it is plausible that the same process could have happened within the two main groups of selected sprinters with elite athletes possibly experiencing anxiety as more facilitative than county level competitors. Swain and Jones (1996) observed that basketball performance could be more closely predicted by anxiety interpretation than anxiety intensity; similarly, the direction of anxiety could explain the differences in county level vs elite sprinters success rate which is supported by their ability to control independently the cognitive-somatic process which may aid outcome (Cerin, 2003; Jones et al., 1993).

While, Hanton and Connaughton (2002) confirmed that although elite performers initially view CA as debilitative, they use cognitive strategies to overcome negative thoughts and change them to positive ones whereas lower level athletes are less able to use such process as effectively. Hence is possible that elite sprinters were generally better than county level sprinters at using cognitive strategies to re-direct their CA into facilitative, again, the better success rate coupled with their ability to manage independently both anxiety dimensions support this rationale. Eysenck’s (1984, 1992) instead explained that athletes may use CA resources to aid performance (but at a cost in efficiency which might affect outcome as task demands increases). Thus, the sprinter ability to independently control worries and
somatic reaction (or vice-versa) appears most valuable to accomplish his/her own expected performance.

In the third purpose of this study comparative analyses indicated that 11.4% of the variance in SC between sprinters is due to sex differences. Moreover, the interaction effect of sex and status showed that both elite males and county level males recorded higher SC than elite females; thus raising the question as whether an increase in SC in the latter group can improve their sprint performance. For example, Burton (1988) found that increased SC corresponded to better long-distance running times. Similarly, is important raising awareness of females SC findings among athletics coaching staff to prevent anxiety related complications; for example, in North America anxiety is an issue of a large scale in the under 24 age group, particularly among female athletes (Patel, 2010). Additionally, as explained by Hardy (1990) high SC athletes in general maybe protected against the catastrophic effects of high CA, hence is important that female athletes retain high SC to avoid excessive worries, this may apply particularly to elite females as shown by their poorer success rate compared to county level females.

Overall, all sprinters regardless of sex, should also be aware that when low SC is coupled with a debilitating interpretation of CA, optimal performance can be impaired, (Jones et al., 1993., Eysenck, 1982). Conversely, studies suggested that high SC athletes tend to view CA as more facilitating than low SC one’s (Malllieu and Hall, 2004). This finding is in agreement with the studies of Clifton et al. (1994) that observed higher SC in male athletes than in female athletes. Sex difference results are also in accordance with the results of Kotnik et al. (2012) who investigated the psychological trait of 56 Olympians taking part at the 2008 Beijing Olympics, which also was noted that males had significantly higher SC than females. Conversely, Zaccagni et al. (2017), observed no differences in SC among competitive sprinters of different sex. Results also indicated that in contrast with the finding of (Mellalieu et al., 2004) both males and females (whether elite or regional sprinters) had all similar CA and SA level; signifying that anxiety intensity does distinguish the profile of the elite or more successful sprinters. Thus, as explained earlier the much higher success rate of the elite group compared to the county level one appears to be
connected with their ability to regulate CA-SA independently. By contrast, Zaccagni et al. (2018) found higher CA intensity in female sprinters than in male sprinters.

Further analysis between sex only indicated that elite sprinters (as whole sample) were not endorsed with greater SC than their less skilful counterpart group; indicating that regional athletes may not need to focus on SC by itself in order to cover a potential gap with higher level performers. A study on football players indicated instead that lower league players were endorsed with greater SC than higher league one’s (Erceg et al., 2013).

The fourth objective observed the PCSA distribution among sex and status groups thus answering the fourth research question. It emerged that the anxiety dimensions did not heavily fall neither into the upper end of the scale in accordance with the fight or flight mechanism (Cannon, 1929) not purely within low values which conversely would signal a para-sympathetic response (Figures 3 and 4).

There was a tendency of low CA and mid-range SA which generally meet the rationale of Martens et al. (1990) on the MDTA. However, the heterogenic results indicated that individual athlete’s PCSA response may differ substantially one from another as typically suggested by the IZOF model (Hanin, 1980). SC levels pointed towards the mid-high end of the scale indicating that the large majority of sprinters (regardless of gender) were moderately or high confident. Additionally, many other variables can influence PCSA dimensions, including: TA, importance of the event and external environment, (Alpert and Haber, 1960; Hanin, 1980; Woods, 2004; Weinberg and Gould, 2017), hence other multiple factors can interact to regulate PCSA. Particularly higher TA athletes are likely to have a significantly higher state anxiety than lower trait anxiety competitors (Martens et al., 1990). Overall, investigating anxiety directions within the IZOF model, which explains the existence of zone of optimal functions according to emotions could be a way forward for further analyses of competitive anxiety in sprinters. Finally, is important to remind the need to meet data-collection ethical challenges of sensitive issues. It was in-fact very important to guarantee and ensuring athletes anonymity, confidentiality and sensitivity as participants were required to disclose personal feelings on very personal matters; this was done adopting a number of measures fully described in
the ethical section. Future studies should always respect ethical values. Further information is provided in the appendix.

**Recommendations – Practical application to coaching and athletes**

Race results coupled by the two distinct psychophysiological responses indicate that sprinters should acquire control in managing both cognitive and physical pre-race symptoms. Robazza et al. (2008) explained that effective coping strategies can promote positive CA interpretation (or re-appraisal) which in turn can help an athlete to tune into an optimal zone of functioning; such mechanism may help to tune into a desired physical arousal state (Table 6) and maybe learned with the help of a certified mental coach or sports psychologist.

Lazarus (1999) explained that coping in athletes is an on-going process, hence any strategies should be part of a constant procedure; which as explained by Robazza et al. (2008) need to include a comprehensive examination of the individual using activation management strategies: behavioural, cognitive and somatic based techniques are most often used (Robazza et al., 2008). Such strategies can moderate both anxiety intensity and direction thus maximising performance. Goal setting, self-talk and imagery are examples of three cognitive restructuring techniques that can change the intensity and the interpretation of anxiety as soon as they manifest (Mellalieu et al. 2006; Hanton and Jones, 1999). Moreover, when imagery and focusing are coupled with muscle relaxation and deep breathing can be used to diminish worries and physical symptoms intensity; while, pep talk and muscle tension can be used to increase self-confidence and muscles activation Robazza et al. (2008). By using such established techniques, the athlete’s aim to manage cognitive and somatic responses as he/she wishes can be met; practical examples (Table 6) describe the pre-race process, there are however long-term coping strategies beyond the scope of this manuscript to be described. Additionally, Folkman (1997) divided coping strategies into two main groups: “problem focused coping” (solving the problem that is causing stress) and “emotion focused coping” (regulating the emotional response). For example, a practical problem of the county level sprinter could be expecting large improvements within a single race
which in turn can place excessive stress to deal with on race day. Hence, setting realistic goals and planning several small steps of improvement over time is important as it may reduce worries associated with the consequences of not meeting unrealistic demands. It is recommended that as part of the process parents and coaching staff are aware of the TA anxiety of the athletes as this by itself can impact on pre-race anxiety (Weinberg and Gould, 2016). Practically, the sprinter experiencing a number of uncomfortable pre-race worries coupled with a number of undesired high intensity physical reactions may need to re-adjust into a better psycho-physical state. Although “better” may be difficult to identify, athlete’s competitive experience coupled with written notes of pre-race symptoms can be an initial step of such process (Bull, 2002). For example, experiencing extreme body tension as a result of worrying of “chocking under pressure” is to avoid, hence using self-talk re-appraisal may be possible. Such process can turn worries into positive thinking thus allowing the athlete to concentrate on deliberate pre-race muscle activation (regardless of the new CA reached) and being in charge of his/her physical state. While body tension may be independently regulated by either muscle relaxation or pep talk to oppose respectively high cognitive worries or an over-relaxed mental state in case the athlete feels to be psyched-up.

Table 5. Proposed techniques as pre-race strategies, Mellalieu et al. (2006).

<table>
<thead>
<tr>
<th>INITIAL UNDESIRED STATE</th>
<th>CHANGE DESIRED</th>
<th>PRE-RACE TECHNIQUE</th>
<th>DESIRED NEW STATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>High worries + high physical symptoms</td>
<td>Reduce worries And/or moderate physical symptoms (Relax face, neck and shoulders)</td>
<td>Cognitive restructuring using Imagery + focusing with muscle relaxation &amp; deep breathing</td>
<td>Increased ability to regulate both CA and SA as athlete wishes</td>
</tr>
<tr>
<td>Low worries + low physical symptoms</td>
<td>Moderate-Increase physical arousal to a comfortable state whilst maintaining low worries yet increasing focus and changing approach</td>
<td>Cognitive restructuring using Self-talk + muscle tension</td>
<td>Increased ability to regulate both CA and SA as athlete wishes</td>
</tr>
<tr>
<td>Low confidence</td>
<td>Increase confidence</td>
<td>Pep-talk -Self-talk</td>
<td>More confident and might be able to use CA as facilitative</td>
</tr>
</tbody>
</table>
STUDY LIMITATION

Participants were unequal in gender distribution, higher in males compared to females. PCSA was examined in intensity only. The selected events were not major championships, therefore PCSA was perhaps overall not evaluated where sprinters were under the most stressful competitive anxiety. However, for some participants competitive pressure might have been higher than for others as some were in pursuing of National/International qualifying times others not. Although the methodology to assess and categorise performance was successful, the cut-off race times sets to distinguish a good vs a slower race were set by the investigator, in the future these could be set by the athlete themselves.

CONCLUSIONS

The considerably greater race success among elite sprinters (as whole) observed in conjunction with a more prominent cognitive-somatic anxiety independence is key to a faster race; it indicates their superior ability to control and regulate their own pre-race worries and the physical responses according to their needs. Thus, coping strategies in sprinters should focus to promote such process. Strategies, especially in elite females need also to be SC orientated. The large PCSA distribution indicated a considerable diversity of anxiety reactions suggesting that the IZOF model where athletes have either optimal or dysfunctional zones (Robazza et al., 2007) could be object of future investigation in this field.

Acknowledgements

A big thank you to all the athletes who volunteered to take part in this study and to my course supervisors Dr. Helen Hanstock and Dr. Handers Flykt for their valuable assistance. Many thanks also to all Mid-Sweden University staff and the Sports Science department for their effort in running this Master degree course. Last but not least I am grateful to my wife Giusy and my daughter Elisa for being patient with me while working on this project.
Appendices/supplementary information

ETHICS (ADDITIONAL INFORMATION)

Safety and full privacy were both considered by the investigator of paramount importance. Physical-safety, was fully ensured by the nature of study itself, as the only requirement of the participants was to fill-out a form in a designed safe area of the athletics arena. At the time that the investigator approached the athletes for the investigation proposal, these had already entered the race by their own will, therefore the investigator had no control over that part of the study, limiting himself to observe the race time. Therefore, none of the athletes, were asked (or had been previously asked) to take part in the race, but only to fill-out the questionnaire should they had already entered to take part in the race. No race entry on the day was allowed by the organisers. Additionally, all races were official, fully supervised and under the protection of St. John’s Ambulance service London. Therefore, physical safety was comprehensively and fully ensured.

Emotional safety was also fully ensured under all aspects. Athletes were initially explained that data collection served the purpose of a master’s research project which might be published. None of the questions in the anxiety questionnaire was deemed to have a high degree of potentially causing an emotional distress to the athletes. Nevertheless, during the verbal briefing all the participants were clearly explained that should they experience any emotional distress/discomfort before (during or even after) completing the questionnaire [or the other form] they were free to withdraw at any time without giving any explanation and their data would be destroyed and safely disposed. None of the athletes seen in distress or clearly appeared that he/she did want to be disturbed prior the race was approached. All athletes, were approached in absolutely, non-aggressive manner, fully taking into account that they were preparing to compete.

Privacy.

Privacy was fully guaranteed to all participants with a number of measures. A first step was to allow each participant who volunteered maximum discretion and privacy when filling the forms was to allow them some distance from other athletes.
Secondly, all collected forms where safely placed into a folder immediately after being returned. Thirdly, none of the participant was allowed to see the questionnaire of others at any point. Fourth, the form did not require athletes to disclose an address, emails were optional in the event that the athletes had asked to be emailed their personal questionnaire result. All private data were kept securely locked and would be automatically destroyed after 6 months. None of the athlete private data was used in the study, only overall data as part of the statistical testing as verbally explained to each participant. No group email was used in responding to athlete’s post-study queries.

**Informed consent form**

All athletes were required to fill an informed consent form. This explained that athletes had been asked a totally voluntary participation without monetary reward. They acknowledged that their data would be used solely for the purpose of the study and otherwise be kept private and confidential. They understood and signed that they agreed as above mentioned that they had also verbally explained each step verbally and had been allowed any question. They also agreed as written in the consent form to withdraw at any point.

**Minors**

Those between 16 to 17 years of age as per UK and EU law were allowed to fill the questionnaire without parental consent. However, those aged 16 and 17 were approached and asked their participation only if accompanied by a parent or legal guardian. The investigator introduced himself to both the athlete and the parent and only after the verbal consent of the latter (and in their presence) explained the full procedure in order to eventually continue any further. No under sixteen was either approached or participated in the study.

**Table 6  CSAI-2R results for whole sample [N75]**

<table>
<thead>
<tr>
<th>variable</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC</td>
<td>75</td>
<td>7</td>
<td>20</td>
<td>15.4</td>
<td>3.1</td>
</tr>
<tr>
<td>CA</td>
<td>75</td>
<td>5</td>
<td>17</td>
<td>8.9</td>
<td>3.0</td>
</tr>
<tr>
<td>SA</td>
<td>75</td>
<td>7</td>
<td>20</td>
<td>12.5</td>
<td>3.2</td>
</tr>
</tbody>
</table>
WIND ADJUSTMENTS

According to the Wind-altitude formula of Mureika (2001) provided with a free automated calculator on the author website link. Formula as below:

\[ t_{0,0} \approx t_{w,H} h^{1.03} - 0.03 \exp(-0.000125 \cdot H)(1 - w \cdot t_{w,H}/100) \]

**Table 7.** Main effects and interaction effects of sex and status upon PCSA dimensions.

<table>
<thead>
<tr>
<th>Dependent variables</th>
<th>Variable</th>
<th>df</th>
<th>F</th>
<th>P</th>
<th>% of effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEX</td>
<td>SC</td>
<td>1-66</td>
<td>7.966</td>
<td>&lt;.05</td>
<td>11.4%</td>
</tr>
<tr>
<td>SEX</td>
<td>CA</td>
<td>1-66</td>
<td>2.015</td>
<td>&gt;.05</td>
<td>3.1%</td>
</tr>
<tr>
<td>SEX</td>
<td>SA</td>
<td>1-66</td>
<td>2.508</td>
<td>&gt;.05</td>
<td>3.9%</td>
</tr>
<tr>
<td>STATUS</td>
<td>SC</td>
<td>1-66</td>
<td>0.358</td>
<td>&gt;.5</td>
<td>0.6%</td>
</tr>
<tr>
<td>STATUS</td>
<td>CA</td>
<td>1-66</td>
<td>1.535</td>
<td>&gt;.05</td>
<td>2.4%</td>
</tr>
<tr>
<td>STATUS</td>
<td>SA</td>
<td>1-66</td>
<td>0.406</td>
<td>&gt;.5</td>
<td>0.7%</td>
</tr>
<tr>
<td>SEX + STATUS</td>
<td>SC</td>
<td>1-66</td>
<td>5.541</td>
<td>&lt;.05</td>
<td>8.2%</td>
</tr>
<tr>
<td>SEX + STATUS</td>
<td>CA</td>
<td>1-66</td>
<td>0.006</td>
<td>&gt;.5</td>
<td>0%</td>
</tr>
<tr>
<td>SEX + STATUS</td>
<td>SA</td>
<td>1-66</td>
<td>0.685</td>
<td>&gt;.05</td>
<td>1.1%</td>
</tr>
</tbody>
</table>

** Correlation significant at the 0.01 level (2 tailed) * Correlation significant at the 0.05 level (2 tailed).
The study:

I am conducting a study to investigate the factors influencing anxiety in sprinters. The results of this study can benefit sprinters to have a better insight of how they react in anxiety before a race. All your private data will be treated confidentially. You can withdraw anytime without giving explanation. ALL ATHLETES TAKING PART WILL RECEIVE THE RESULTS OF THE STUDY.

Free refreshment (drink and snack) for all participants (no monetary reward).

The study requires a number of volunteers taking part in “The London Indoor Games” (27th of January). The study will only take a little of your time and it simply requires filling up a questionnaire on one occasion. The questionnaire takes maximum 5’ minutes to complete; this needs to be filled 60 minutes prior your race. All volunteers need to fulfil the following features:

- Have been taking part in competitive sprint events for a minimum of 3 seasons
- Be totally injury free
- Have been injury free for at least the previous 6 months and have not missed more than 2 weeks of consecutive training for the past 6 months before competing in the designated 2019 indoors. Have a PB in the 60m of minimum 7”.30 (males) and 8”.25 (females).

If interested and for further information PLEASE CONTACT MICHELE BELTRAMO BY EMAIL AT 400amanetta@gmail.com or by calling on: 07484 870 901. I will also explain again how to fill the questionnaire on the day. I will PROVIDE & COLLECT THE FORMS ON COMPETITION DAY and be happy to answer any questions you might have.

THANK YOU FOR YOUR CO-OPERATION.

Michele Beltramo
INFORMED CONSENT FORM

“Factors influencing competitive anxiety in sprinters”

**Purpose of the Study:** To investigate competitive anxiety in sprinters.

**Researcher:** Michele Beltramo [Mid-Sweden University student].

I confirm that I have read and understood this information sheet. I have been verbally explained the study and I had the opportunity to consider the information, ask questions these have been answered satisfactorily.

I understand that my participation is voluntary and that I am free to withdraw at any time without giving reason. The participation is voluntary with no money reward.

I agree that my data will be used for the purpose of the above study and that my personal information will be private and confidential (no name against your results).

I agree to take part voluntarily and to allow the use of my data for the purpose of the study.

**Participant**

<table>
<thead>
<tr>
<th>Name</th>
<th>surname</th>
<th>date</th>
<th>signature</th>
</tr>
</thead>
</table>

**Researcher**

<table>
<thead>
<tr>
<th>Name</th>
<th>surname</th>
<th>date</th>
<th>signature</th>
</tr>
</thead>
</table>
COMPETITIVE STATE ANXIETY INVENTORY – 2R

Directions: A number of statements that athletes have used to describe their feelings before a competition are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you feel right now – at this moment. There are no right or wrong answers. Do not spend too much time on one statement, but choose the answer which describes your feelings right now.

1 = Not at all  2 = Somewhat  3 = Moderately So  4 = Very much so

1. I feel jittery. _________
2. I am concerned that I may not do as well in this competition as I could. _________
3. I feel self-confident. _________
4. My body feels tense. _________
5. I am concerned about losing. _________
6. I feel tense in my stomach. _________
7. I’m confident I can meet the challenge. _________
8. I am concerned about choking under pressure. _________
9. My heart is racing. _________
10. I’m confident about performing well. _________
11. I’m concerned about performing poorly. _________
12. I feel my stomach sinking. _________
13. I’m confident because I mentally picture myself reaching my goal. _________
14. I’m concerned that others will be disappointed with my performance. _________
15. My hands are clammy. _________
16. I’m confident of coming through under pressure. _________
17. My body feels tight. ____________
REFERENCES


Jordet, G., Hartman, E. & Sigmundstad, E (2009). Temporal links to performing under pressure in international soccer penalty shootouts. Psychology of Sport & Exercise. 10(6), 621-627


Taber, K.S. (2017). The use of Cronbach’s Alpha when developing and reporting research instruments in science education. Research in Science Education. 48, 1273-1296.


