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Research paper

Anxiety symptom interpretation: A potential mechanism explaining the cardiorespiratory fitness–anxiety relationship

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ABSTRACT

Background: Higher cardiorespiratory fitness is associated with lower trait anxiety, but research has not examined whether fitness is associated with state anxiety levels and the interpretation of these symptoms. The aim of this paper was to (1) reexamine the association between cardiorespiratory fitness and general anxiety and (2) examine anxiety intensity and perceptions of these symptoms prior to an acute psychological stress task.
Methods: Participants ($N=185$; 81% female; $M_{age}=18.04$, SD = 0.43 years) completed a 10-minute Paced Serial Addition Test. General anxiety was assessed using the anxiety subscale of the Hospital Anxiety Depression Scale. Cognitive and somatic anxiety intensity and perceptions of symptoms was assessed immediately prior to the acute psychological stress task using the Immediate Anxiety Measures Scale. Cardiorespiratory fitness was calculated using a validated standardized formula.
Results: Higher levels of cardiorespiratory fitness were associated with lower levels of general anxiety. Path analysis supported a model whereby perceptions of anxiety symptoms mediated the relationship between cardiorespiratory fitness and levels of anxiety experienced during the stress task; results remained significant after adjusting for general anxiety levels. Specifically, higher levels of cardiorespiratory fitness were positively associated with more positive perceptions of anxiety symptoms and lower levels of state anxiety.
Limitations: A standard formula rather than maximal testing was used to assess cardiorespiratory fitness, self-report questionnaires were used to assess anxiety, and the study was cross-sectional in design.
Conclusions: Results suggest a potential mechanism explaining how cardiorespiratory fitness can reduce anxiety levels.

Physical activity can provide a number of psychological health benefits for people of all ages and is recognized as a key form of preventative medicine. The anxiolytic effects of physical activity are well documented (Penedo and Dahn, 2005; Salmon, 2001; Strohle, 2009). Higher levels of physical activity are related to lower levels of trait anxiety (Tulio De Mello et al., 2013; Salmon, 2001; de Moor et al., 2006) and a more favorable course in patients with anxiety (Boschloo et al., 2014). Exercise interventions that have successfully increased physical fitness have also successfully decreased anxiety levels (Wipfli et al., 2008). Aerobic exercise is established as an effective treatment strategy for anxiety and mood disorders (for reviews see Penedo and Dahn (2005), Salmon (2001), Strohle (2009) and Stonerock et al. (2015)). However, research has yet to comprehensively examine whether cardiorespiratory fitness is related to state anxiety levels in response to a stressful situation such as that experienced by exposure to an acute psychological stress task.

Individuals differ in both the magnitude of anxiety levels and the perceptions of how the anxiety impacts them (i.e., is the anxiety helpful or hurtful). In sport settings, athletes report that the anxiety symptoms they experience (e.g., racing heart, concerns about a situation) can have a facilitative/positive impact on how they approach a stressful or challenging situation (Chamberlain and Hale, 2007; Jones and Swain, 1995; Swain and Jones, 1996). These findings are not restricted to sport, as positive perceptions of anxiety symptoms can also be experienced in an academic setting (Carrier et al., 2014). Consequently, high levels of anxiety are not always negative and the directional perceptions of anxiety (i.e., whether symptoms are perceived as being helpful or hurtful) can be just as important for successful coping in stressful situations (Chamberlain and Hale, 2007; Swain and Jones, 1996).

Anxiety can be classified as cognitive or somatic. Cognitive anxiety refers to the mental component of anxiety and includes negative thoughts, concerns, and worries (Martens et al., 1990;

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Morris et al., 1981). By contrast, somatic anxiety refers to the bodily symptoms and sensations that can be experienced (Martens et al., 1990) such as increases in heart rate, perspiration, and respiration. Exercise elicits sensations reflective of somatic anxiety. It has been suggested that being repeatedly exposed to somatic anxiety symptoms through exercise and physical activity can help individuals become more accustomed to these feelings and sensations and, in turn, make the interpretation of them more positive (de Coverley Veale, 1987). Higher somatic, but not cognitive, symptoms of anxiety predict lower levels of physical activity in patients diagnosed with panic disorder (Tschiedel Belem da Silva et al., 2014).

Studies have demonstrated that anxiety sensitivity – a fear of anxiety and anxiety-related sensations (Taylor, 1999) – can be reduced following repeated exposure to both low-intensity and high-intensity exercise sessions, but this reduction is more rapid in high-intensity exercise (Broman-Fulks et al., 2004). Consequently, higher levels of cardiorespiratory fitness may be associated with less negative interpretations of anxiety symptoms experienced during acute psychological stress as a result of more frequent exposure to analogous symptoms during physical activity. Although anxiety intensity and direction are distinct constructs, more positive perceptions of anxiety are generally associated with lower levels of anxiety intensity (e.g., Hanton et al., 2000; Hanton et al., 2004; Jones and Hanton, 2001; Jones et al., 1993). Therefore, it can be proposed that a relationship between cardiorespiratory fitness and anxiety intensity during an acute stress exposure could be mediated through the interpretation of these symptoms.

The aims of the present study were to (1) replicate previous research showing the inverse association between fitness and general anxiety (e.g., Tulio De Mello et al., 2013); (2) use a standardized laboratory stress task to examine if the association between cardiorespiratory fitness and anxiety could be explained by interpretation of the anxiety symptoms experienced (i.e., if the participants perceive the anxiety to be more positive or negative). It was hypothesized that higher levels of cardiorespiratory fitness would be associated with lower levels of general anxiety. It was also hypothesized that during the acute psychological stress task, higher cardiorespiratory fitness would be associated with lower cognitive and somatic anxiety and more positive perceptions of these symptoms. Given that people who experience more positive perceptions of anxiety symptoms tend to experience lower levels of anxiety (e.g., Hanton et al., 2000; Hanton et al., 2004; Jones and Hanton, 2001; Jones et al., 1993), we predicted that anxiety perceptions would mediate the relationship between cardiorespiratory fitness and cognitive and somatic anxiety intensity experienced during the acute psychological stress task.

1. Methods

1.1. Participants

One-hundred and eighty five participants (female = 150) with a mean age of 18.04 (SD = 0.43) years and body mass index (BMI) of 23.31 (SD = 4.39) kg/m^2 were recruited from high schools in the West Midlands (UK). All participants were in their final year of high school, were non-smokers, had no history of cardiovascular disease, and were free from current immune disorders, acute infections, and chronic illnesses. Participants refrained from exercising and consuming alcohol 12 h and consuming caffeine or food 2 h prior to stress testing. The study was approved by the appropriate ethics committee and all participants and parents, if participants were under 18 years old, provided written informed consent prior to participating in the study. Participants were paid £10 upon completion of the laboratory session.

1.2. Measures

1.2.1. General anxiety

Symptoms of general anxiety were measured using the anxiety subscale of the Hospital Anxiety Depression Scale (HADS; Zigmond and Snaith, 1983). The HADS anxiety subscale consists of 7 items measuring anxiety and is a well-recognized assessment instrument. Example items include "I feel tense or wound up", "I get sudden feelings of panic", "Worrying thoughts go through my mind". Items are scored on a 4-point scale, 0–3; the higher the score, the greater the anxiety. The HADS is recognized as a psychiatric screening device (Herrmann, 1997; Bjelland et al., 2002) and has good concurrent validity (Bramley et al., 1988; Herrmann, 1997). The HADS has acceptable psychometric properties, and good test-retest and internal reliability (Herrmann, 1997; Moorey et al., 1991). The HADS is a valid and reliable measure of general anxiety in an adolescent population (White et al., 1999) and has been extensively used in UK based student populations (e.g., Webb et al., 1996). The HADS demonstrated good reliability in the present study with a Cronbach alpha coefficient of .79.

1.2.2. Cognitive and somatic anxiety intensity and perceptions

Task cognitive and somatic anxiety and the perception of these feelings were assessed using the Immediate Anxiety Measures Scale (IAMS) (Thomas et al., 2002). Participants rate the intensity with which they feel cognitively anxious, somatically anxious, and self-confident (1 = not at all, to 7 = extremely) and whether their cognitive and somatic anxiety and self-confidence is facilitative/positive or debilitative/negative to upcoming performance (−3 = very debilitative/negative, to +3 = very facilitative/positive). The IAMS is a valid and reliable measure (Thomas at al., 2002) frequently used to assess anxiety and confidence immediately prior to exposure to a stress task (Gray et al., 2013; Moore et al., 2012). For the present study cognitive and somatic items were used.

1.2.3. Task evaluation

Following the acute psychological stress task participants indicated how difficult and engaging they found the task. Responses to each item were made on a 7-point scale ranging from 0 *(not at all)* to 6 *(extremely)*.

1.2.4. Fitness

Cardiorespiratory fitness was assessed using a validated formula designed to assess fitness without exercise testing (Jurca et al., 2005; Mailey et al., 2010). This formula has previously been used in adolescent and young adult populations (Ginty et al., 2012; Heaney et al., 2011). For the formula, women were assigned a 0 and men assigned a 1. Resting heart rate (HR) was measured continuously by electrocardiography (ECG) with spot electrodes placed on the lower left rib and the right and left clavicle. Raw ECG data was collected using Spike 2 software at a sampling frequency of 1000 Hz. Each trace was visually inspected for artifacts and using Kubios HRV, a software suite designed for analyzing human heart rate, artifacts were removed. Participants sat quietly for 20 min; the first 10 min were an adaptation phase and the second 10 min were the resting phase. Average resting HR was calculated from inter-beat intervals using Kubios HRV using the full 10 min of resting phase data. Participants were asked to categorize their physical activity levels on a scale from 1–5, where 1 signified inactivity and 5 indicated participation in a brisk exercise for over 3 h per week. These physical activity levels, 1, 2, 3, 4, and 5 were then assigned scores of .00, .32, 1.06, 1.76, and 3.03 respectively (Jurca et al., 2005). Cardiorespiratory fitness in METS was estimated using the following formula, ((gender) × 2.77) − ((age) × 0.10) − ((BMI) × 0.17) − ((resting heart rate) × 0.03) + (physical