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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 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.

Key words: aerobic fitness; anxiety sensitivity; cognitive anxiety; coping; somatic anxiety

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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 & 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, Beem, Stubbe, Boomsma, & de Geus, 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, Rethorst, & Landers, 2008). Aerobic exercise is established as an effective treatment strategy for anxiety and mood disorders (for reviews see Penedo & Dahn, 2005; Salmon, 2001; Strohle, 2009; Stonerock, Hoffman, Smith, & Blumenthal, 2015). However, research has yet to 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 & Hale, 2007; Jones & Swain, 1995; Swain & 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 & Hale, 2007; Swain & 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, Vealy, & Burton, 1990; Morris, Davis, & Hutchings, 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, Jones, & Mullen, 2000; Hanton, Thomas, & Maynard, 2004; Jones & Hanton, 2001; Jones, Swain, & Hardy, 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 & 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.

Methods

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 hours and consuming caffeine or food 2 hours 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.

Measures

General Anxiety. Symptoms of general anxiety were measured using the anxiety subscale of the Hospital Anxiety Depression Scale (HADS; Zigmond & 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; Hermann, 1997). The HADS has acceptable psychometric properties, and good test-retest and internal reliability (Hermann, 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, Ashton, Kelly, & Kamali, 1996). The HADS demonstrated good reliability in the present study with a Cronbach alpha coefficient of .79.

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, Hanton, & Jones, 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, Allsop, & Williams, 2013; Moore, Vine, Wilson, & Freeman, 2012). For the present study cognitive and somatic items were used.

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)*.

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, Phillips, Higgs, Heaney, & Carroll, 2012; Heaney, Ginty, Carroll, & Phillips, 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 minutes; the first 10 minutes were an adaptation phase and the second 10 minutes 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, 3.02, respectively (Jurca et al., 2005). Cardiorespiratory fitness in METS was estimated using the following formula, ((gender) x 2.77) – ((age) x 0.10) – ((BMI) x 0.17) – ((resting heart rate) x 0.03) + (physical activity score) + 18.07 (Jurca et al., 2005).

Acute Psychological Stress Task

Participants completed the Paced Auditory Serial Addition Test (PASAT) (Grownwall, 1977). The test has been shown to demonstrate good test-retest reliability (Ginty, Gianaros, Derbyshire, Phillips, & Carroll, 2013; Willemsen et al., 1997) and to elicit a stress response (Ring, Burns, & Carroll, 2002; Veldhuijzen van Zanten et al., 2004). During the 10-minute stress phase, participants were presented with a series of single-digit numbers by CD recording and were asked to add consecutive single-digit numbers while remembering the most recent number so it could be added to the next number presented. Thus, the task involved attention and memory as well as simple addition. The numbers were presented at increasing speed and participants were required to watch themselves in a mirror and were videotaped so that "body language experts" could assess anxiety levels. Participants were also told they would hear a loud beep if they hesitated or said a wrong answer. In reality, participants were not videotaped and all participants received the same standardized number of noise bursts every 10 numbers.

Procedures

Upon arrival the laboratory, a participant's height and weight were measured. Participants then completed questionnaires assessing demographic information, physical activity levels, and general anxiety levels. Questionnaire completion was separate from the psychological stress testing protocol to prevent any anxiety associated with the task from influencing answers. The ECG electrodes were then attached. Participants then sat quietly for 10-min (adaptation phase), followed by a further formal 10-min resting baseline period, after which participants were read instructions regarding the PASAT and undertook a brief practice to ensure they understood the task. Participants then completed the IAMS followed immediately by the 10-min stress task. On completion of the stress task participants rated task difficulty, as well as their engagement with the task.

Data Reduction and Analysis

A simple correlation was used to examine the relationship between fitness and general anxiety (HADS anxiety score). Mean and standard deviation scores of general anxiety, cognitive and somatic anxiety intensity and perceptions, task difficulty, and task engagement were calculated. Bivariate correlations were computed to examine the relationship between fitness and the anxiety responses to the stress task. Mediation analysis was then conducted using path analysis in the computer package AMOS 16.0 (Arbuckle, 2007). The model's goodness of fit was tested using the chi-squared likelihood statistic ratio (χ^2) (Jöreskog, & Sörbom, 1993). Since a nonsignificant value is rarely obtained in practice, additional fit indices based on Hu and Bentler's recommendations (Hu & Bentler, 1999) were also employed. The standardized root mean square residual (SRMR) (Bentler, 1995) and Root Mean Square Error of Approximation (RMSEA) indicated absolute fit (values of ≤ .08 and .06 respectively representing an adequate fit) (Hu & Bentler, 1999). The Tucker Lewis Index (TLI) and Comparative Fit Index (CFI) reflected incremental fit (values > .90 and > .95 indicating an adequate and excellent model fit respectively) (Hu & Bentler, 1999).

First, we established whether cardiorespiratory fitness was associated with cognitive anxiety intensity and somatic anxiety intensity. Next, a model was tested in which; (a) cardiorespiratory fitness predicted cognitive and somatic anxiety intensity; (b) cardiorespiratory fitness predicted perceptions of cognitive and somatic anxiety symptoms; and (c) perceptions of cognitive and somatic anxiety predicted cognitive and somatic anxiety intensity. To control for task difficulty and task engagement, these variables were entered into the model as predictors of cognitive and somatic anxiety intensity, and perceptions of cognitive and somatic anxiety symptoms. Gender, age, and BMI were not controlled for due to being included in the calculation of our independent variable, cardiorespiratory fitness. Correlations between cognitive and somatic intensity and between cognitive and somatic direction were included in the model due to the strong association between these constructs

(Martens et al., 1990; Jones & Hanton, 2001). Following examination of this model, a second model was examined in which the direct regression paths between cardiorespiratory fitness and cognitive and somatic anxiety intensity were removed. All other aspects of the model remained the same. Fit indices and regression weights were then examined for each model.

Mediation analysis followed Hayes (2013) recommendation of testing for indirect effects. This involved testing the indirect effects of cardiorespiratory fitness that predicted cognitive and somatic anxiety direction (i.e., the mediators) to examine whether they indirectly predicted cognitive and somatic anxiety intensity respectively. Bootstrapping of 2000 samples was used to generate 90% confidence intervals. Standardized regressions and 90% confidence intervals were reported for all significant indirect effects.

To account for the influence of pre-existing differences on general anxiety (HADS anxiety score) sensitivity analyses were run controlling for the effect of general anxiety on the proposed relationship between cardiorespiratory fitness, cognitive and somatic state anxiety intensity, and the perception of these symptoms. The analysis was identical to that described with the exception that general anxiety was added to all models as a predictor of cognitive and somatic anxiety intensity and perceptions of these symptoms.

Results

Descriptive Statistics and Correlations between Cardiorespiratory Fitness and Anxiety

Mean scores for general anxiety (*M* = 9.02, *SD* = 3.78), state anxiety intensity (cognitive: *M* = 3.99, *SD* = 1.37; somatic: *M* = 3.36, *SD* = 1.42), state anxiety perceptions (cognitive: *M* = -0.57, *SD* = 1.30; somatic: *M* = -0.43, *SD* = 1.10), task difficulty (*M* = 4.20, *SD* = 1.04), and task engagement (*M* = 4.09, *SD* = 1.24) demonstrated that participants experienced anxiety prior to the task and they found the task to be challenging and were engaged throughout. Cardiorespiratory fitness correlated negatively with general anxiety, (*r* =

-.22, $p = .004$); higher levels of fitness were associated with lower levels of general anxiety (measured, as indicated, by HADS anxiety score). Likewise, cardiorespiratory fitness correlated negatively with cognitive ($r = -.19$, $p = .015$) and somatic ($r = -.20$, $p = .009$) anxiety intensity; higher levels of fitness were associated with lower levels of cognitive and somatic anxiety. Cardiorespiratory fitness was correlated positively with cognitive ($r = .23$, $p = .003$) and somatic ($r = .20$, $p = .008$) anxiety direction; those who were fitter were more likely to perceive their anxiety as facilitative.

Path Analysis

Cardiorespiratory fitness was significantly associated with cognitive ($\beta = -.17$, $p = .020$) and somatic ($\beta = -.19$, $p = .010$) anxiety intensity. Second, cognitive and somatic anxiety perceptions were added to the model as mediators and regression paths were added from cardiorespiratory fitness to both cognitive and somatic perceptions. Paths were also added from cognitive perceptions to cognitive intensity and from somatic perception to somatic intensity. The results revealed a very good fit to the data, χ^2 (2) = 1.78, $p = .412$, CFI = 1.00, TLI = 1.02, SRMR = .02, RMSEA < .001 (90% CI < 0.01 - 0.15). Cardiorespiratory fitness related positively to cognitive ($p = .004$) and somatic ($p = .011$) anxiety perceptions, which, in turn, were negatively associated with cognitive ($p = .001$) and somatic ($p < .001$) anxiety intensity. Additionally, in this model, cardiorespiratory fitness no longer predicted cognitive ($p = .086$) and somatic ($p = .101$) intensity.

After removing the non-significant paths between cardiorespiratory fitness and cognitive and somatic intensity, the final model still had a good fit to the data, χ^2 (4) = 5.83, $p = .212$, CFI = .99, TLI = .93, SRMR = .04, RMSEA = .05 (90% CI < 0.01 - 0.14). This final model is displayed in Figure 1 with standardized regression weights. Although cardiorespiratory fitness did not directly predict cognitive and somatic intensity when accounting for perception, results identified that there was an indirect effect via anxiety perceptions on both cognitive (β = -.05, *p* = .008, CI = -.11 – -.02), and somatic (β = -.09, *p* = .006, CI = -.15 – -.04) intensity. The model also accounted for self-report task difficulty and engagement. This suggests the relationship between cardiorespiratory fitness and how anxious someone feels about a stressful situation is mediated by both cognitive and somatic anxiety perceptions.

Sensitivity Analysis

When controlling for general anxiety assessed by the HADS, cardiorespiratory fitness was still negatively associated with cognitive (β = -.17, *p* = .020) and somatic (β = -.19, *p* = .010) anxiety intensity. The hypothesized model controlling for the effects of general anxiety revealed a very good fit to the data, χ^2 (2) = 2.19, *p* = .334, CFI = 1.00, TLI = .98, SRMR = .02, RMSEA = .02 (90% CI < 0.01 - 0.16). Similar to the main analysis, cardiorespiratory fitness related positively to cognitive (*p* = .004) and somatic (*p* = .042) anxiety perceptions, which, in turn, were negatively associated with cognitive (*p* = .002) and somatic (*p* < .001) anxiety intensity. Additionally, in this model, cardiorespiratory fitness no longer predicted cognitive (*p* = .143) and somatic (*p* = .203) intensity. Removing the non-significant paths between cardiorespiratory fitness and cognitive and somatic intensity, yielded final model with a good fit to the data, χ^2 (4) = 4.93, *p* = .294, CFI = .99, TLI = .96, SRMR = .03, RMSEA = .04 (90% CI < 0.01 - 0.13). Results revealed an indirect relationship between cardiorespiratory fitness and state anxiety via anxiety perceptions of both cognitive (β = -.04, *p* = .010, CI = -.11 – -.02), and somatic (β = -.05, *p* = .026, CI = -.13 – -.02) anxiety symptoms.

Discussion

This is the first study to our knowledge to specifically examine potential psychological mechanisms through which cardiorespiratory fitness is associated with lower levels of anxiety. The results supported our hypotheses; higher cardiorespiratory fitness was associated with lower levels of trait and state anxiety. Existing research has long promoted the use of physical activity to lower anxiety (Fremont & Craighead, 1987; McAuley, Mihalko, & Bane, 1996; McEntee & Haglin, 1999). Further, higher intensity exercise – requiring greater cardiorespiratory fitness – is more effective at reducing anxiety levels than lower intensity exercise (Steptoe et al., 1989). The present study findings add to anxiety and physical activity literature by showing that greater cardiorespiratory fitness is also related to lower state anxiety experienced during acutely stressful situations. In this context, it is worth noting that most of the stress we experience in everyday life is short-term or acute rather than long-term or chronic.

As hypothesized, whether anxiety symptoms were perceived as facilitative or debilitative accounted for the relationship between higher cardiorespiratory fitness and lower levels of cognitive and somatic anxiety in response to the acute psychological stress task. The association survived adjustment for trait anxiety levels. Those with higher levels of cardiorespiratory perceived their anxiety in response to the acute psychological stress task to be less debilitative. It has been proposed that repeated exposure to physical symptoms resonant of anxiety (e.g., increases in HR and perspiration) as a consequence of physical activity could diminish the fear and negative connotations of such symptoms in other contexts such as stress, and potentially change how anxiety symptoms are interpreted (de Coverley Veale, 1987). Indeed, engagement in more frequent exercise at a higher intensity has been shown to reduce anxiety sensitivity (Broman-Fulks et al., 2004). The present study supports these previous findings in that individuals who display higher levels of physical fitness, likely to be a result of more frequent exposure of higher intensity exercise, tend to perceive more positive perceptions of anxiety symptoms (Broman-Fulks et al., 2004; de Coverley Veale, 1987) and thus felt less anxious. Consequently, it appears that exercise has the capacity to not only reduce anxiety sensitivity, but also help individuals view anxiety symptoms experienced during stressful situations as more facilitative. This could have important implications in developing exercise interventions to reduce anxiety. Exercise that can rapidly increase heart rate and overall cardiorespiratory fitness, such as high intensity exercise, may be most beneficial in reducing anxiety symptoms. Future research should explore the effects of an exercise intervention in reducing anxiety in this population.

Although theory would expect the observed relationship between cardiorespiratory fitness and somatic anxiety symptom interpretation, and somatic anxiety levels, it is interesting to note that a parallel relationship emerged for cognitive anxiety. While this may initially appear surprising given the contention that exercise induces physical symptoms resonant of somatic anxiety, there is research showing that regular physical activity is associated with greater optimism and more positive mood (Kavussanu & McAuley, 1995; Steptoe & Cox, 1988). Therefore, it is possible that such increased optimism may bias an individual to perceive worries and negative concerns about an upcoming stressful situation (i.e., cognitive anxiety) as more facilitative. Future intervention studies should measure things such as optimism pre- and post- intervention.

The current study has a number of strengths. As well as being the first study to assess the relationship between cardiorespiratory fitness and anxiety responses to an actual stressful exposure, measurement of anxiety was extensive. It included not only both cognitive and somatic anxiety, but also a measure of intensity and directional perceptions of these different components. This enabled us to more comprehensively explore the mechanism through which cardiorespiratory fitness relates to anxiety. Additionally, the use of a stressful mental challenge is a reasonable analogue of the sorts of acute stress likely to be experienced by an adolescent population in day-to-day life (e.g., examinations and tests).

The present study is also not without its limitations. Most notably, cardiorespiratory fitness was not assessed by a VO_2 max test, but derived by calculation. However, the algorithm used has been extensively validated against maximal and submaximal exercise tests in different age groups (Jurca et al., 2005, Mailey et al., 2010) and has been used in a number of studies assessing relationships between cardiorespiratory fitness and other outcomes in nonclinical and clinical settings (Alomari et al., 2012; McAuley et al., 2011; Stamatakis et al., 2012).

Secondly, determining causality and the direction of causality in cross-sectional studies is impossible. Future research should examine the changes that occur to anxiety experienced in a stress-evoking situation following a physical activity intervention to increase cardiorespiratory fitness. Specifically, this would confirm whether the relationship between cardiorespiratory fitness and cognitive and somatic anxiety is due to cardiorespiratory fitness as a byproduct of engagement in regular physical activity at a high intensity or whether it is due to dispositional cardiorespiratory fitness. Although it appears that regular physical activity at higher intensities can desensitize individuals to anxiety symptoms and help them see anxiety as more facilitative (Broman-Fulks et al., 2004; de Coverley Veale, 1987), it has been suggested that the psychological and physiological reactions to psychological stress exposures may be related to individuals' aerobic fitness levels at a dispositional level (de Geus et al., 1990).

Third, the participants were adolescents in their final year of school prior to starting university and a substantial number were female. This potentially limits the external validity of the study. Additionally, the mean HADS anxiety score could be interpreted as being relatively high. However, there was a wide range of scores (minimum score = 1, maximum score = 19) and scores were only slightly higher than that of the British adult population (Crawford, Henry, Crombie, & Taylor, 2001). Previous research has shown students tend to have high levels of anxiety (Andrews & Wilding, 2004; Webb, Ashton, Kelly, & Kamali, 1996), suggesting that this is an ideal population to study potential mechanisms and to target when developing anxiolytic interventions.

In conclusion, the present study examined whether cardiorespiratory fitness was associated with cognitive and somatic anxiety intensity and direction in an adolescent population. Perceptions of cognitive and somatic anxiety symptoms mediated the relationship between cardiorespiratory fitness and cognitive and somatic anxiety intensity. Higher cardiorespiratory fitness predicted more facilitative perceptions of anxiety symptoms. This, in turn, was negatively associated with anxiety intensity, an outcome that was obtained for both cognitive and somatic anxiety. These results suggest that engaging in regular physical activity can reduce anxiety symptoms experienced during provocative stressful situations. An exercise intervention study would help confirm that improved cardiorespiratory fitness attenuates state anxiety during stressful situations.

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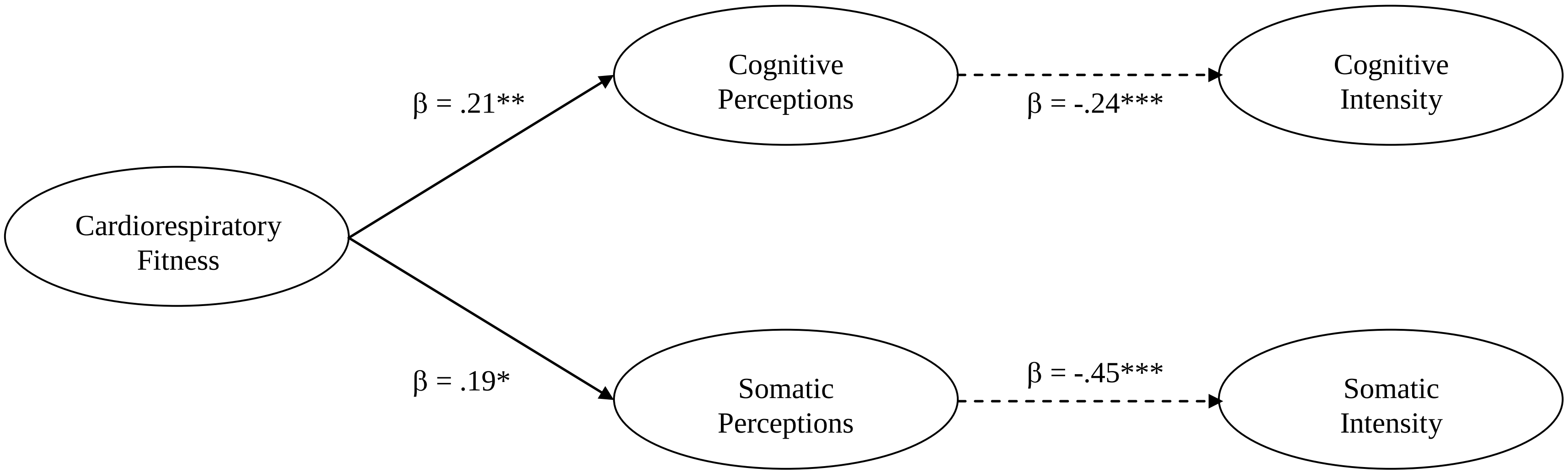
Figure 1. Final mediation model examining cardiorespiratory fitness predicting cognitive and somatic anxiety intensity.



Note: All coefficients are standardized. * $p < .05$, ** $p < .01$, *** $p < .001$. Full lines are positive predictions and dashed lines are negative predictions. For visual simplicity controlling variables body mass index, task difficulty, and task engagement are not presented but were controlled for in the analysis.