DOCTORATE IN CLINICAL PSYCHOLOGY

An Investigation into the Effects of Different Types of Exercise on the Maintenance of Approach Motivation Levels Using a Population Analogous to Individuals with Bipolar Disorder.

LITERATURE REVIEW AND MAJOR RESEARCH PROJECT

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Contents

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A critical review of the literature relating to the behavioural activation system, Bipolar Disorder and exercise.

LITERATURE REVIEW

Intended Journal: Clinical Psychology Review[1]

Word Count: 4000 (excluding footnotes, figures & references)

[1] For instructions for authors, see Appendix A

Contents

Abstract

Research into the benefits of exercise for individuals with Bipolar Disorder (BD) is very limited particularly in relation to hypomania/mania. A majority of research has focused on relieving the symptoms of depression (Blumenthal, & Ong, 2009; Mead et al., 2008; Nahas, & Sheikh, 2011) and hence there are no current guidelines around recommending exercise to individuals during a hypomanic/manic state (NICE, 2006). It has in fact been reported that exercise during a hypomanic/manic state has the potential to be harmful with individuals describing an 'upward spiral' where exercise leads to increased agitation and decreased control (Wright, Armstrong, Taylor, & Dean, 2012)

The Behavioural Activation System (BAS) dysregulation theory (Depue, & Iacono, 1989; Depue, Krauss, & Spoont, 1987) is a popular psycho-bio-social model that attempts to explain the difficulties that individuals with BD experience. It has gained a considerable amount of support (Alloy, & Abramson, 2010; Depue, & Iacono, 1989; Urosevic, Abramson, Harmon-Jones, & Alloy, 2008) and may offer an explanation for the 'upward spiral' reported by a number of individuals with a diagnosis of BD in response to certain types and intensities of exercise (Wright, et al., 2012). This review looks to summarise the literature in these areas.

Keywords: Bipolar Disorder, behavioural activation system, behavioural approach system, approach motivation, exercise.

A critical review of the literature relating to the behavioural activation system, Bipolar Disorder and exercise.

Introduction to the Topic Area

The beneficial effects of exercise on physical health are well researched (WHO, 2010). Furthermore a large amount of research has explored the effects of exercise on mood levels with a number of systematic reviews concluding that exercise can improve depressive symptoms (Blumenthal, & Ong, 2009; Mead et al., 2008; Nahas, & Sheikh, 2011).

Despite these encouraging findings, limited research exists on the effects of exercise for individuals with Bipolar Disorder (BD). A recent systematic review identified a total of 484 articles with only six that quantitatively examined the effects of exercise upon the physical or mental health of individuals with BD (Wright, Everson-Hock, & Taylor, 2009). The current guidelines by the National Institute of Clinical Excellence (NICE) state that there is a "potential for exercise to be both helpful and harmful in mania but there is no research evidence to support either scenario" (*p*. 390, NICE, 2006). This suggests that very little is known and that making recommendations to increase exercise may be potentially harmful during a hypomanic/manic state.

A recent paper qualitatively investigated the relationship between exercise and BD (Wright, Armstrong, Taylor, & Dean, 2012). A number of individuals with a BD diagnosis reported an 'upward spiral' in response to certain types and intensities of exercise. Within the paper, a parallel was drawn between these reports and the behavioural activation system (BAS) dysregulation theory (Depue, & Iacono, 1989; Depue, Krauss, & Spoont, 1987; see Appendix B). It was proposed by Wright et al.

(2012) that certain types and intensities of exercise could act as a possible catalyst for driving individuals with trait BAS sensitivity into an upward spiral. See Figure 1 for an overview.

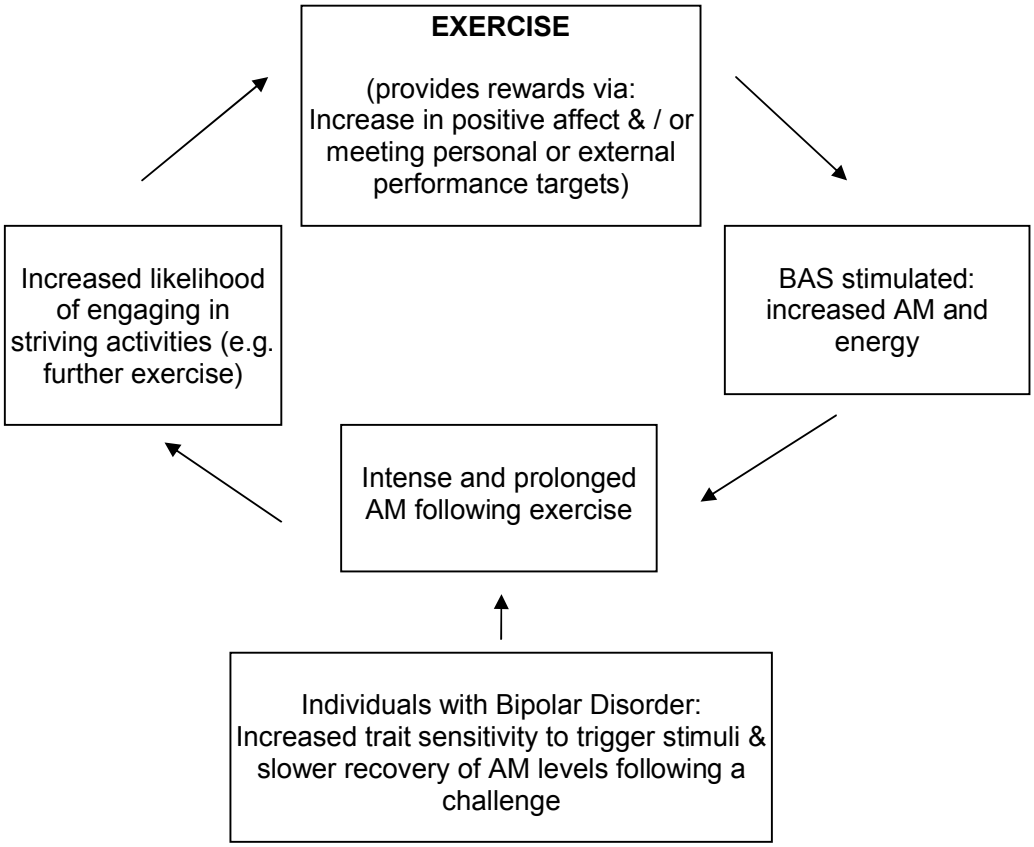

Figure 1. Upward Spiral of Approach Motivation Levels

The BAS dysregulation theory is an integrated model used for understanding the biopsychosocial features of BD (Alloy, & Abramson, 2010). The current review will systematically and critically review the literature around BD, exercise and the BAS dysregulation theory.

Overview of Literature Review[2]

The purpose of this review was to look at the existing literature on exercise, BD, and the BAS dysregulation theory. Although the current literature is limited in the area of exercise and BD, a number of parallels can be taken from the plethora of exercise and affect research. The literature on the BAS dysregulation theory and BD is also extensive.

Rationale for Choice of Topic

This review was important for a number of reasons. Firstly, the existing research literature on BD and exercise is limited and few studies have considered how physical activity may impact on the physical/mental health of individuals with BD (Wright et al., 2009). This suggests that further research needs to be carried out in this area starting with an updated review of the current literature.

Secondly, the current guidelines by the NICE recommend exercise for individuals with BD in relation to treating the depressive phase of the disorder and to treat potential weight gain associated with the side effects of medication. However, the guidelines are ambiguous in relation to the interaction between exercise and acute hypomania/mania stating that "Exercise may be a healthy way of using up the excess energy in a person with mania and a useful distraction. However, exercise might further arouse the body physiologically, increasing energy, social contact and self-efficacy, exacerbating manic symptoms and potentially increasing further cardiovascular strain" (*p*. 390, NICE, 2006).

Finally, the reported findings of Wright et al. (2012) suggest that exercise can have both a calming and an energising effect depending on small distinctions such as the type of exercise engaged in. For example their findings suggest that lower

[2] See Appendix C for further information on the literature search strategy and an overview of the results.

intensity and more rhythmical exercises are more likely to have a calming affect than more intense or less rhythmical exercises. The BAS dysregulation theory is a popular model for explaining the extreme contrasts in mood and behaviour seen in BD. It may also offer an explanation for the different outcomes reported from different activities.

Definition of Key Terms and Concepts

In order to be clear and explicit in the current review the following section will define the key constructs that will be used in the model.

Behavioural activation system/behavioural approach system (BAS). The BAS is a psycho-biological system controlled by the central nervous system that governs approach motivation (AM) and activates behaviour in response to goals and signals of reward or pleasure (Gray, 1987; 1991). Its basic adaptive function is to ensure that organisms obtain resources (e.g. food, shelter, companionship) and is therefore essential to survival of the individual and the species (Watson, Wiese, Vaidya, & Tellegen, 1999). The physiological underpinnings of the BAS are not clear, however it is thought to be regulated by catecholaminergic pathways (Carver, & White, 1994; Gray, 1991). Activation of the BAS causes an increase in an individual's cognitive activity aimed at promoting goal attainment (Depue, & Iacono, 1989).

Approach motivation (AM). AM can be defined as the energization of behaviour by, or the direction of behaviour toward, positive stimuli (objects, events, possibilities) (Elliott, 1999). It is the process involved when a person takes action towards anything that gives them happiness, pleasure, or joy.

Positive and negative affect. The concept of affect incorporates both individual biological predispositions (traits) and transient fluctuations in mood in

response to environmental or internal cues (states). Trait affect is how an individual 'typically' feels every day and state affect is how an individual feels over a short period of time, such as a day or a week (Diener, & Emmons, 1984). Affective responses can also be categorized as having either a negative or positive valence (Barrett, & Russell, 1999). This review focuses more on the concept of state affect because it is interested in the changes that occur in response to exercise.

Positive affect (PA) has been closely linked with the underlying motivational system of the BAS (for reviews see Davidson, & Irwin, 1999; Heller, 1993; Tomarken, & Keener, 1998). Due to the much larger amount of research in this area, this was also included in the review.

Search Strategy

Searches were conducted on Web of Science, SciVerse and PubMed electronic databases using the following search terms: 'bipolar disorder AND exercise', 'bipolar disorder AND behavioural approach system', 'bipolar disorder AND behavioural activation system', bipolar disorder AND approach motivation', exercise AND approach motivation, exercise AND behavioural approach system', 'exercise AND behavioural activation system', 'exercise AND intensity AND affect'. Lemmatization was switched on to allow the search engines to include alternative forms of the search term (for example, tooth and teeth). For searches which revealed more than 500 hits the search term 'bipolar' was added within the results to limit these to the most relevant studies and reviews.

Exclusion and Inclusion Criteria

Articles not written in English have been excluded from the review along with all book chapters. The review did not exclude studies based on demographic characteristics of participants such as age, nationality and ethnicity.

Review of the Theoretical and Research Literature

This review will look to summarise the existing research on exercise and BD. It will then focus on the research around the BAS and BD and then BAS and exercise. Finally it will look at the current research on the BAS and goal striving. In total, 7030 articles were identified: 174 of these had relevant titles and 65 had relevant abstracts and content. There was considerable repetition across the three searches and out of the 65 articles identified, 33 were used for the review.

Exercise as an Intervention with Bipolar Disorder

The research on exercise and BD is extremely limited. Of the six studies identified in the systematic review by Wright et al. (2009), none were adequately-powered RCTs. Furthermore, only two studies reported on the use of physical activity as a therapeutic intervention and both of these had methodological limitations that reduce the generalisability of the findings. For example, the first was an unpublished doctoral dissertation by Edenfield (2007 cited in Barbour, Edenfield, & Blumenthal, 2007) involving eight individuals with a diagnosis of BD I or II. Participants were asked to engage in an Exercise Prescription (EP) involving eight 30 minute walking sessions over a two week period and/or a Standard Behavioural Activation (SBA) condition involving 30 minute sessions of chosen sedentary activity in the place of the walking sessions. Participants were randomised into one of four conditions (EP followed by SBA, SBA followed by EP, EP only or SBA only). The results indicated that regular exercise was associated with an overall decrease in depressive symptoms and decrease or no change in mania symptoms.

A second study (Ng, Dodd, & Berk, 2007) examined the effectiveness of a walking group in an Australian psychiatric unit for 98 individuals with a BD diagnosis. Participants engaged in 40 minutes of exercise at any intensity up to five times per

week. Whilst the two groups did not differ at discharge in clinician ratings of severity or symptom improvement, attendance at the walking group was associated with significantly lower anxiety. Wright and colleagues (2009) concluded the review by reporting that no studies to date had been conducted to examine the effect of physical activity on mania /hypomania.

Following on from this study, Wright et al. (2012) conducted a qualitative study with 25 individuals with a BD diagnosis. From this, three key themes were identified. The first, 'regulating exercise for mood regulation' illustrated how some individuals described using exercise to regulate mood. For example, to lift mood levels if feeling too low or to calm mood if feeling too high. A second theme, 'bringing structure to chaos' described how participants had reported that having a structured exercise program could help to reduce manic symptoms and facilitate clear thinking. This idea of structure was separated into an internal process which encapsulated the inherent structure resulting from exercises that are more rhythmical in nature (i.e. running) and external structure of having a set daily routine.

A third theme, 'exercise as a double-edged sword' resulted from participants reporting that exercise could have both helpful and harmful effects at the same time depending on small distinctions such as mood state at time of the exercise or the type of exercise engaged in.

In another qualitative study of 32 individuals with BD, exercise was a popular self-management strategy identified to maintain or regain wellness. The importance of finding the right type of exercise was highlighted with participants describing a wide variety of activities such as, walking, dance, yoga, snowboarding, and swimming. The location of the exercise was also noted to be important and outdoor activities were often preferred (Suto, Murray, Hale, Amari, & Michalak, 2010).

In a paper by Goodrich and Kilbourne (2010) anecdotal evidence of exercise as a strategy to manage mood symptoms is provided. Exercise is confirmed as an effective strategy to regulate excess energy and to promote normalisation of the circadian rhythm. The authors stressed the importance of further research and encourage other researchers to use the review by Wright et al. (2009) as "a basic blueprint" (*p*. 3) to launch clinical studies that could vastly improve the long-term health of individuals with BD.

Finally, Moore, Wright and Taylor (2011) looked to investigate the exercise/hypomania relationship by asking 60 students, selected to represent a spectrum of trait mood variability to participate in moderate intensity exercise. The results indicated, in line with previous research, that participants experienced a significant increase in positive affect following the exercise. Trait mood variability was found to have no impact on the size of this increase in affect but a significant positive correlation was reported between trait mood variability and the likelihood of engaging in risky exercise behaviour.

The Behavioural Activation System and Bipolar Disorder

The BAS dysregulation theory (Depue, & Iacono, 1989; Depue, et al., 1987) proposes that individuals with BD have a BAS that is overly sensitive. This over sensitivity results in large fluctuations in the activation/deactivation of the BAS which is reflected in the symptoms of BD. When vulnerable individuals experience events involving rewards/goal striving the overly sensitive BAS becomes excessively activated resulting in manic symptoms, such as excessive goal-directed behaviour, increased energy, optimism, and euphoria and a reduction in the need for sleep. (Alloy, & Abramson, 2010; Depue, & Iacono, 1989; Urosevic, Abramson, Harmon-Jones, & Alloy, 2008).

Evidence supporting the BAS dysregulation theory and the idea of trait BAS sensitivity has been provided via three main approaches. The first is through self-report questionnaires looking at individual differences in a particular variable and relating these to future or previous episodes of hypomania/mania. The second has involved the use of self-report measures and the correlation between these and performance on behavioural tasks involving rewards. Finally a third approach has involved the use of electroencephalograms (EEG) in order to look for evidence of a possible correlation between trait BAS sensitivity measured by self report measures and neurological differences.

Studies involving self-report measures. The Behavioural Inhibition System (BIS)/BAS scales (Carver & White, 1994) and the Behavioural Engagement Scale (BES, Krauss, Depue, Arbisi, & Spoont 1992) are the most widely used self-report measures. Using these, BAS hypersensitivity has been reported in individuals with BD I (Meyer, Johnson, & Winters, 2001; Salavert et al., 2007), BD II, cyclothymia (Urosevic et al., 2010), and individuals prone to bipolar symptoms (Carver, & White 1994; Meyer, Johnson, & Carver, 1999). Self-report measures have also been used to predict the onset of hypomanic symptoms over a 17 day period (Meyer, & Hofmann, 2005) and longer periods of six months (Meyer et al., 2001) and 33 months (Alloy et al., 2008). Alloy et al. (2006) found that individuals with higher self-reported BAS sensitivity on the BIS/BAS scale were six times more likely to meet the criteria for a diagnosis of BD (50% vs. 8.3%). Individuals with higher self-reported BAS sensitivity and no prior history of BD were still found to be three times more likely to develop BD in the future in comparison to moderate BAS scorers (15.4% vs. 4.4%; Alloy, & Abramson, 2009).

Studies involving behavioural tasks and self-report measures. A number of studies have demonstrated that individuals with BD exhibited heightened responsiveness to rewards on behavioural tasks. For example, Stern and Berrenberg (1979) examined how hypomania relates to reward responses by providing participants with success feedback. It was found that individuals with a history of hypomania made more internal attributions about their performance and had greater expectations of success on the subsequent task compared to those without a history of hypomania. These results were replicated more recently with current hypomanic symptoms or a lifetime history of hypomania found to be predictive of a greater expectancy of success after reward. It was concluded that the findings offered further support for the idea that the normal tendencies to respond to success by feeling good, expecting further success, and taking on greater challenges are exaggerated amongst individuals with hypomania/mania (Johnson, Ruggero, & Carver, 2005). Other studies have also reported that individuals prone to hypomania/mania exhibit cognitive styles with high BAS relevance such as autonomy, perfectionism (Scott, Stanton, Garland, & Ferrier, 2000), overly ambitious goal striving and goal setting characteristics (Carver & Johnson, 2009; Gruber, & Johnson, 2009; Johnson & Carver, 2006; Johnson et al., 2005; Meyer, & Krumm-Merabet, 2003) and increased cognitive reactions and positive generalisation following successful experiences (Carver, & Johnson, 2009; Eisner, Johnson, & Carver, 2008).

Studies involving electroencephalograms and self-report measures. Studies measuring prefrontal cortical activation using an EEG, in a state of rest and in response to rewards have been consistent with the BAS hypersensitivity model. It has been reported that greater relative left frontal cortical activity reflects higher BAS

sensitivity and activation and hence an increased trait tendency to approach or respond to affectively positive stimuli (Carver, 2004; Coan, & Allen, 2003; 2004; Davidson, Jackson, & Kalin, 2000; Harmon-Jones, & Allen, 1997; 1998; Harmon-Jones, Gable, & Peterson, 2010; Harmon-Jones, & Sigelman, 2000; Sobotka, Davidson, & Senulis, 1992; Sutton, & Davidson, 1997). This is in comparison to greater right frontal activity which is reported to correspond with an increased trait tendency to withdraw or respond more to stimuli of a negative affective nature (Tomarken, Davidson, & Henriques, 1990; Wheeler, Davidson, & Tomarken, 1993).

The research specifically for individuals with a diagnosis of BD is consistent with the findings above with increased right frontal activity reported for individuals during a depressive phase (Allen, Iacono, Depue, & Arbisi, 1993) and increased left frontal activity reported during mania (Kano Nakamura, Matsuoka, Iida, & Nakajima, 1992). It has also been reported that individuals with BD exhibit greater relative left frontal cortical activation in response to difficult but rewarding tasks compared to controls with self-reported hypomanic state being positively related to left frontal activation (Harmon-Jones et al., 2008). Finally, further research has demonstrated that individuals with BD exhibit greater left frontal cortical activity than controls even after controlling for BD symptoms, (Harmon-Jones et al., 2010) or during a resting state (Hayden et al., 2008).

The Behavioural Activation System and Exercise

Only two studies looked specifically at the impact of exercise on the BAS. One study found that high scores on the reward subscale of the BAS scale were positively correlated with enjoyment of exercise, and participants with high BAS scores reported having more positive feelings and higher energetic arousal in response to moderate exercise but not in response to hard exercise. The items on

the reward subscale are designed to assess positive responses to the anticipation of reward, and the results indicate that participants with greater trait sensitivity to cues of impending reward were more likely to report enjoying exercise and were also more likely to experience pleasure during exercise. Within the study, it appears that the impact of negative physiological cues such as shortness of breath or increased heart rate, masked this predisposition to experience positive affect when involved in physical activity at a harder intensity (Schneider, & Graham, 2009). Similar results were found in an earlier study by Hall, Ekkekakis and Petruzzello (2005) where BAS scores were negatively correlated with Rates of Perceived Exertion (RPE) at a moderate intensity but disappeared at higher exercise intensities.

The Behavioural Activation System and Goal Striving

Research into the BAS and goal striving is important because of the goal striving nature of exercise. As well as the documented increases in positive affect (Ekkekakis, Backhouse, Gray, & Lind, 2008), exercise also provides rewards via meeting personal or external performance targets.

A number of studies have reported that life events that involve goal striving/goal attainment that activate the BAS can prospectively predict the onset of hypomanic/manic symptoms. This has been reported over a two-month (Johnson et al., 2000), one-year (Alloy, Abramson, Urosevic, Bender, & Wagner, 2009) and a 27 month period (Johnson et al., 2008). For example, Nusslock, Abramson, Harmon-Jones, Alloy and Hogan, (2007) reported that ten times as many undergraduates with BD studying for and taking an exam developed hypomanic symptoms compared with individuals with BD not taking exams during the same week (42 % vs. 4%). Overall, these findings are consistent with the BAS dysregulation theory which

proposes that individuals with BD are overly sensitive to environmental cues of potential reward.

Review and Critical Appraisal of the Literature

Limitations of the Current Literature

There are a number of limitations that can be identified from the literature.

Limitations of the behavioural activation system literature. As mentioned, the BAS deregulation theory has a lot of empirical support, however, it has been suggested that the model needs greater specificity and revision. Firstly, the model needs to specify the specific nature of the events that are likely to trigger depression/hypomania. Secondly, to specify the nature of the events that are likely to trigger hypomania/mania with an irritable mood as opposed to a euphoric mood. Finally, it must explain why negative events can predict the onset of both hypomanic/manic and depressive episodes (Urosevic et al., 2008).

Limitations of exercise literature. The literature around exercise and mental health seems to have produced a relatively strong evidence base and broadly supports the hypothesis that exercise can improve mental wellbeing (Whitelaw, Swift, Goodwin & Clark, 2008). However, a huge majority of the literature has focussed on the effect of exercise on anxiety and depression and has neglected more serious mental health conditions such as BD (Goodrich, & Kilbourne, 2010). This gap in the literature is surprising given the ambiguous recommendations made by the NICE (2006). In order to make exercise a safe and recommendable treatment for individuals with BD, it is essential that further empirical research is carried out with this population to establish when it can be helpful and when it may be unhelpful.

Limitations of approach motivation literature. It is clear from reviewing the literature that whilst a lot of studies focus on the effect of exercise on positive affect,

there are a very limited number that focus on measuring AM specifically. Although the two are related concepts, within the BAS dysregulation model it is the increase in AM levels that are proposed to be correlated with hypomania/mania and therefore this concept needs to be investigated further. Further to this, no studies exist that have looked at the effects of exercise when people are in a state of high AM which would provide an analogous population to an individual in a hypomanic/manic state. This indicates that there is no empirical evidence, even from the general population, that can provide insight into the effects of exercise during a hypomanic state.

Critique of Methodologies Used

The methodologies used within the literature can be critiqued.

Methodologies used to investigate the BAS. As mentioned previously, research into the BAS has been conducted using three approaches. Reviewing the available literature did not uncover any studies that have used all three. The majority of studies used self-report measures (Alloy, & Abramson, 2009; Alloy et al., 2006; Alloy et al., 2008; Carver, & White 1994; Meyer, & Hofmann, 2005; Meyer et al., 1999; Meyer et al., 2001; Salavert et al., 2007; Urosevic et al., 2010). with some studies using both self-report measures and behavioural tasks (Carver, & Johnson, 2009; Eisner et al., 2008; Johnson, & Carver, 2006; Johnson et al., 2005; Gruber, & Johnson, 2009; Meyer, & Krumm-Merabet, 2003; Scott et al., 2000; Stern, & Berrenberg, 1979) and some using an EEG (Coan, & Allen, 2003; 2004; Davidson et al., 2000; Diego et al., 2001; Harmon-Jones & Allen, 1997; Sobotka et al., 1992; Sutton, & Davidson, 1997; Tomarken et al., 1990; Wheeler et al., 1993).

Methodologies used to investigate exercise and mood. Research into the effect of exercise on individuals with BD is a neglected area and hence critical appraisal of the methodologies used is difficult. However, the relationship between

exercise and affect has received a lot of empirical attention and a plethora of studies exist on this. Therefore a review of the methodologies used for investigating this closely related concept was completed.

Ekkekakis, Parfitt and Petruzzello (2011) provide a comprehensive review of 33 articles published from 1999 to 2009 on the relationship between exercise intensity and affect. All studies involved some type of exercise condition with three involving a sedentary/control condition (Oweis, & Spinks, 2001; Smith, O'Connor, Crabbe, & Dishman, 2002; Tieman, Peacock, Cureton, & Dishman, 2002). All studies involved at least two conditions which differed in intensity but the definitions of low, moderate and high/vigorous (designated heart rates or oxygen uptake rates) varied substantially between the different studies. Sixteen of the studies involved cycling equipment and 17 involved the use of a treadmill for running walking or jogging. All studies incorporate a combination of both self-report measures (such as affect, energetic arousal, anxiety and stress) and psycho-physiological measures (such as heart rate and oxygen uptake).

Conclusions and Clinical Implications

The current review has examined the literature regarding exercise and BD, the BAS and BD, the BAS and exercise and finally the BAS and goal striving. It is clear that strong support exists for the BAS dysregulation theory from studies conducted using a range of designs but this has not yet been extended into the arena of studies that incorporate exercise. Exercise studies have focussed primarily on improving the affect of individuals in clinical and non-clinical settings but have not yet examined the effects of exercise upon hypomanic/manic symptoms.

This review is the starting point in examining the effects of different types and intensities of exercise on individuals prone to hypomania/mania. It has been reported

in two qualitative studies that the type of exercise engaged in is critical (Suto et al., 2009; Wright et al., 2012) as is the intensity of the exercise and an individual's state of mind at the time of the exercise (Wright et al., 2012). Investigating the interaction between exercise and individuals prone to hypomania/mania and using the BAS dysfunctional theory as an overarching model will provide further insight into this neglected but critical area. This could in turn have an impact on any future recommendations made by the NICE because the current guidelines are ambiguous in supporting or opposing the use of exercise as an intervention for BD.

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DOCTORATE IN CLINICAL PSYCHOLOGY

An Investigation into the Effects of Different Types of Exercise on the Maintenance of Approach Motivation Levels Using a Population Analogous to Individuals with Bipolar Disorder.

MAJOR RESEARCH PROJECT

Intended Journal: International Journal of Sport and Exercise Psychology [3]

Word Count: Abstract: 265; Major Research Project: 7998 (excluding tables, figures and references)

[3] For instructions for authors, see Appendix D

Contents

Abstract

Background

Research into the benefits of exercise for individuals with Bipolar Disorder (BD) is limited and no current guidelines exist around recommending exercise during a hypomanic/manic state. The Behavioural Activation System (BAS) dysregulation theory is a popular model that attempts to explain the link between approach motivation (AM) and the difficulties that individuals with BD experience. It may offer an explanation for the 'upward spiral' reported by individuals with a diagnosis of BD in response to certain types and intensities of exercise. This study looked to investigate the impact of different intensities of exercise on the maintenance of AM levels. The presence of hypomanic traits and how these interacted between AM and exercise was also of interest.

Method

Participants filled out an online pre-screening questionnaire identifying hypomanic traits. 61 then completed a computer task designed to induce higher levels of AM before taking part in one of three 15 minute activities (sedentary, moderate exercise or vigorous exercise). Various measures linked to hypomanic symptoms were taken during testing.

Results

The main findings indicated that vigorous exercise significantly increased individuals AM levels in comparison to moderate or no exercise. This relationship was not however found to be moderated by the presence of hypomanic traits.

Conclusions

Vigorous exercise seems to have a greater impact on AM levels regardless of an individual's levels of hypomanic traits. This has implications in terms of the type of

exercise should engage in when experiencing hypomania. Any recommendations however within this study should be taken in light of the limitations identified. Further research replicating these results with a larger sample or using a BD population are recommended.

Keywords: Bipolar Disorder, behavioural activation system, behavioural approach system, approach motivation, exercise.

An Investigation into the Effects of Different Types of Exercise on the Maintenance of Approach Motivation Levels Using a Population Analogous to Individuals with Bipolar Disorder.

The beneficial effects of exercise on physical health are well established (WHO, 2010 and a number of systematic reviews suggest that exercise can improve depressive symptoms (Blumenthal, & Ong, 2009; Nahas, & Sheikh, 2011). For example, a recent Cochrane review of 25 randomised controlled trials (RCT'S) involving 1505 patients diagnosed with Major Depressive Disorder (MDD) reported a large clinical effect (d=-0.82; Mead et al., 2008).

Despite these encouraging findings, limited research exists on the effects of exercise for individuals with Bipolar Disorder (BD). This was highlighted in a recent systematic review that incorporated a number of electronic databases from inception to January 2009. Of the 484 articles retrieved, only six studies were identified that looked quantitatively at the effects of exercise upon the physical or mental health of individuals with Bipolar Disorder, and of these, none were adequately-powered RCT's (Wright, Everson-Hock, & Taylor, 2009).

The current guidelines by the National Institute of Clinical Excellence (NICE) state that effective simple treatments for depression can play a useful role in treating BD because depressive symptoms are present in around one third of the individuals (Judd et al., 2002). Therefore, exercise is recommended on this basis and in relation to weight gain associated with the side effects of medication (NICE, 2006).

Very little is known however, about the interaction between exercise and acute hypomania or mania. Mania, is defined by a distinct period of elevated mood, accompanied by symptoms such as increased psychomotor activity, decreased need

for sleep, increased self-confidence, pressured speech, racing thoughts and the pursuit of pleasurable activities regardless of the potential risks (American Psychiatric Association, 2011). NICE states that there is a "potential for exercise to be both helpful and harmful in mania but there is no research evidence to support either scenario" (*p*. 390, NICE, 2006). This clearly suggests that very little in known and that making recommendations to increase exercise may be potentially harmful for individuals during a hypomanic/manic state.

A recent qualitative paper by Wright, Armstrong, Taylor, and Dean (2011) involved a semi structured interview with 25 individuals with a diagnosis of BD. From this, experiences and opinions were reported of both the positive and negative effects of exercise and three key themes were identified. The first, 'regulating exercise for mood regulation' illustrated how a number of individuals described using exercise to regulate mood. For example, to lift mood levels if feeling too low or to calm mood if feeling too high.

A second theme, 'bringing structure to chaos' described how a number of participants had reported that having a structured exercise program could help to reduce manic symptoms and facilitate clear thinking. This idea of structure was separated into an internal process which encapsulated the inherent structure resulting from exercises that are more rhythmical in nature (i.e. running, swimming etc.) and external structure of having a daily routine to follow.

A third theme, 'exercise as a double-edged sword' alluded to the fact that exercise had was reported to have both helpful and harmful effects depending on small distinctions such as mood state at time of the exercise or the type of exercise engaged in. The possibility of an 'upward spiral' was reported in which the onset of

manic symptoms lead to an increase in the amount or intensity of the exercise which in turn exacerbates symptoms further.

This concept of an upward spiral through the interaction of physiological activation and behaviour resulting in a manic episode is a very similar concept to the Behavioural Activation System (BAS) dysregulation theory (Depue, & Iacono, 1989; Depue, Krauss, & Spoont, 1987). See Appendix B for an overview of the model.

The BAS is proposed to be an internal structure that governs approach motivation (AM) (Gray, 1987). AM can be defined as the energization of behaviour by, or the direction of behaviour toward, positive stimuli (objects, events, possibilities) (Elliott, 1999). It is the process involved when a person takes action towards anything that gives them happiness, pleasure, or joy. Its basic adaptive function is to ensure that organisms obtain resources (e.g. food, shelter, companionship) and is therefore essential to survival of the individual and the species (Watson, Wiese, Vaidya, & Tellegen, 1999). The BAS dysregulation theory proposes that individuals with BD have a BAS that is overly sensitive to goal orientated cues. This over sensitivity results in large fluctuations in the activation and deactivation of the BAS which is reflected in the symptoms of BD. For example, when vulnerable individuals experience events involving rewards or goal striving the overly sensitive BAS becomes excessively activated resulting in manic symptoms, such as excessive goal-directed behaviour, increased energy, optimism, and euphoria and a reduction in the need for sleep. (Depue, & Iacono, 1989; Urosevic, Abramson, Harmon-Jones, & Alloy, 2008).

Within the concept of exercise, the BAS dysregulation theory represents one potential explanation for the difficulty of disengaging from exercise whilst in a manic state reported in Wright et al.'s study (Wright et al., 2011). This process sf further

explained within Figure 1.

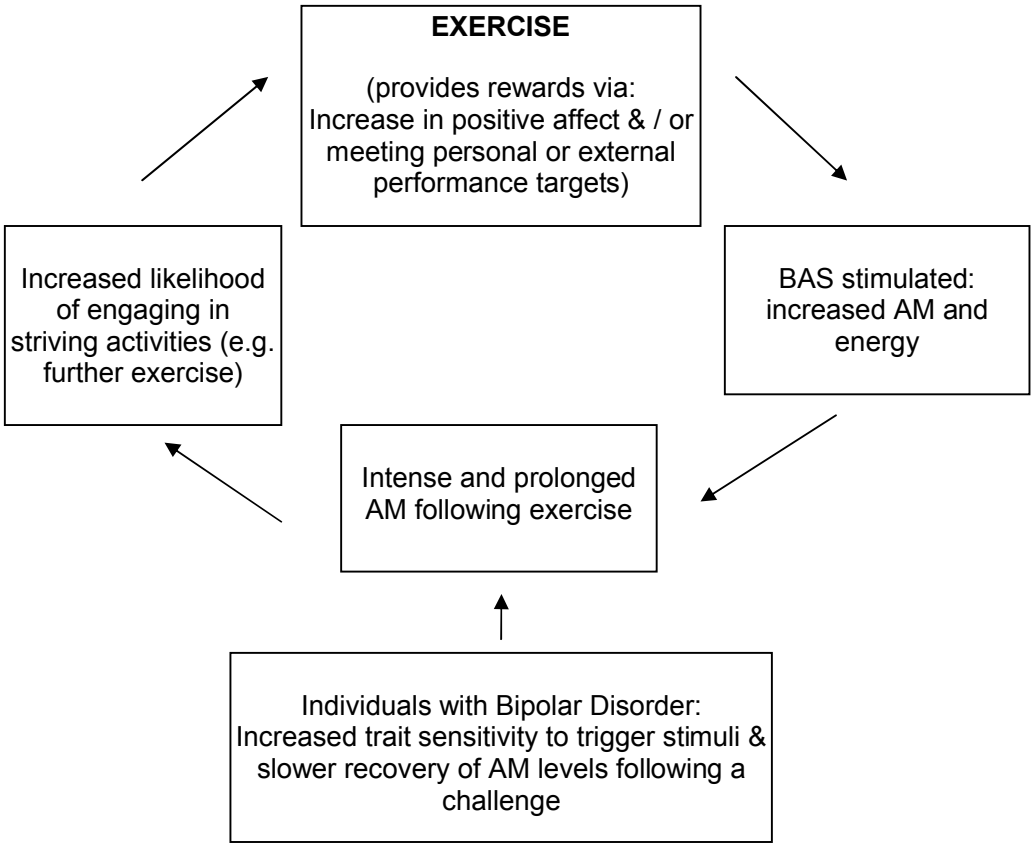

Figure 1. Upward Spiral of Approach Motivation Levels

The BAS dysregulation theory incorporates both specific psychosocial factors and specific neurobiological systems in explaining the symptoms and behaviours of BD and has received a large amount of support (for reviews see Alloy & Abramson, 2010; Urosevic et al., 2008).

The above model, in combination with the findings of Wright et al. (2011) was the basis for this study. From the model, and the reports of the participants it would be expected that moderate and vigorous exercise will lead to greater stimulation of the BAS and hence increases in AM levels in comparison to no exercise. However, previous literature within the remit of exercise and affect has shown that vigorous

exercise leads to decreases in affect in comparison to moderate exercise (see review by Ekkekakis, Parfitt, & Petruzzello, 2011). This may suggest that individuals may demonstrate reduced AM levels following vigorous exercise because of the close relationship between the two concepts. Therefore, this is an important area of further investigation.

Aims, Research Questions and Hypotheses

Aim of the Research

The aim of the current study was to look at the effect of different intensities of exercise on the maintenance of AM levels. Additionally this was looked at in the context of a population who are analogous to individuals with a diagnosis of BD.

Research Question

The main research question for the study was: 'Are approach motivation levels maintained following different intensities of exercise and is the interaction between AM and exercise predicted by the presence of hypomanic traits?'

Hypotheses

The following hypotheses were proposed.

Primary hypotheses. Following an initial increase in approach motivation:

1. Relative to individuals undergoing a sedentary activity, individuals taking part in an exercise activity will show increased levels of:
    a) Approach motivation.
    b) High activation positive affect (valence and arousal)

And during the recovery phase following an activity, increased levels of:

c) Perceived thought speed.
d) Symptoms associated with mania (i.e., feelings of power, feelings of creativity and a heightened sense of energy).

e) Psychomotor activity.

Secondary Hypotheses. Additional effects that will be tested:

2. The relationships predicted in hypothesis one will be moderated by the presence of hypomanic traits such that they will be stronger in individuals reporting higher levels of hypomanic traits.
3. Following an initial increase in approach motivation, there will be a positive relationship between hypomanic traits and time taken for approach motivation levels to return to baseline.
4. There will be a positive relationship between hypomanic traits and participants' reported desire to continue with exercise.

Method[45]

Recruitment Methods

Participants were recruited primarily from Psychology students who could participate for course credit. This was done via email and flyers posted at the University of Exeter. The study also recruited from the wider student population using a student database.

Inclusion/Exclusion Criteria

Participants were included in the study if the following criterion was met:

- From the student population at The University of Exeter.
- Aged 18 or over.
- Able to read and understand English.

Participants were excluded from the second stage of the study if the following criterion were met:

[4] For expanded Method including descriptions of power calculations, design and user involvement see Appendix E.
[5] For examples of recruitment material see Appendix F

- Physical health problems that would make exercise dangerous.
- Non responsive to a laboratory induction procedure (see below).
- Scores of seven or above on a standardised depression scale (see below).
- Scores above six on a standardised mania rating scale (see below).

Sample

Sample characteristics. Following completion of an online screening questionnaire, 72 participants were recruited to take part in this study. Seven did not attend the second stage of the study and four did not respond to the induction procedure described later. Hence, 11 participants in total did not proceed to the testing phase of the study.

Of the remaining 61 participants, 38 were females with an age range from 18 to 40 years old (M = 20.05, SD 3.67). 45 participants were White British English, three were White British Welsh, one participant was of another White British origin, one was Irish, four were of another White ethnic origin, one participant was dual White/ Asian origin, one participant Black British, one participant Black African, and four participants were Chinese. As expected, a large majority of the participants' highest level of education was currently attending university or equivalent (n=55) with two having completed university and four having completed a postgraduate qualification.

Materials[6]

Demographic information. A short, non-standardised self-report form to obtain gender, age, ethnicity, marital status, educational level and exercise preference.

Self Assessment Manikin (SAM; Lang, 1980). A nine point self-rating scale that consists of a graphic figure representing three dimensions involved in emotion: valence, arousal, and dominance. Only the valence and arousal subscales were used.

Hypomanic Personality Scale (HPS, Eckblad, & Chapman, 1986). A 48 item true/false self-report questionnaire used to assess stable hypomanic traits.

Godin Leisure-Time Exercise Questionnaire (GLTEQ, Godin, & Shephard, 1985; 1997). A subjective measure of the amount of leisure time exercise lasting at least 15 minutes that an individual has participated in over the last seven days. A total exercise index is calculated by weighting each frequency by intensity.

Self-Reported Physical Activity Index (SRPA, Jurca et al., 2005; Mailey et al., 2010; McAuley et al., 2011). A measure used along with gender, age, Body Mass Index (BMI) and resting HR within a validated formula to calculate cardiovascular fitness (CRF) levels. Participants are asked to choose one of five activity categories that best describe the usual pattern of daily physical activity.

Behavioural Engagement Scale (BES, Krauss, Depue, Arbisi, & Spoont 1992). A five item self-report measure of state behavioural engagement/AM levels. Participants are required to rate current feelings for each of the 5 items in turn (A. feelings of energy, B. optimism, C. mood, D. thought liveliness, and E. excitement)

[6] For psychometric properties and copies of the measures and see Appendix G.

using a 10 point scale. Scores will potentially range between 0 and 50 with lower scores indicating higher levels of AM.

Borg Rating of Perceived Exertion Scale (RPE, Borg, 1998). A 15 point scale used to quantify the self-rated perceived exertion levels of participants. Judgements are required to be based on an amalgamation of all physical sensations such as increased heart rate, respiration, sweating, and muscle fatigue.

Hospital Anxiety and Depression Scale (HADS; Zigmond, & Snaith, 1983). A 14 item self-rating measure for anxiety/depression. Only the depression subscale (HADS-D) was used with potential scores ranging from 0 to 21.

Altman Self-Rating Mania Scale (ASRM; Altman, Hedeker, Peterson, Davis, 1997). A five item measure for rating symptoms of mania on a scale from 0-4 based on increasing severity. It looks at the following symptoms; elevated/euphoric mood, increased self-esteem, decreased need for sleep, pressured speech and psychomotor agitation.

Manic Symptoms Questionnaire (MSQ). Using a nine point scale, participants completed a questionnaire on a number of mania related symptoms[7] at five points during the testing.

Thought Speed. The MSQ also included an item on speed of thoughts that was completed at the same five time points. This procedure has been used previously by Pronin and Wegner (2006) in order to gather participant's perceptions of thought speed changes.

Psychomotor activity. At the same time points as completing the MSQ, participants' psychomotor activity was measured via an accelerometer (GENEActiv)

[7] MSQ includes current levels of alertness, jitteriness, tiredness, attentiveness, activeness, strength, powerfulness, determination, creativity, insightfulness and inspiration.

worn on the wrist of the hand not used for writing. An accelerometer is a device which detects and logs movement intensity and duration. Prior to the testing, the accelerometer was synced to the local time of a computer in the testing room and set to collect triaxial data at a sampling frequency of 100 Hz.

During the testing, the time was noted by the experimenter at the outset of completing each of the five MSQs and this time was later used during the analyses to identify the correct accelerometer data. The mean score of a 60 second period (6000 data points) for each of the axes (x, y and z) was calculated and then the overall mean of these three was used for further analyses.

Blood pressure monitor. A blood pressure monitor (AND Digital Blood Pressure Monitor) was used at the start of the testing.

Height and weight. An electronic column scale (SECA 704) and a height rod (SECA 213) were both used to measure the height and weight of participants.

Heart rate monitor. Each participant wore a chest monitor (Polar Electro T31) throughout the testing which transmitted heart rates to a separate wrist unit held by the experimenter (Polar FT1). Resting heart rate was logged whilst the participants completed the initial questionnaires by calculating the mean of five heart rates recorded over a two and a half minute period. Heart rate was then recorded every three minutes during the activity (at the same time as gaining RPE ratings) for a total of five times.

Physical Activity Readiness Questionnaire (PAR-Q; Thomas, Reading, & Shephard, 1992). A self-screening tool used to determine the safety or possible risk of exercising based upon an individual's answers to health history questions.

Cardiovascular disease (CVD) risk assessment form (risk assessment reference SSHS/HAZ/0078 & SSHS/HAZ/0080). An additional self-screening tool recommended for individuals engaging in vigorous exercise.

Experimental manipulation. Participants were allocated to one of three conditions (control, moderate exercise and vigorous exercise). For the control condition participants were asked to read a magazine of neutral content for 15 minutes whilst sitting on a cycle ergometer. Participants in the moderate and vigorous exercise conditions completed a 15 minute period of exercise on a cycle ergometer at an experiment desired level of intensity. Participants were asked to maintain a consistent level of perceived exertion throughout the activity phase of the experiment. The same cycle ergometer (Monark Ergonedic 874E) was used for the all three conditions. The requirements of each condition are noted in Table 1.

Table 1
Three Conditions

	Task	Target RPE	Target HR
Control condition	Reading sat on an ergometer.	-	-
Moderate intensity exercise	Cycling	11	65-75% HR max
Vigorous intensity exercise	Cycling	15	76-90% HR max

Laboratory approach motivation induction procedure. Participants participated in a laboratory AM induction adapted from a widely used procedure developed by Velten (1968) and used more recently by Pronin and Wegner (2006). Standardised instructions were provided (Appendix H) and then a series of 58 statements that became increasingly elating in content were presented using

Microsoft PowerPoint. Each statement scrolled into view one letter at a time from the bottom of the screen stopping in the middle of a yellow background and was presented in large black print (Arial Rounded 48-point font). Once participants had initiated the computer task, the statements advanced at a speed of 40 ms per letter with an additional 320 ms between slides. This procedure has been used to successfully to induce feelings of high energy, power, creativity, grandiosity and perceived increased thinking speed (Pronin, & Wegner, 2006).

Procedure[8]

Prior to starting recruitment, ethical approval was sought and granted from the Research Ethics Committee at the School of Psychology, University of Exeter[9].

Participants initially completed the HPS online. Following this, participants attended the testing phase of the study. Participants read the participant information (Appendix K) and signed the consent form (Appendix L). The participants were then fitted with an accelerometer and heart rate band. Participants were informed of potential risk (such as fatigue) and asked to provide some basic demographic information and to complete the PAR-Q and CVD risk assessment forms[10]. Finally, the blood pressure, weight and height of participants were measured to calculate BMI scores.

Those able to proceed completed the GLTEQ, SRPA and MSQ, and whilst doing this, a HR measure was taken at five 30 second intervals in order to calculate an accurate resting HR. The time was noted (in order to identify the appropriate data from the accelerometer during later analyses) and participants provided baseline ratings on the BES and SAM.

[8] For a procedural flow chart see Appendix I.
[9] For an overview of the ethical considerations, ethics documentation and correspondence see Appendix J.
[10] Those who reported any significant physical or mental health concerns were directed towards their GP or university health service in line with the mood disorders centre protocol.

Participants completed a laboratory AM induction. Following this, a second BES and SAM rating was taken, a second MSQ was completed and the time was noted. Participants were randomly allocated to one of three conditions. In all conditions except the control condition, participants were asked to warm up by pedalling for 2 minutes on a cycle ergometer at 30% of age-predicted HR max (calculated from resting HR). Following this warm-up period, the conditions began. Following the start of each condition, participants provided exertion levels at minutes 3, 6, 9, 12, and 15 using a poster-size version of Borg's RPE scale which was situated in front of the cycle ergometer. HR was also taken at these time points. Participants provided a third and fourth BES and SAM rating at minutes 5 and 10 after the start of the condition.

Immediately following the conclusion of the condition, participants provided a fifth BES and SAM score along with rating levels of wanting to continue with the activity (0 being not at all and 10 being very much). After a 2-minute cool down cycle at 30% of age-predicted HR max (or 2 minutes further magazine reading in the sedentary group) participants were asked to complete a third MSQ and the time was noted again. Finally, participants completed a sixth BES and SAM and a fourth MSQ at a 5 minute follow up and a seventh BES and SAM and a fifth MSQ at a 10-min follow-up from the end of the condition. The time was noted at both of these points.

After the experiment participants were fully debriefed (Appendix M).

Statistical Analysis

Data was analysed using IBM SPSS Statistics (Version 19) for Windows Vista. Prior to the analysis, all data were visually inspected using histograms. Transformation of data was not considered necessary because of the relatively

normal distributions.[11] A priori hypotheses were one-tailed and an alpha level of $p < .05$ was applied.

Results[12]

Manipulation Check

In order to establish the success of the laboratory induction procedure, repeated measures t-tests were conducted comparing the average scores of participants before and after the computer task. It was found that following the computer task, participants reported increased scores for mania symptoms $t(60) = 7.42$, $p < .001$, thought speed $t(60) = 6.22$, $p < .001$, BES $t(60) = 13.06$, $p < .001$, valence $t(60) = 5.87$, $p < .001$, and arousal $t(60) = 4.14$, $p < .001$. The results of participants with BES scores the same or lower following the laboratory induction were excluded from the study (n=4). This is because the study was interested in the impact of exercise on participants already experiencing an analogue hypomanic state.

Hypothesis 1

Hypothesis 1a[13]. A mixed design ANCOVA was used to establish if there were any significant differences between the three conditions in terms of the maintenance of AM levels following the induction procedure. The dependent variable was BES scores over six time points (post induction, five minutes into activity, 10 minutes into activity, end of activity, 5 minute follow-up and 10 minute follow-up) and

[11] Data found to violate Levene's test of homogeneity of variances were transformed and if this did not improve then a non-parametric test was used. When no non-parametric equivalent analyses was available, such as with a mixed design ANCOVA, data which could not be transformed was still included in these tests as it has been argued that these tests are robust enough to account for deviations from normality (Field, 2009). Violations of Box's test of the assumption of homogeneity of covariance matrices were disregarded due to the similar sample sizes in each condition (Field, 2009). Where Mauchley's Test of Sphericity was violated in the ANCOVAs, the Greenhouse-Geisser epsilon was used to correct for this.

[12] For expanded results section including assumptions of normality, baseline data check, condition validity and manipulation analyses, see Appendix N.

[13] For interaction graphs see Appendix O.

the independent variable was the condition (sedentary, moderate or vigorous exercise)[14]. A significant main effect of Time, $F(2.49, 129.75) = 4.89$, $p = .005$, and of Condition, $F(2, 52) = 7.21$, $p = .002$, was found. A significant Time x Condition interaction was found, $F(4.99, 129.75) = 3.24$, $p = .009$, indicating that AM levels over different time points differed depending on the condition. Figure 2 illustrates the pattern of results for BES scores across time and conditions. AM levels in the vigorous condition clearly increased over time in comparison to the control and moderate conditions.

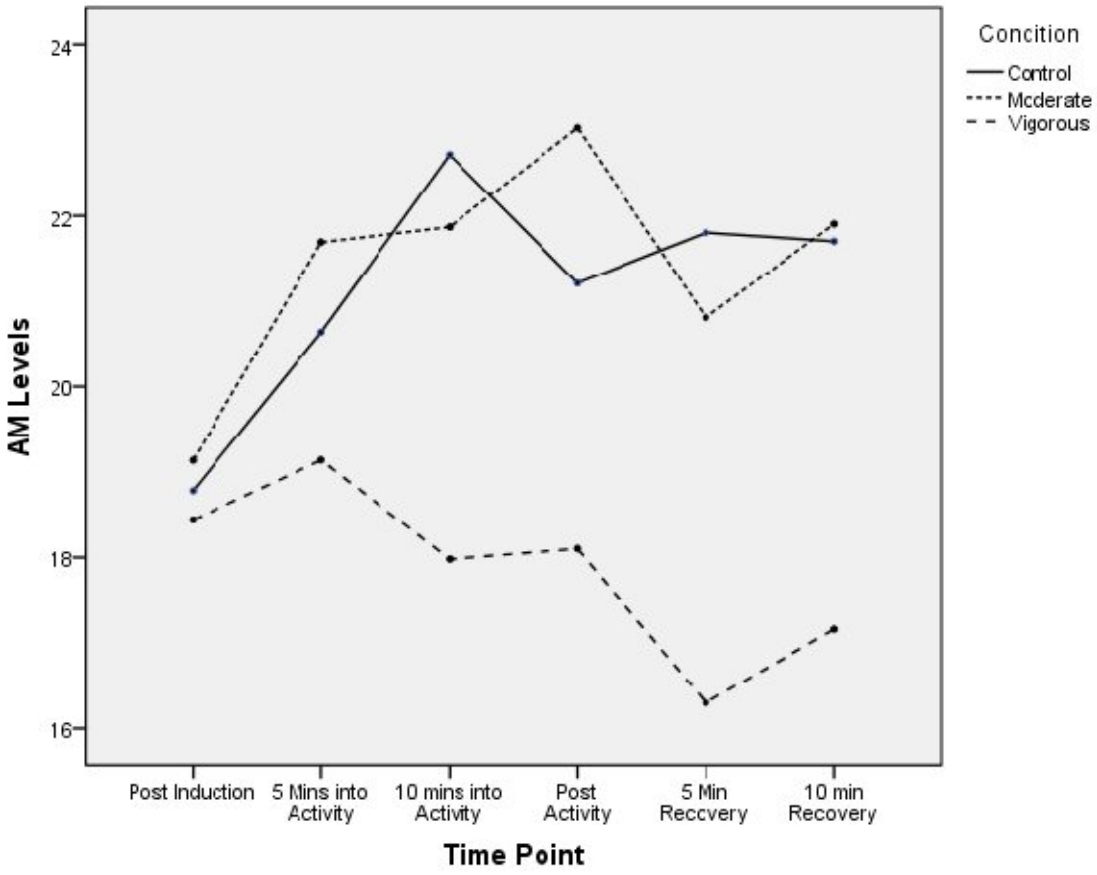

Figure 2. Time x Condition interaction for BES scores.[15]

[14] The analysis included the following covariates: gender, fitness levels, initial valence score, initial thought speed, pre/post induction BES score change and total HPS score.
[15] Lower BES scores indicate higher levels of AM

Polynomial contrasts of the Time x Condition interaction revealed a significant linear trend, $F(2, 52) = 6.62$, $p = .003$, with the vigorous exercise condition leading to increased AM levels and the moderate and no exercise conditions leading to decreasing AM levels.

A planned comparison of only the vigorous and control conditions, repeating the above ANCOVA did not reveal a significant main effect of Time, $F(2.44, 80.55) = 2.74$, $p = .060$ but did reveal a significant main effect of Condition, $F(1, 33) = 10.42$, $p = .003$, and a significant Time x Condition interaction, $F(2.44, 80.55) = 5.22$, $p = .004$. This indicates that AM levels over different time points remained significantly higher in the vigorous compared to the control condition following the induction.

A planned comparison of the moderate and control conditions revealed a significant main effect of Time, $F(2.62, 86.28) = 5.06$, $p = .004$, but not a significant effect of Condition, $F(1, 33) = 0.02$, $p = .892$, nor a significant Time x Condition interaction, $F(2.62, 86.28) = 0.77$, $p = .500$. This indicates that AM levels significantly decreased over time but were not different between the two conditions.

Finally, looking at just the vigorous and moderate conditions[16] , significant main effects of Time, $F(2.10, 67.24) = 5.16$, $p = .007$, and Condition, $F(1, 32) = 7.46$, $p = .010$, were found but no significant Time x Condition interaction, $F(2.10, 67.24) = 1.09$, $p = .343$. This indicates that on average AM levels were significantly higher in the vigorous compared to the moderate condition and that scores changed significantly for both conditions over time. However, AM levels were not affected significantly differently for the two conditions over different time points.

Hypothesis 1b[17].

[16] The p value was adjusted to 0.017 (0.05/3) for the moderate vigorous comparison due to it being post-hoc.
[17] For interaction graphs see Appendix P.

Valence. A mixed design ANCOVA was conducted on reported valence levels. The dependent variable was Valence scores over six time points and the independent variable was the condition[18]. There was a significant main effect of Time, $F(3.39, 176.22) = 8.71$, $p < .001$, and Condition, $F(2, 52) = 6.8$, $p = .002$. The Time x Condition interaction was significant, $F(6.78, 176.22) = 3.40$, $p = .002$, indicating that valence levels differed depending on the condition over different time points.

Polynomial contrasts of the Time x Condition interaction revealed significant linear, $F(2, 52) = 5.46$, $p = .007$) and quadratic, $F(2, 52) = 4.45$, $p = .016$, trends with an initial decrease in the levels of valence during the activity phase of the testing followed by an increase during the recovery phase.

A planned comparison of just the vigorous and control conditions, repeating the above ANCOVA, revealed a significant main effect of Condition, $F(1, 33) = 6.49$, $p = .016$, Time, $F(3.02, 99.6) = 12.21$, $p < .001$, and a significant Time x Condition interaction, $F(3.02, 99.6) = 3.85$, $p = .012$, such that valence scores increased in the recovery period for vigorous exercise condition relative to the sedentary condition.

A planned comparison of the moderate and control conditions did not reveal a significant main effect of Time, $F(3.63, 119.7) = 1.90$, $p = .121$, or Condition, $F(1, 33) = 1.84$, $p = .184$, but it did reveal a significant Time x Condition interaction, $F(3.63, 119.7) = 5.03$, $p = .001$, such that valence levels increased in the recovery period in the moderate condition relative to the control condition.

[18] The analysis included the following covariates: gender, fitness levels, initial BES score, initial thought speed, pre/post induction valence score change and total HPS score

Finally, looking at just the vigorous and moderate conditions[19], significant main effects of Condition, $F(1, 32) = 9.44$, $p = .004$ and Time, $F(2.73, 87.32) = 6.08$, $p = .001$,were found but no significant Time x Condition interaction, $F(2.73, 87.32) = 0.95$, $p = .413$. This indicates that on average valence levels were significantly higher in the vigorous compared to the moderate condition and that scores changed significantly for both conditions over time. However, valence levels were not affected significantly differently for the two conditions over different time points.

Arousal. A mixed design ANCOVA was conducted on reported arousal levels. The dependent variable was Arousal scores over six time points and the independent variable was the condition[20]. There was a significant main effect of Time, $F(2.99, 152.56) = 9.61$, $p < .001$, and Condition, $F(2, 51) = 14.13$, $p < .001$. The Time x Condition interaction was significant, $F(5.98, 152.56) = 8.71$, $p < .001$. This indicates that arousal levels were significantly different for the three conditions over different time points.

Polynomial contrasts revealed a significant quadratic trend, $F(2, 51) = 19.11$, $p < .001$, with the vigorous exercise condition leading to increased arousal initially, followed by a decrease during the recovery period compared to the control condition which both demonstrated the opposite effect. The moderate condition demonstrated decreasing levels of arousal both during the activity and recovery periods.

A planned comparison of just the vigorous and control conditions, repeating the above ANCOVA, revealed a significant main effect of Condition, $F(1, 32) = 28.5$, $p < .001$, Time, $F(2.7, 86.26) = 7.69$, $p < .001$, and a significant Time x Condition interaction, $F(3.02, 99.6) = 11.47$, $p < .001$, such that arousal levels increased during

[19] The p value was adjusted to 0.017 (0.05/3) for the moderate vigorous comparison due to it being post-hoc.
[20] The analysis included the following covariates: gender, fitness levels, initial BES score, initial valence score, initial thought speed, pre/post induction arousal score change and total HPS score

the activity and then decreased during the recovery period for the vigorous condition compared to an opposite pattern in control condition.

A planned comparison of the moderate and control conditions did not reveal a significant main effect of Condition $F(1, 32) = 0.458$, $p = .503$ but a significant effect of Time $F(2.7, 86.51) = 2.96$, $p = .042$, was found and a significant Time x Condition interaction $F(2.7, 86.51) = 3.78$, $p = .016$, such that during the recovery period the arousal levels in the moderate condition continued to decrease compared to the control condition.

Finally, looking at just the vigorous and moderate conditions[21], no significant main effect of Condition, $F(1, 31) = 2.23$, $p = .145$ was found but a significant effect of Time, $F(3.39, 105.05) = 9.68$, $p < .001$, was found suggesting that scores changed significantly over time but were not significantly different on average between the two conditions. No significant Time x Condition interaction was found, $F(3.39, 105.05) = 2.91$, $p = .032$, indicating that arousal levels were not affected significantly differently for the two conditions over different time points.

Hypothesis 1c[22] . A mixed design ANCOVA was conducted on perceived thought speed following the activity. The dependent variable was perceived thought speed scores and the independent variables were the condition over three time points[23]. The main effects of Time, $F(1.36, 70.67) = 3.32$, $p = .060$, and Condition, $F(2, 52) = 2.61$, $p = .083$ were not found to be significant and contrary to the hypothesis, the Time x Condition interaction was not significant, $F(2.72, 70.67) =$

[21] The p value was adjusted to 0.017 (0.05/3) for the moderate vigorous comparison due to it being post-hoc.
[22] Data was transformed due to violation of Levene's assumption however this was unsuccessful and original data was used. For an interaction graph see Appendix Q.
[23] The analysis included the following covariates: gender, fitness levels, initial BES score, initial valence score, pre/post induction thought speed score change and total HPS score

1.84, p = .152, indicating that reported thought speed was not significantly different for the three conditions over different time points.

Hypothesis 1d[24] . A mixed design ANCOVA was conducted on reported mania symptoms following the activity. The dependent variable was total score on the MSQ and the independent variables were the condition over three time points[25]. The main effect of Time was not found to be significant F(1.37, 69.75) = 2.08, p = .147, but a significant main effect was found for Condition F(2, 51) = 3.58, p = .035, with scores in the vigorous condition reported to be the highest relative to the sedentary and moderate exercise conditions. Contrary to the hypothesis, no significant Time x Condition interaction was found F(2.74, 69.75) = 0.45, p = .70, indicating that mania symptoms were not significantly different for the three conditions over different time points.

Hypothesis 1e[26] . A mixed design ANCOVA was conducted on reported psychomotor activity following the activity. The dependent variable was average accelerometer scores at three time points and the independent variable was the condition[27].The main effect of Time was not found to be significant, F(1.83, 94.94) = 3.13, p = .053, but a significant main effect was found for Condition, F(2, 52) = 3.65, p = .033 with scores in the vigorous condition reported to be the highest relative to the sedentary and moderate exercise conditions. Contrary to the hypothesis, the Time x Condition interaction was not significant, F(3.65, 94.94) = 1.03, p = .39, indicating that recorded psychomotor activity was not significantly different for the three conditions over different time points.

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[24] For an interaction graph see Appendix R.
[25] The analysis included the following covariates: gender, fitness levels, initial BES score, initial valence score, initial thought speed, pre/post induction MSQ score change and total HPS score
[26] Data was transformed due to violation of Levene's assumption however this was unsuccessful and original data was used. For an interaction graph see Appendix S.
[27] The analysis included the following covariates: gender, fitness levels, initial BES score, initial valence score, initial thought speed, pre/post induction psychomotor change and total HPS score

Hypothesis 2[28]

Mixed design ANCOVAs were conducted on the data to investigate whether HPS total scores moderated the effects reported in Hypotheses 1. The same variables entered into the models used for hypotheses 1 were used in the analyses reported here, however an additional three-way interaction between HPS scores, Condition (three levels) and Time (6 levels) was additionally included.

Approach motivation. The analyses did not reveal a significant HPS x Condition x Time interaction for AM levels $F(4.99, 124.78) = 1.72$, $p = .136$.

Valence. The analyses did not reveal a significant HPS x Condition x Time interaction for Valence scores $F(10.03, 167.22) = 1.07$, $p = .385$.

Arousal. The analyses did not reveal a significant HPS x Condition x Time interaction for Arousal scores $F(6.00, 147.06) = 1.44$, $p = .202$.

Thought speed. A significant HPS x Condition x Time interaction was found for thought speed $F(2.62, 65.45) = 3.22$, $p = .034$. Simple contrasts on this interaction revealed that participants thoughts speed was significantly different between post activity (level 1) and the five minute recovery point (level 2), $F(2, 50) = 4.89$, $p = .012$, such that it increased for vigorous condition and reduced in the control and moderate conditions.

The sample was separated into two subsamples, one containing those scoring below the median HPS score ("low HPS"), and the other containing those scoring above ("high HPS"). Repeating the ANCOVA on thought speed for both subsamples separately revealed a significant Condition x Time interaction for low HPS scorers $F(2.56, 29.6) = 6.16$, $p = .003$, but not for high HPS scorers $F(2.63, 21)$

[28] For further details and interaction graphs see Appendix T.

= 2.28, *p* = .116. Figure 3 illustrates the pattern of change over time in thought speed for the different conditions for both high and low HPS scorers.

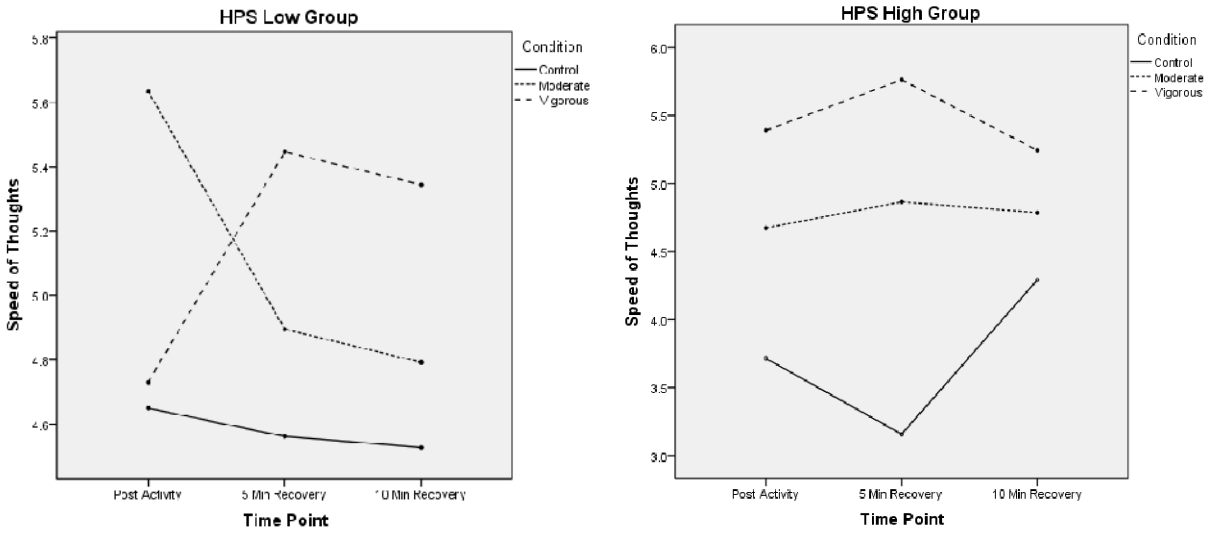

Figure 3. Condition x Time interaction for thought speed for high/low HPS scorers

Figure 3 suggests that low HPS scorers in the vigorous exercise condition demonstrated an increase in thought speed relative to the other two conditions. High HPS scorers in the two exercise conditions seemed to show increases in thought speed during the five minute recovery period compared to the control condition.

Mania symptoms. The HPS x Condition x Time interaction for mania symptoms was not found to be significant $F(2.74, 67.13) = 0.75$ $p = .513$.

Psychomotor activity. The HPS x Condition x Time interaction for psychomotor activity was not found to be significant $F(3.65, 91.29) = 1.37$, $p = .255$.

Hypothesis 3[29]

A Kendall's tau non parametric correlation did not reveal a significant correlation between the time taken for AM levels to return to baseline and HPS scores, r = 0.12, *p* = 0.453.

[29] A non-parametric test was used due to ordinal nature of the data. For SPSS outputs see Appendix U.

Hypothesis 4[30]

A hierarchical regression was conducted on the relationship between hypomanic symptoms and wanting to continue with the activity for the two exercise conditions. The predictors were the total HPS scores and condition (0 for moderate and 1 for vigorous) and the dependent variable was participants' ratings of wanting to continue with the activity. Condition and HPS were entered in the model first followed by the Condition x HPS interaction in the second step. Analyses did not reveal a significant correlation between wanting to continue with the activity and HPS scores, $R^2 = .06$, $F(2, 39) = 1.10$, $p = .345$, or between wanting to continue with the activity and a Condition x HPS interaction $R^2 = .09$, $F(3, 39) = 1.16$, $p = .337$.

Discussion

There has been little research into the relationship between exercise, AM and individuals in a hypomanic state. The main aim of the current study was to test the hypothesis that exercise would have an impact on the maintenance of AM levels once elevated, and this hypothesis was broadly supported. Additionally, it was predicted that this relationship would be moderated by participants' hypomanic trait levels. This was not supported. Hypomanic traits were also not found to be correlated with the time taken for participant's AM levels to return to baseline or with ratings of wanting to continue with the activity.

Exercise and Approach Motivation

The condition participants engaged in was found to have a significant effect on the maintenance of AM levels following a laboratory induced hypomania-

[30] For SPSS outputs see Appendix V.

analogous state. No significant difference was found in the maintenance of AM levels between the moderate and control conditions, or the moderate and vigorous conditions, but there was between the vigorous and control conditions. This suggests that vigorous exercise is significantly different to sedentary activity in terms of the impact on the maintenance AM levels. Inspection of plots of the results revealed that the control condition led to decreasing AM levels whereas participants in the vigorous reported increasing levels of AM.

As mentioned previously, there is very limited research on the effects of exercise on individuals in a manic state, therefore comparison with previous research is difficult. No studies have looked exclusively at the impact of different exercise intensities on the maintenance of an individual's AM levels over time however two studies have looked more generally at the relationship between exercise and the approach system. For example, Schneider and Graham (2009) reported a positive correlation between the reward subscale of the BIS/BAS Scale (Carver, & White,1994) completed at baseline and scores provided during an exercise task (enjoyment, positive feelings and higher energetic arousal). An earlier second study again did not look at changes in AM over time in response to exercise but instead focussed on the relationship between BAS scores and RPE scores provided whilst engaging in moderate and higher exercise intensities (Hall, Ekkekakis, & Petruzzello, 2005).

In terms of the wider literature on exercise and individuals with BD, this is equally as limited (see Wright et al., 2009; Zschucke, Gaudlitz, & Ströhle, 2013). It has been reported, that the current evidence base lacks adequate empirical strength and further research is needed to determine both the potential benefits and risks of exercise as an intervention for individuals with BD. It was concluded, that no studies

to date had been conducted to examine the effect of physical activity on mania/hypomania (Wright et al., 2009).

The discrepancy between the effects of the vigorous exercise and sedentary activity but not between moderate exercise and sedentary activity on AM levels may be explained by one of the themes identified by Wright et al. (2011). The theme, 'exercise as a double-edged sword' referred to the idea that exercise was reported to be able to both exacerbate and relieve manic symptoms at different times. It was reported that the outcome could be dependent on a number of variables such as the individual's mood state at time of the exercise or the type of exercise engaged in.

The idea that vigorous exercise may lead to increasing AM levels fits with the upward spiral identified earlier. It has been reported that individuals with BD often tend to over exercise whilst in a manic state (Meyer, Rahman, & Shepherd, 2007; Wright et al., 2011) and, the BAS dysregulation theory (Depue & Iacono, 1989; Depue et al., 1987) represents one potential explanation for this. The theory suggests that individuals with BD are prone to an overly sensitive BAS that can also remain activated for longer following a trigger. This BAS can continue to remain dysregulated if it is continually activated which in turn increases goal striving, leading to an upward spiral in AM levels. It is possible that the intensity of the exercise within the vigorous condition caused participants to experience increased energy and motivation. Outside of the laboratory setting of this study, this state could result in individuals being prone to engage in more striving activities (which may or may not include exercise) thus stimulating the approach system further.

In summary, the results of this study suggest that vigorous exercise may be deleterious if an individual is experiencing hypomania because it may exacerbate symptoms, however this did not seem to be the case for moderate exercise.

Although the result can only be considered as preliminary due to methodological limitations, it does suggest that one should be cautious in making recommendations about exercise for individuals that are likely to experience BAS dysregulation such as populations within the BD spectrum of diagnoses.

Exercise, Valence and Arousal

Participants were found to experience different levels of valence and arousal in different conditions. The results revealed that participants in the two exercise conditions did not experience significantly different patterns of valence throughout the testing whereas participants in the sedentary condition did. Examination of the plots of the result indicated that overall valence scores for participants in the sedentary condition reduced whereas scores increased for the two exercise conditions during the recovery period. This suggests that exercise has a significant impact on valence levels particularly during a recovery period.

Arousal scores rose significantly within the vigorous condition during the activity phase in comparison, to the sedentary and moderate exercise conditions where arousal levels slowly reduced over time. During the recovery period, participants in the two exercise conditions demonstrated decreased arousal compared to participants in the sedentary condition. Overall, this suggests that exercise can significantly increase valence levels during the subsequent recovery period, and vigorous exercise specifically can have a significant impact on arousal levels during activity.

A large majority of research has reported on the impact of exercise on depressive symptoms (Blumenthal, & Ong, 2009; Nahas, & Sheikh, 2011) or positive activated affect (PAA, Ekkekakis et al., 2011) but not on valence or arousal individually. PAA is defined as an amalgamation of two dimensions of activation and

valence (Reed, & Ones, 2006) and hence has been used as a relatively alike comparison.

Reed & Ones (2006) conducted a large meta-analysis and found that exercise conditions had a significantly greater impact on PAA than sedentary conditions. Additionally it was concluded that moderate and high intensity exercise on average produced smaller post-exercise improvements in PAA than low-intensity exercise. However, the categorisation of low, moderate and high intensity were different to this study[31]. The finding that the patterns of valence scores over time were similar between the two exercise conditions is consistent with Reed & Ones (2006) conclusions. The finding that arousal levels were higher within the vigorous condition and the pattern over time was different from the moderate and sedentary condition are likely to be linked to the fact that arousal is a closely related concept to the energising behaviour involved in AM (Ferguson, 2010).

Exercise and Additional Hypomanic Symptoms

Participants in the vigorous exercise condition were found to be exhibiting increased mania symptoms (e.g. feelings of powerfulness, alertness or creativity etc.) and psychomotor activity but not thought speed following the activity. This result partially fits with previous research which has demonstrated that exercise increases psychomotor speed, reaction time, and thought speed (Brisswalter, Collardeau, & Rene, 2002; Emery, Schein, Hauck, & MacIntyre, 1998), while improving affect and increasing energy and arousal (Hansen, Stevens, & Coast, 2001; Osei-Tutu, & Campagna, 2005).

[31] Reed and Ones (2006) categorised data using the following criteria; 1) low, 10–30 minutes low intensity or 7–20 minutes moderate intensity, 2) moderate, 30–40 minutes moderate intensity to 20–30 minutes high intensity, 3) high, 60–90 minutes moderate intensity to 40–60 minutes high intensity.

However, the levels of mania symptoms, psychomotor activity and thought speed were not significantly affected over the recovery period by the type of condition participated in. This result is surprising because it would be expected that higher levels of AM indicating increased hypomania would lead to changes in these areas. It is possible that the measures used within this study were not sensitive enough to pick up on changes that have occurred or that the levels of AM reported were not high enough to elicit changes. Additionally, any results may have been masked because two (out of three) of the time points that the above measures were taken were in the recovery phase of the testing. It is possible that if additional measures were included over a longer recovery period that the differences between conditions may become more salient. For example, it may be found that increased levels of thought speed, mania symptoms and psychomotor activity are maintained for a longer period of time.

The Impact of Hypomanic Traits

The final three hypotheses focused on the impact of hypomanic traits as a moderator for the relationships above as well as the relationship with the time taken for AM levels to return to baseline and participants desire to continue with an activity.

Hypomanic traits as a moderator. Against earlier predictions, results indicated that hypomanic traits did not moderate the presence of AM levels, valence, arousal, mania symptoms or psychomotor activity. This finding is surprising because it would be expected that hypomanic traits would lead to greater dysregulation of an individual's BAS and hence moderate activities that perturb the BAS such as exercise. Previous research has shown that hypomanic traits are positively related to BAS scores (Carver, & Johnson, 2009; Meyer et al., 1999) and are predictive of manic episodes, substance use, and involvement in pleasurable but potentially

harmful leisure activities (Krumm-Merabet, & Meyer, 2005; Kwapil, Miller, Zinser, Chapman, Chapman, & Eckblad, 2000; Meyer, & Hautzinger, 2003; Meyer, & Hoffman, 2005) as well as the course and severity of manic symptoms over time (Meyer et al., 2001). Additionally, the BAS subscale of the BIS/BAS Scale (Carver, & White,1994) has been reported to be positively correlated with the HPS scale (Jones, & Day, 2008; Meyer, & Hofmann, 2005). Similarly, research suggests that mania is highly correlated with psychomotor activity (Johnson, Edge, Holmes, & Carver, 2012), such that physical activity is considered by some to be a more reliable criterion than changes in mood for making a diagnosis (Akiskal, & Benazzi, 2005).

Hypomanic traits were found to moderate reported thought speed following an activity in different conditions however, this effect seemed to be driven by an increase in thought speed for low HPS scorers in the vigorous condition compared to the other conditions. A moderating effect of HPS scores was not found for participants with higher hypomanic traits. This is contrary to the hypothesis as it would be expected that individuals with higher trait levels of hypomania would be more likely to experience greater fluctuations in their AM levels and hence increased thought speed following exercise. A plethora of research exists that documents the prevalence of racing thoughts in mania (see Goodwin, & Jamison, 2007 for a review) and Benazzi and Akiskal (2003) stated that racing thoughts were the most common symptom reported in previous episodes of hypomania (65.1 percent).

This result, along with the previous findings contesting the moderating role of hypomanic traits would suggest that individuals with high trait hypomanic symptoms do not need to avoid vigorous exercise in terms of how this impacts on AM levels, valence, arousal, mania symptoms, psychomotor activity or thought speed. However, it is possible that the levels of hypomanic traits reported by participants within this

study were not high enough in general to demonstrate this moderating effect. Regardless of this, the results found with respect to hypothesis one may suggest that when hypomania is experienced, vigorous exercise is something to be avoided irrespective of an individual's trait hypomanic symptoms (particularly in terms of the significant effect of vigorous exercise on AM levels and arousal).

Returning to baseline approach motivation. No relationship was found between participant's hypomanic traits and the time taken to return to baseline. Again this is surprising because it would be expected that increased hypomanic traits would indicate a more dysregulated BAS and hence AM levels would take longer to return to their baseline. Previous research has been mixed in terms of the link between a diagnosis of BD and slower BAS recovery (Johnson et al., 2012) but it has generally been supported (Goplerud. & Depue, 1985), particularly when an individual's history of mania is considered (Wright, Lam & Brown, 2008).

In the case of this study, it is possible that any potential experimental effects may have been masked by the fact that recovery measures were only taken at five and ten minutes for this study. This meant that a large number of participants (n=33, 54%) were still experiencing elevated AM Levels at the conclusion of the testing. An increased recovery period may have been more successful in demonstrating that participant's with higher hypomanic traits, continued to experience elevated AM levels. Interestingly, of the participants whose AM levels did not return to baseline, 14 were in the vigorous, 13 were in the moderate and 6 were in the sedentary condition[32].

Continuing with the activity. The hypothesis proposed was not supported in that a relationship was not found between hypomanic traits and wanting to continue

[32] See Appendix W

with the activity. This does not offer support for the BAS dysregulation theory because it would be expected that individuals with higher levels of hypomanic traits would feel driven to continue with the activity due to a more dysregulated BAS and hence become locked in the 'upward spiral'. This was the conclusion of the qualitative review by Wright et al. (2011) in which a number of participants discussed over-exercising when experiencing a manic state. Other studies have also reported tendency towards addiction to exercise amongst individuals vulnerable to BD (Meyer et al., 2007). It is possible that the method of measuring individuals desire to continue with the activity may have been too crude or that an insufficient proportion of participants with HPS scores at the higher end were included within the sample.

Limitations

Firstly, the population used within this sample did not have a diagnosis of BD and hence generalisations made to a clinical population must be made with caution. The sample did include some individuals scoring highly on the HPS however a large proportion of the sample were lower scoring (median= 13) and it is possible that the spread of HPS scores (range, 2-31, mean 13, SD 6.8) and proportion of higher scoring individuals was not sufficient in comparison to previous research[33]. In the original study by Eckblad and Chapman (1986), participants were selected using stratified random sampling of HPS scores to ensure the inclusion of an adequate proportion of high scorers. However due to the limited time frames within this study this strategy was not possible.

Secondly, previous research using exercise focusing on PAA changes has used longer lengths of activity and it is possible that this may have impacted o the results found in this study. Reed and Ones (2006) have reported that a duration of

[33] For a summary of these see Appendix X

30 to 35 minutes produced the largest effect sizes within an extensive meta analyses.

Thirdly, as mentioned earlier, it is possible that the limited recovery times employed with the methodology of this study may have masked some of the experimental effects such as the return of AM levels to baseline.

Fourthly, the laboratory induction tasked used within this study may not have produced as strong results as other available techniques (e.g. Johnson et al., 2005). Although only small number of individuals did not experience heightened AM levels (n=4) a large proportion (n=14) only experienced a change of one point (mean 3.74, SD 2.24). It was also considered that the computer task required very rapid reading of text on a screen and hence any individual with learning difficulties (e.g. dyslexia) may have struggled significantly.

Finally, the positioning of the accelerometer when measuring psychomotor activity may have limited any possible experimental effects. Being positioned on the participant's non-writing hand possibly meant that only arm or hand movement was measured. It may have been more accurate to have positioned it near the participant's chest in order to measure all over body movement.

Future Research[34]

The first logical step for future research may be to replicate these results with a larger and more diverse sample in terms of age, socio-economic status and education. Consideration of the limitations raised above would also be recommended, particularly in terms of extending the duration of exercise and recovery periods. Following on from this, it may be useful to think about using a

[34] For further future research discussion see Appendix Y

population with diagnosed BD although this may be ethically challenging due to the possible harmful effects of vigorous exercise. Current literature suggests that individuals with BD (Harmon-Jones et al., 2008; Johnson et al., 2012) and student populations at high risk for mania (Harmon-Jones et al. 2002) are more likely to expend effort, work harder and sustain effort for longer when offered a reward and this may another future area of interest. It would be important to look at the impact of different intensities of exercise on mania as well as hypomania because it may be that individuals with a more dysregulated BAS may react differently to exercise and as such may experience an even more beneficial or detrimental outcome.

Conclusions/Implications

This study has provided preliminary evidence that vigorous exercise increases individual's AM levels compared to no exercise but has not found a relationship between hypomanic traits and this. A moderating relationship has been found between hypomanic traits and levels of thought speed experienced but only for low scoring individuals. Vigorous exercise also has a significant impact on the closely related concept of arousal but not on valence, thought speed, mania symptoms or psychomotor activity. Much more research is needed before any clinical recommendations can be made, however it does suggest that individuals in a hypomanic state should be cautious about engaging in vigorous exercise as it may exacerbate AM levels. Future research should look to replicate and build on these early but promising results with different samples and increased sample sizes. The type of exercise as well as intensity should also be considered along with the context of the exercise and the individual's state of mind[35].

Conflict of Interest

[35] For dissemination statement, see Appendix Z.

None of the authors have conflict of interest/financial disclosures.

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Extended Appendices

Appendix A

Clinical Psychology Review Author Information Pack

CLINICAL PSYCHOLOGY REVIEW

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Reference to a book: Strunk, W., Jr., &White, E. B. (1979). *The elements of style.* (3rd ed.). New York: Macmillan, (Chapter 4).

Reference to a chapter in an edited book: Mettam, G. R., & Adams, L. B. (1994). How to prepare an electronic version of your article. In B.S. Jones, & R. Z. Smith (Eds.), *Introduction to the electronic age* (pp. 281-304). New York: E-Publishing Inc.

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- Full postal address
- Phone numbers

All necessary files have been uploaded, and contain:

- Keywords
- All figure captions
- All tables (including title, description, footnotes)

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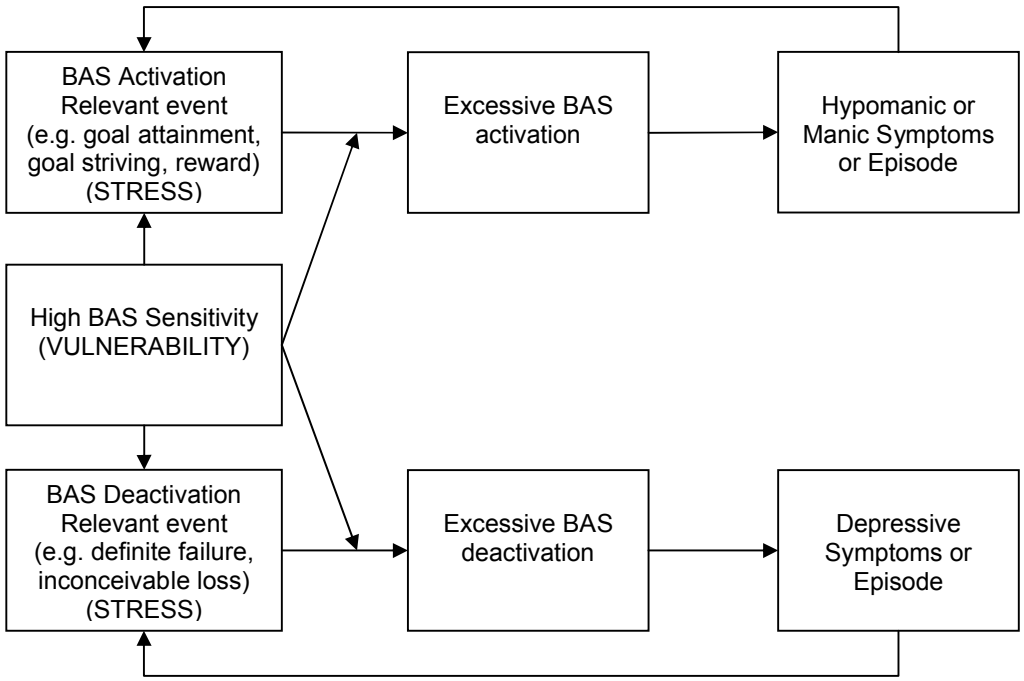
Appendix B

BAS Dysregulation Model of Bipolar Disorder (Alloy & Abramson, 2010)



Appendix C

Search Strategy

The titles were scanned for potentially relevant articles and the abstracts of those deemed relevant were read. After reading abstracts the author read the full texts of relevant studies and from this made their final selection for which studies should be included in the review. If it was not possible to access the full text for the review then the first author would be emailed to request a copy. However, not all articles could be reviewed which will have added some bias to the review.

Overview of Review Results

Search Term	Database	Hits	Relevant Title	Relevant Abstract	Date Searched
'bipolar disorder' AND 'exercise'	WoS	118	12	2	01.04.2013
'bipolar disorder' AND 'behavioural approach system'	WoS	67	11	8	01.04.2013
'bipolar disorder' AND 'behavioural activation system'	WoS	72	10	10	01.04.2013
'bipolar disorder' AND 'approach motivation'	WoS	37	7	5	01.04.2013
'exercise' AND 'approach motivation'	WoS	299	2	0	01.04.2013
'exercise' AND 'behavioural approach system'	WoS	144	2	2	01.04.2013
'exercise' AND 'behavioural activation system'	WoS	51	5	1	01.04.2013
'exercise' AND 'intensity' AND 'affect'	WoS	2	41	7	01.04.2013
'bipolar disorder' AND 'exercise'	SciVerse	139	10	3	01.04.2013
'bipolar disorder' AND 'behavioural approach system'	SciVerse	459	14	1	01.04.2013
'bipolar disorder' AND 'behavioural activation system'	SciVerse	303	15	5	01.04.2013
'bipolar disorder' AND 'approach motivation'	SciVerse	116	11	2	01.04.2013
'exercise' AND 'approach motivation'	SciVerse	460	8	1	01.04.2013
'exercise' AND 'behavioural approach system'	SciVerse	405	0	0	01.04.2013
'exercise' AND 'behavioural activation system'	SciVerse	400	1	1	01.04.2013
'exercise' AND 'intensity' AND 'affect'	SciVerse	3333	4	4	01.04.2013
'bipolar disorder' AND 'exercise'	PubMed	133	7	3	01.04.2013
'bipolar disorder' AND 'behavioural approach system'	PubMed	5	0	0	01.04.2013
'bipolar disorder' AND 'behavioural activation system'	PubMed	8	2	1	01.04.2013
'bipolar disorder' AND 'approach motivation'	PubMed	45	12	9	01.04.2013
'exercise' AND 'approach motivation'	PubMed	392	0	0	01.04.2013
'exercise' AND 'behavioural approach system'	PubMed	23	0	0	01.04.2013
'exercise' AND 'behavioural activation system'	PubMed	17	0	0	01.04.2013
'exercise' AND 'intensity' AND 'affect'	PubMed	2	0	0	01.04.2013
Total		7030	174	65	

Appendix D

Instructions for Authors

This journal uses ScholarOne Manuscripts (previously Manuscript Central) to peer review manuscript submissions. Please read the guide for ScholarOne authors before making a submission. Complete guidelines for preparing and submitting your manuscript to this journal are provided below. The instructions below are specifically directed at authors who wish to submit a manuscript toInternational Journal of Sport and Exercise Psychology . For general information, please visit the Author Services section of our website.

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paper file. Files should be saved as one of the following formats: TIFF (tagged image file format), PostScript or EPS (encapsulated PostScript), and should contain all the necessary font information and the source file of the application (e.g. CorelDraw/Mac, CorelDraw/PC). All figures must be numbered in the order in which they appear in the paper (e.g. Figure 1, Figure 2). In multi-part figures, each part should be labelled (e.g. Figure 1(a), Figure 1(b)). Figure captions must be saved separately, as part of the file containing the complete text of the paper, and numbered correspondingly. The filename for a graphic should be descriptive of the graphic, e.g. Figure1, Figure2a.

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Appendix E

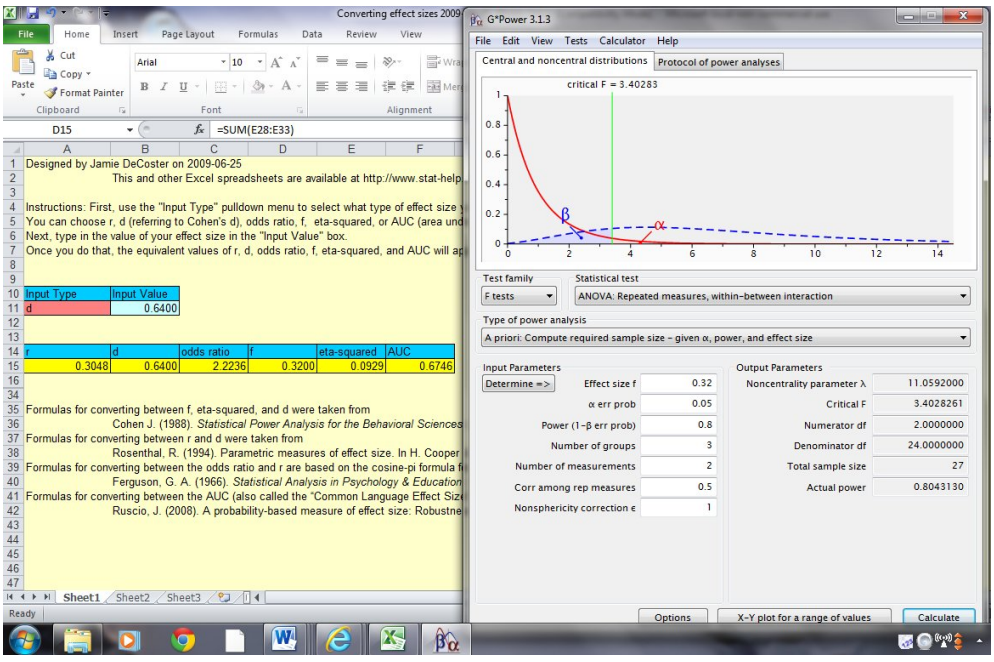
Expanded Method

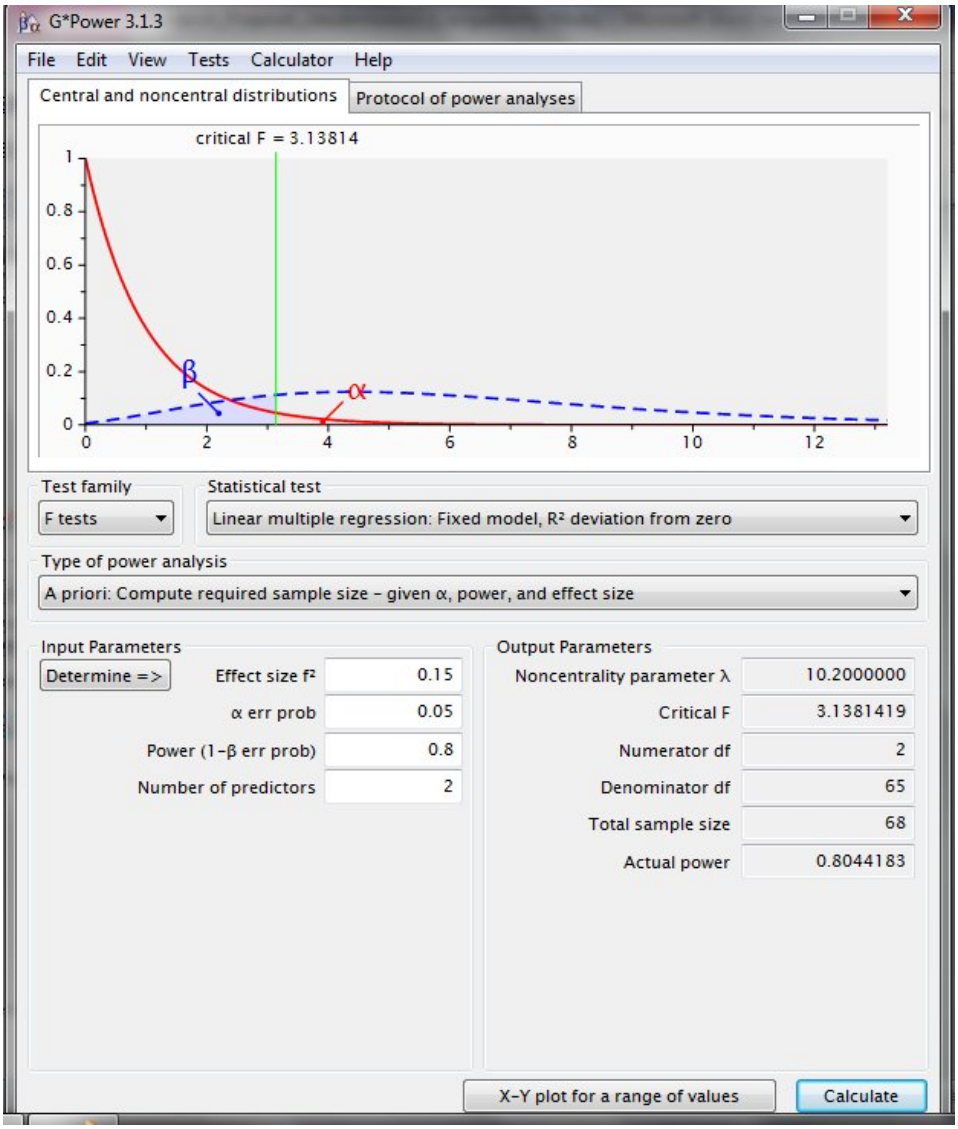
Power Calculations. To date, no current studies exist that have quantitatively examined the effect of exercise on AM levels. For this reason, and because both hypotheses two and hypothesis three were speculative in nature, the sample size calculation for this study was based on previous research for hypothesis one and hypotheses five.

Considering hypothesis one first, existing literature and personal correspondence with leading researchers in the area of exercise and affect has been used as an analogous comparison due to the close relationship between AM and affect. From this, a medium effect size (d=0.64) has been previously found between exercise and sedentary conditions (see meta-analysis by Reed & Ones, 2006). Using the program G*Power 3 (Faul, Erdfelder, Lang, & Buchner, 2007), a total sample size of 27 was calculated (f= 0.32, α=0.05, power =0.8) meaning that 9 participants were needed for each condition.

Considering hypothesis two, again there were no direct comparisons available from previous literature therefore a moderate effect size was assumed in order to remain conservative. Using G*Power 3 a total sample size of 68 was calculated (f= 0.15, α=0.05, power =0.8) suggesting that 23 participants were needed for each condition.

G*Power 3 calculations.





User involvement. An undergraduate student 'MK' from The University of Exeter was consulted over the design of the project. The student felt that the instructions and information were sufficient to be able to carry out the study and the consent and confidentiality arrangements were appropriate. It was felt that the study would not be too distressing for participants.

Design

The proposed project was a mixed design with both between and within subject factors. The within subject factor was the time at which the AM was measured which incorporates seven levels (pre AM induction, post AM induction, two during the experimental condition, post condition, 5 minute and 10 minute follow up).

The between subject factor was the condition which had three levels (sedentary, moderate intensity exercise and vigorous intensity exercise).

Appendix F

Examples of Recruitment Material

Would you like to take part in an interesting study that looks at the impact of exercise on mood?

The study involves two stages completed at the same time. You will be asked to do a quick computer task and then to do one of three activities. Other measurements will also be taken during the study such as your height, weight and heart rate.

The whole study should take around 45 minutes to complete and all participants will be entered into a prize draw to win a £50 voucher. There are only 60 participants in total so that's better odds than the lottery!

As soon as the owner's back was turned, Bob tried to ride off without paying.

I am available to test on the following dates and times:

Weds 21st March (10-4pm)
Thurs 22nd March (10-1pm)
Fri 23rd March (10-1pm)
Monday 9th April (10-4pm)
Monday 16th April (10-4pm)
Tuesday 17th April (10-4pm)
Weds 18th April (2-4pm)
Mon 23rd April (10-4pm)
Tues 24th April (10-4pm)
Weds 20th June (10-3pm)

To take part, or if you have any questions, please email me

jasl201@exeter.ac.uk

EXERCISE AND APPROACH MOTIVATION

Would you like to take part in an interesting study that looks at the impact of exercise on mood? • Takes 45 minutes to complete • Gain 1 hour course credit if needed. • Plus prize draw for a **£50 voucher**. • Only 60 participants in total • Better odds than the lottery! **Email – jasl201@exeter.ac.uk**	**I am available to test on the following dates and times:** Weds 21st March (10-4pm) Thurs 22nd March (10-1pm) Fri 23rd March (10-1pm) Mon 9th April (10-4pm) Mon 16th April (10-4pm) Tues 17th April (10-4pm) Weds 18th April (2-4pm) Mon 23rd April (10-4pm) Tues 24th April (10-4pm) Weds 20th June (10-3pm)	**Would you like to take part in an interesting study that looks at the impact of exercise on mood?** • Takes 45 minutes to complete • Gain 1 hour course credit if needed. • Plus prize draw for a **£50 voucher**. • Only 60 participants in total • Better odds than the lottery! **Email – jasl201@exeter.ac.uk**	**I am available to test on the following dates and times:** Weds 21st March (10-4pm) Thurs 22nd March (10-1pm) Fri 23rd March (10-1pm) Mon 9th April (10-4pm) Mon 16th April (10-4pm) Tues 17th April (10-4pm) Weds 18th April (2-4pm) Mon 23rd April (10-4pm) Tues 24th April (10-4pm) Weds 20th June (10-3pm)
Would you like to take part in an interesting study that looks at the impact of exercise on mood? • Takes 45 minutes to complete • Gain 1 hour course credit if needed. • Plus prize draw for a **£50 voucher**. • Only 60 participants in total • Better odds than the lottery! **Email – jasl201@exeter.ac.uk**	**I am available to test on the following dates and times:** Weds 21st March (10-4pm) Thurs 22nd March (10-1pm) Fri 23rd March (10-1pm) Mon 9th April (10-4pm) Mon 16th April (10-4pm) Tues 17th April (10-4pm) Weds 18th April (2-4pm) Mon 23rd April (10-4pm) Tues 24th April (10-4pm) Weds 20th June (10-3pm)	**Would you like to take part in an interesting study that looks at the impact of exercise on mood?** • Takes 45 minutes to complete • Gain 1 hour course credit if needed. • Plus prize draw for a **£50 voucher**. • Only 60 participants in total • Better odds than the lottery! **Email – jasl201@exeter.ac.uk**	**I am available to test on the following dates and times:** Weds 21st March (10-4pm) Thurs 22nd March (10-1pm) Fri 23rd March (10-1pm) Mon 9th April (10-4pm) Mon 16th April (10-4pm) Tues 17th April (10-4pm) Weds 18th April (2-4pm) Mon 23rd April (10-4pm) Tues 24th April (10-4pm) Weds 20th June (10-3pm)

Hi Everyone,

I am a Trainee Clinical Psychologist looking to recruit some participants for an exercise based study located at St Luke's Campus, Heavitree Road. The study involves two stages that are completed at the same time. You will be asked to do a quick computer task and then to do one of three activities following this. Other measurements will also be taken during the study such as your height, weight and heart rate.

The whole study should take less than 45 minutes to complete and all participants will be entered into two separate prize draws (A £20 Amazon voucher for completing an online pre study questionnaire and a £50 Amazon voucher for completing the study). Rest assured I will be running these draws together with my supervisor! I am only recruiting 60 participants in total so that's better odds than the lottery! Plus those seeking course credit will also receive this on top!

I will be available to test on the following dates:

October - 17th (10-3pm), 22nd (10-5pm), 23rd (10-3pm), 29th (10-5pm), 30th (10-3pm)
November - 5th (5-8pm), 6th (5-8pm), 7th (10-3pm), 12th (5-8pm), 19th (10-5pm), 20th (10-3pm), 26th (5-8pm), 27th (5-8pm), 28th (10-3pm)
December - 10th (5-8pm), 11th (5-8pm), 12th (10-3pm)

Please could you let me know if you are interested in participating and when you would be available.

Thanks,

Joe

Joe Lowenstein
Trainee Clinical Psychologist

Appendix G

Psychometric Properties of Standardised Measures.

Self Assessment Manikin (SAM). Correlations of r=.937 for valence and r=.938 for arousal have been reported for a set of pictures using the Semantic Differential Scale (Mehrabian, & Russell, 1974), and the SAM (Bradley, & Lang, 1994).

Hypomanic Personality Scale (HPS). High scores on the HPS have been shown to predict symptoms of BD in the short term (Eckblad, & Chapman, 1986) and over the long-term (Blechert, & Meyer, 2005; Kwapil, Miller, Zinser, Chapman, & Eckblad, 2000). The HPS has demonstrated both good reliability (r=0.81, Eckblad, & Chapman, 1986; Klein, Lewinsohn, & Seeley, 1996) and internal consistency (α=0.89, Meyer, Druke, & Hautzinger, 2000).

Godin Leisure-Time Exercise Questionnaire (GLTEQ). The reliability of the GLTEQ is reported to be good over two weeks (r = 0.74-0.81, Godin, & Shephard, 1985; Salis, Buono, Roby, Micale, & Nelson, 1993) and one month (r = 0.62, Jacobs, Ainsworth, Hartman, & Leon, 1993). It has demonstrated moderate validity with an accelerometer (r=0.32) and the percentage of body fat (r=-0.43) and a strong correlation with maximum ventilation (r=0.56).

Self-Reported Physical Activity Index (SRPA). CRF levels estimated from the equation using the SRPA have been found to be strongly positively correlated with two other measures of CRF. The “gold standard” maximal graded exercise test (GXT) (r = 0.66) and the sub-maximal Rockport 1-mile walk test (r = 0.67, Mailey et al., 2010; McAuley et al., 2011).

Behavioural Engagement Scale (BES). The BES has demonstrated high internal consistency across 28 time points, (α= 0.85-0.94, Wright, Lam & Brown, 2008).

Rating of Perceived Exertion Scale (RPE). The RPE scale has been found to be a fairly good estimate of actual heart rate with strong correlations between RPE ratings and the indices of intensity and HR (r=0.62), percentage of maximal aerobic capacity (r=0.64), oxygen consumption (r=0.63), ventilation (r=0.61) and respiratory rate (0.72, Chen, Fan, & Moe, 2002).

Hospital Anxiety and Depression Scale (HADS). The Good internal consistency has been found for the HADS-D (α=.82) and good correlation with other

commonly used measures has been reported (r=.49-.83; Bjelland, Dahl, Haug, & Neckelmann, 2002).

Altman Self-Rating Mania Scale (ASRM). The test-retest reliability of the ASRM is significant (r=.86) and it is reported to be significantly correlated with other mania measures (r=.718- .766; Altman et al., 1997).

Demographic Form

Demographic Information

Date:_____ Participant Number_____

1. Gender:

Male ____ Female ____

2. Age:

_____ years Date of Birth _____/_____/_____

day month year

3. Current marital status: *(check all that apply)*

____ married with spouse
____ living with partner
____ separated
____ divorced
____ widowed
____ in an intimate relationship but not living together
____ never married

4. Highest level of education reached:

(please tick any that apply)

____ Left school before 16
____ Finished school at 16
____ Finished school at 18
____ Attended/attending university or equivalent
____ Completed university or equivalent
____ Completed postgraduate qualification

Total number of years of education completed _____ years

If the above options do not fit exactly (e.g. you left education at 16 and then returned as a mature student), please specify here:

……
……
……

5. Ethnicity:

What is your ethnic group?

(please tick as many boxes as you feel apply to you)

1 ☐ White

11 ☐ British (white)

111 ☐ English

112 ☐ Scottish

113 ☐ Welsh

114 ☐ Other British (white) - please specify

...……...……...…….

12 ☐ Irish

13 ☐ Any other White background - please specify

…….……...……..

2 ☐ Mixed

21 ☐ White & Black Caribbean

22 ☐ White & Black African

23 ☐ White & Asian

24 ☐ Any other Mixed background - please specify

……..….

3 ☐ Asian, Asian British, Asian English, Asian Scottish or Asian Welsh

31 ☐ Indian

32 ☐ Pakistani

33 ☐ Bangladeshi

34 ☐ Any other Asian background - please specify

……

4 ☐ Black, Black British, Black English, Black Scottish or Black Welsh

41 ☐ Caribbean

42 ☐ African

43 ☐ Any other Black background - please specify

……..……...….

5 ☐ Other ethnic background

51 ☐ Chinese

52 ☐ Middle Eastern/North African

53 ☐ Any other background - please specify

……

6. Exercise Preference: *(please note which exercise activities that you prefer to engage in)*

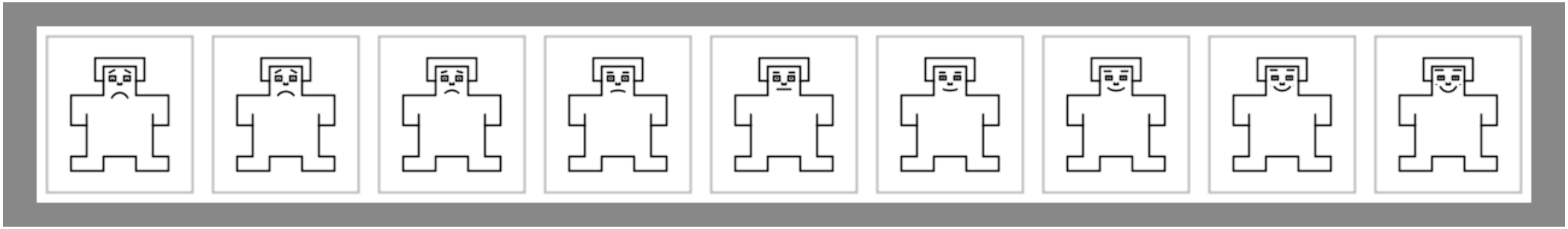
…….

……..

EXERCISE AND APPROACH MOTIVATION

Self-Assessment Manikin (SAM; Lang, 1980)

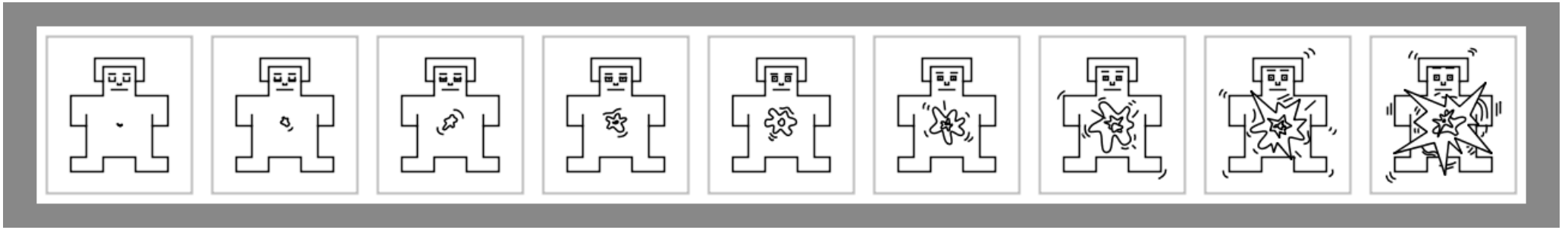
Please rate you current mood:



1 2 3 4 5 6 7 8 9

Sad **Happy**

Please indicate you current feelings of arousal:



1 2 3 4 5 6 7 8 9

Calm **Excited**

Hypomanic Personality Scale (HPS, Eckblad, & Chapman, 1986)

Hypomanic Personality Scale

Please answer each item true or false. Please do not skip any items. It is important that you answer every item, even if you are not quite certain which is the best answer.

An occasional item may refer to experiences that you have had only when taking drugs. Unless you have had the experience at other times (when not under the influence of drugs), mark it as if you have not had that experience.

Some items may sound like others, but all of them are slightly different. Answer each item individually, and don't worry about how you answered a somewhat similar previous item.

Circle either

	True or False
A. The beauty of sunsets is greatly overrated.	

	True or False
1. I consider myself to be pretty much an average kind of person.	
2. It would make me nervous to play the clown in front of other people.	
3. I am frequently so `hyper' that my friends kiddingly ask me what drug I'm taking.	
4. I think I would make a good night club comedian.	
5. Sometimes ideas and insights come to me so fast that I cannot express them all.	
6. When with groups of people, I usually let someone else be the centre of attention.	
7. In unfamiliar surroundings, I am often so assertive and sociable that I surprise myself.	
8. There are often times when I am so restless that it is impossible for me to sit still.	
9. Many people consider me to be amusing but kind of eccentric.	
10. When I feel an emotion, I usually feel it with extreme intensity.	
11. I am frequently in such high spirits that I can't concentrate on any one thing for too	

long.	
12. I sometimes have felt that nothing can happen to me until I do what I am meant to do in life.	
13. People often come to me when they need a clever idea	
14. I am no more self-aware than the majority of people.	
15. I often feel excited and happy for no apparent reason.	
16. I can't imagine that anyone would ever write a book about my life.	
17. I am usually in an average sort of mood, not too high and not too low.	
18. I often have moods where I feel so energetic and optimistic that I feel I could outperform almost anyone at anything.	
19. I have such a wide range of interests that I often don't know what to do next.	
20. There have often been times when I had such an excess of energy that I felt little need to sleep at night.	
21. My moods do not seem to fluctuate any more than most people's do.	
22. I very frequently get into moods where I wish I could be everywhere and do everything at once.	
23. I expect that someday I will succeed in several different professions.	
24. When I feel very excited and happy, I almost always know the reason why.	
25. When I go to a gathering where I don't know anyone, it usually takes me a while to feel comfortable.	
26. I think I would make a good actor because I can play many roles convincingly.	
27. I like to have others think of me as a normal kind of person.	
28. I frequently write down the thoughts and insights that come to me when I am thinking especially creatively.	
29. I have often persuaded groups of friends to do something really adventurous or crazy.	
30. I would really enjoy being a politician and hitting the campaign trail.	
31. I can usually slow myself down when I want to.	

32. I am considered to be kind of a `hyper' person.	
33. I often get so happy and energetic that I am almost giddy.	
34. There are so many fields I could succeed in that it seems a shame to have to pick one.	
35. I often get into moods where I feel that many of the rules of life don't apply to me.	
36. I find it easy to get others to become sexually interested in me.	
37. I seem to be a person whose mood goes up and down easily.	
38. I frequently find that my thoughts are racing.	
39. I am so good at controlling others that it sometimes scares me.	
40. At social gatherings, I am usually the `life of the party'.	
41. I do most of my best work during brief periods of intense inspiration.	
42. I seem to have an uncommon ability to persuade and inspire others.	
43. I have often been so excited about an involving project that I didn't care about eating or sleeping.	
44. I frequently get into moods where I feel very speeded-up and irritable.	
45. I have often felt happy and irritable at the same time.	
46. I often get into excited moods where it's almost impossible for me to stop talking.	
47. I would rather be an ordinary success in life than a spectacular failure.	
48. A hundred years after I'm dead, my achievements will probably have been forgotten.	

Score _____

Godin Leisure-Time Exercise Questionnaire. (GLTEQ, Godin, & Shephard, 1985; 1997)

Godin Leisure-Time Exercise Questionnaire

1. During a typical **7-Day period** (a week), how many times on the average do you do the following kinds of exercise for **more than 15 minutes** during your free time (write on each line the appropriate number).

Times Per Week

a) STRENUOUS EXERCISE

_____

(HEART BEATS RAPIDLY)
(e.g., running, jogging, hockey, football, soccer,
squash, basketball, cross country skiing, judo,
roller skating, vigorous swimming,
vigorous long distance bicycling)

b) MODERATE EXERCISE

_____

(NOT EXHAUSTING)
(e.g., fast walking, baseball, tennis, easy bicycling,
volleyball, badminton, easy swimming, alpine skiing,
popular and folk dancing)

c) MILD EXERCISE

_____

(MINIMAL EFFORT)
(e.g., yoga, archery, fishing from river bank, bowling,
horseshoes, golf, snow-mobiling, easy walking)

2. During a typical **7-Day period** (a week), in your leisure time, how often do you engage in any regular activity **long enough to work up a sweat** (heart beats rapidly)?

OFTEN	SOMETIMES	NEVER/RARELY
1. ☐	**2.** ☐	**3.** ☐

Self-Reported Physical Activity Index (SRPA, Jurca et al., 2005)

SRPA

Please indicate which level of activity best describes your usual pattern of daily physical activities, including activities related to your house and family care, transportation, occupation, exercise and wellness and leisure or recreational purposes.

Level 1:	Inactive or little activity other than usual daily activities.	☐ (0)
Level 2:	Regularly (≥5 days per week) participate in physical activities requiring low levels of exertion that result in slight increases in breathing and heart rate for at least **10 minutes** at a time.	☐ (0.32)
Level 3:	Participate in aerobic exercises such as brisk walking, jogging or running, cycling, swimming, or vigorous sports at a comfortable pace or other activities requiring similar levels of exertion for **20 to 60 minutes** per week.	☐ (1.06)
Level 4:	Participate in aerobic exercises such as brisk walking, jogging or running, cycling, swimming, or vigorous sports at a comfortable pace or other activities requiring similar levels of exertion for **1 to 3 hours** per week.	☐ (1.76)
Level 5:	Participate in aerobic exercises such as brisk walking, jogging or running, cycling, swimming, or vigorous sports at a comfortable pace or other activities requiring similar levels of exertion for **over 3 hours** per week.	☐ (3.03)

Behavioural Engagement Scale (BES, Krauss, Depue, Arbisi, & Spoont 1992)

BES - A

1. Exuberant vitality, surging with energy

2. Vigorous, extremely energetic

3. Active, lively, animated

4. Fresh, slightly energetic

5. Fairly fresh, adequate energy

6. Slightly tired, somewhat lacking in energy

7. Rather tired, lethargic, not much energy

8. Very fatigued, sluggish

9. Tremendously weary, hard to keep going

10. Utterly exhausted, entirely worn out, practically at a standstill

BES - B

1. Everything is possible for me

2. Extremely optimistic

3. Very confident about things

4. Feel self-assured, things seem good

5. Feel adequate about myself and prospects

6. Slightly discouraged about things

7. Little confidence in things, about my abilities

8. Feel inadequate, nothing seems to be going right

9. Extremely pessimistic about everything

10. Everything seems bleak and futile, feel totally inept

BES - C

1. Elated, euphoric, ecstatic

2. Tremendous delight and happiness

3. Cheerful, in high spirits

4. Pretty good

5. O.K.

6. A little bit low

7. In low spirits, somewhat sad and blue

8. Clearly depressed

9. Very depressed, feels painful

10. Utter depression and gloom

BES - D

1. Thoughts are literally racing through my head

2. I have rapid, penetrating ideas

3. Thoughts come quickly and effortlessly

4. Thoughts are fairly quick and clear

5. My mind is alert

6. Not particularly alert

7. Thoughts are slow, takes longer to pick up on things

8. Thoughts are sluggish

9. My mind feels dull and monotonous

10. My mind is stagnant, dead, nothing moves

BES - E

1. Passionately absorbed in the world's excitement

2. Excited, stimulated, great zest for life

3. Enthusiastic about life

4. Motivated and interested in things

5. Somewhat interested in things

6. Not very enthusiastic about things

7. Generally unenthusiastic about life

8. Apathetic, unmotivated

9. No real interest or desire for anything

10. Nothing is interesting - not even family or friends

Borg Rating of Perceived Exertion (RPE, Borg, 1998)

RPE - V

6 No exertion at all

7 Extremely light

8

9 Very light

10

11 Light

12

13 Somewhat hard

14

15 Hard (heavy)

16

17

18

19 Extremely hard

20 Maximal Exertion

RPE – M

6 No exertion at all

7 Extremely light

8

9 Very light

10

11 Light

12

13 Somewhat hard

14

15 Hard (heavy)

16

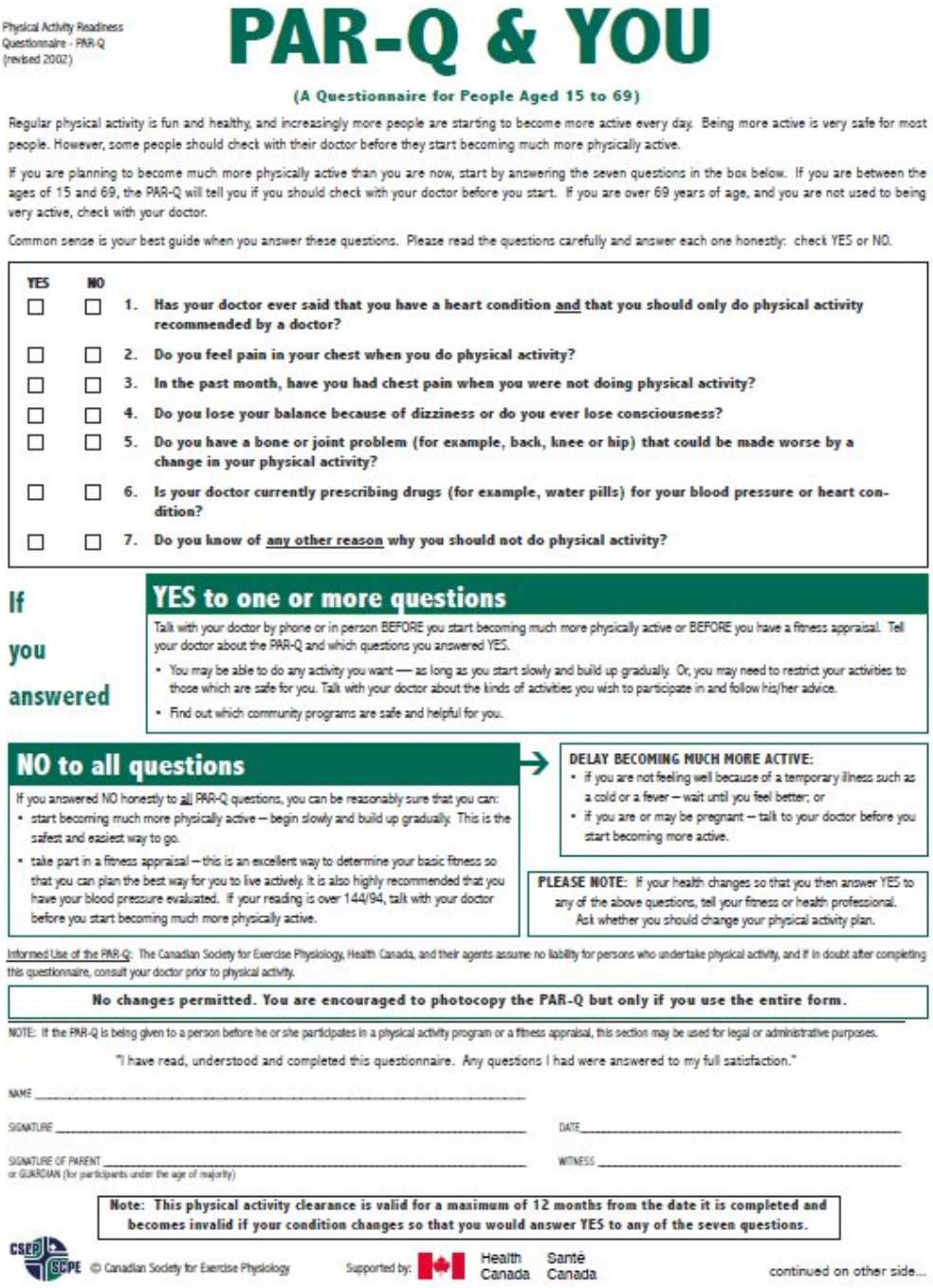
17

18

19 Extremely hard

20 Maximal Exertion

Physical Activity Readiness Questionnaire (PAR-Q; Thomas, Reading, & Shephard, 1992)



Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO		
☐	☐	1.	**Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?**
☐	☐	2.	**Do you feel pain in your chest when you do physical activity?**
☐	☐	3.	**In the past month, have you had chest pain when you were not doing physical activity?**
☐	☐	4.	**Do you lose your balance because of dizziness or do you ever lose consciousness?**
☐	☐	5.	**Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?**
☐	☐	6.	**Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
☐	☐	7.	**Do you know of any other reason why you should not do physical activity?**

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- if you are or may be pregnant – talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME _____

SIGNATURE _____ DATE _____

SIGNATURE OF PARENT or GUARDIAN (for participants under the age of majority) _____ WITNESS _____

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

CSEP SCPE © Canadian Society for Exercise Physiology Supported by: Health Canada Santé Canada

continued on other side...

Cardiovascular Disease (CVD) risk assessment form (risk assessment reference SSHS/HAZ/0078 & SSHS/HAZ/0080)

CVD

Please complete questions with a * next to them.

CVD Risk Factor Assessment for Exercise Testing and Prescription

To be used following completion of PAR-Q

Study: _____ **Subject ID:** _____ **Date:** _____

	Enter a 1 for yes or 0 for no
* Family History [1]	____
* Current smoker or smoker in the last 6 months	____
Systolic BP> 140 or Diastolic BP > 90 mm Hg (If systolic BP > 200 or Diastolic > 110 **then do not test**)	____
BMI ≥ 30, or waist girth > 102 cm in men or > 88 cm in women [2]	____
* Sedentary [3]	____
* Age > 45 if male or > 55 if female	____
Sum of positive risk factors (A1)	☐

If sum of above positive risk factors, A1, is **zero** then OK to test without further assessment.

If sum is **1 or more** then the following blood measurements **must** be made and assessed:-

	Enter a 1 for yes or 0 for no
Total cholesterol > 5.2 mmol·l^{-1}	____
Fasting blood glucose ≥ 6.1 mmol·l^{-1} or non-fasting blood glucose > 11.1 mmol·l^{-1} [4]	____
Sum of positive risk factors (A2)	☐

	Enter a 1 for yes or 0 for no (enter 0 if unknown)
HDL-C > 1.6 mmol·l^{-1}	____
Sum of negative risk factors (B)	☐
Total risk factor score [(A1 + A2) – B]	☐

(1) Family History refers to heart attack in father or brother before age 55 or mother or sister before age 65.

(2) Waist girth should be measured with an inelastic tape in a horizontal plane at the narrowest part of the torso.

(3) Sedentary refers to individuals not engaged in a regular exercise programme or those not undertaking 30 minutes of moderate physical activity on three or more days of the week

(4) Impaired fasting glucose should be confirmed by measurements on at least two separate occasions.

Hospital Anxiety and Depression Scale (HADS; Zigmond, & Snaith, 1983)

HADS

Thinking about the last week, please provide a rating for each of the statements below.

I still enjoy the things I used to enjoy:	
Definitely as much	0
Not quite so much	1
Only a little	2
Hardly at all	3

I can laugh and see the funny side of things:	
As much as I always could	0
Not quite so much now	1
Definitely not so much now	2
Not at all	3

I feel cheerful:	
Not at all	3
Not often	2
Sometimes	1
Most of the time	0

I feel as if I am slowed down:	
Nearly all the time	3
Very often	2
Sometimes	1
Not at all	0

I can enjoy a good book or radio or TV program:	
Often	0
Sometimes	1
Not often	2
Very seldom	3

I look forward with enjoyment to things:	
As much as I ever did	0
Rather less than I used to	1
Definitely less than I used to	2
Hardly at all	3

I have lost interest in my appearance:	
Definitely	3
I don't take as much care as I should	2
I may not take quite as much care	1
I take just as much care as ever	0

Altman Self-Rating Mania Scale (ASRM; Altman, Hedeker, Peterson, Davis, 1997)

ASRM

Instructions

On this questionnaire are groups of five statements; read each group of statements carefully.
Choose the one statement in each group that best described the way you have been feeling for the past week.
Circle the number next to the statement you picked.
Please note: The word “occasionally” when used here means once or twice; “often” means several times or more; “frequently” means most of the time.
---

0 I do not feel happier or more cheerful than usual 1 I occasionally feel happier or more cheerful than usual 2 I often feel happier or more cheerful than usual 3 I feel happier or more cheerful than usual most of the time 4 I feel happier or more cheerful than usual all of the time

I do not feel more self-confident than usual I occasionally feel more self-confident than usual I often feel more self-confident than usual I feel more self-confident than usual most of the time I feel extremely self-confident all of the time

I do not need less sleep than usual I occasionally need less sleep than usual I often need less sleep than usual I frequently need less sleep than usual I can go all day and night without any sleep and still not feel tired

I do not talk more than usual I occasionally talk more than usual I often talk more than usual I frequently talk more than usual I talk constantly and cannot be interrupted

0 I have not been more active (either socially, sexually, at work, home or school) than usual 1 I have occasionally been more active than usual 2 I have often been more active than usual 3 I have frequently been more active than usual 4 I am constantly active or on the go all the time

Mania Symptoms Questionnaire

MSQ

Please rate how much you currently feel:

Alert

1----------2----------3----------4----------5----------6----------7----------8----------9
Very slightly A little Moderately Quite a bit Extremely

Jittery

1----------2----------3----------4----------5----------6----------7----------8----------9
Very slightly A little Moderately Quite a bit Extremely

Tired

1----------2----------3----------4----------5----------6----------7----------8----------9
Very slightly A little Moderately Quite a bit Extremely

Attentive

1----------2----------3----------4----------5----------6----------7----------8----------9
Very slightly A little Moderately Quite a bit Extremely

Active

1----------2----------3----------4----------5----------6----------7----------8----------9
Very slightly A little Moderately Quite a bit Extremely

Strong

1----------2----------3----------4----------5----------6----------7----------8----------9
Very slightly A little Moderately Quite a bit Extremely

Powerful

1----------2----------3----------4----------5----------6----------7----------8----------9
Very slightly A little Moderately Quite a bit Extremely

Determined

1----------2----------3----------4----------5----------6----------7----------8----------9
Very slightly A little Moderately Quite a bit Extremely

Creative

1----------2----------3----------4----------5----------6----------7----------8----------9
Very slightly A little Moderately Quite a bit Extremely

Insightful

1----------2----------3----------4----------5----------6----------7----------8----------9
Very slightly A little Moderately Quite a bit Extremely

Inspired

1----------2----------3----------4----------5----------6----------7----------8----------9
Very slightly A little Moderately Quite a bit Extremely

Sometimes people have a feeling their thoughts are coming slowly and at other times people feel that their thoughts are 'racing'. What do you feel are the speed of your thoughts at this moment in time?

1----------2----------3----------4----------5----------6----------7----------8----------9
Very slightly A little Moderately Quite a bit Extremely

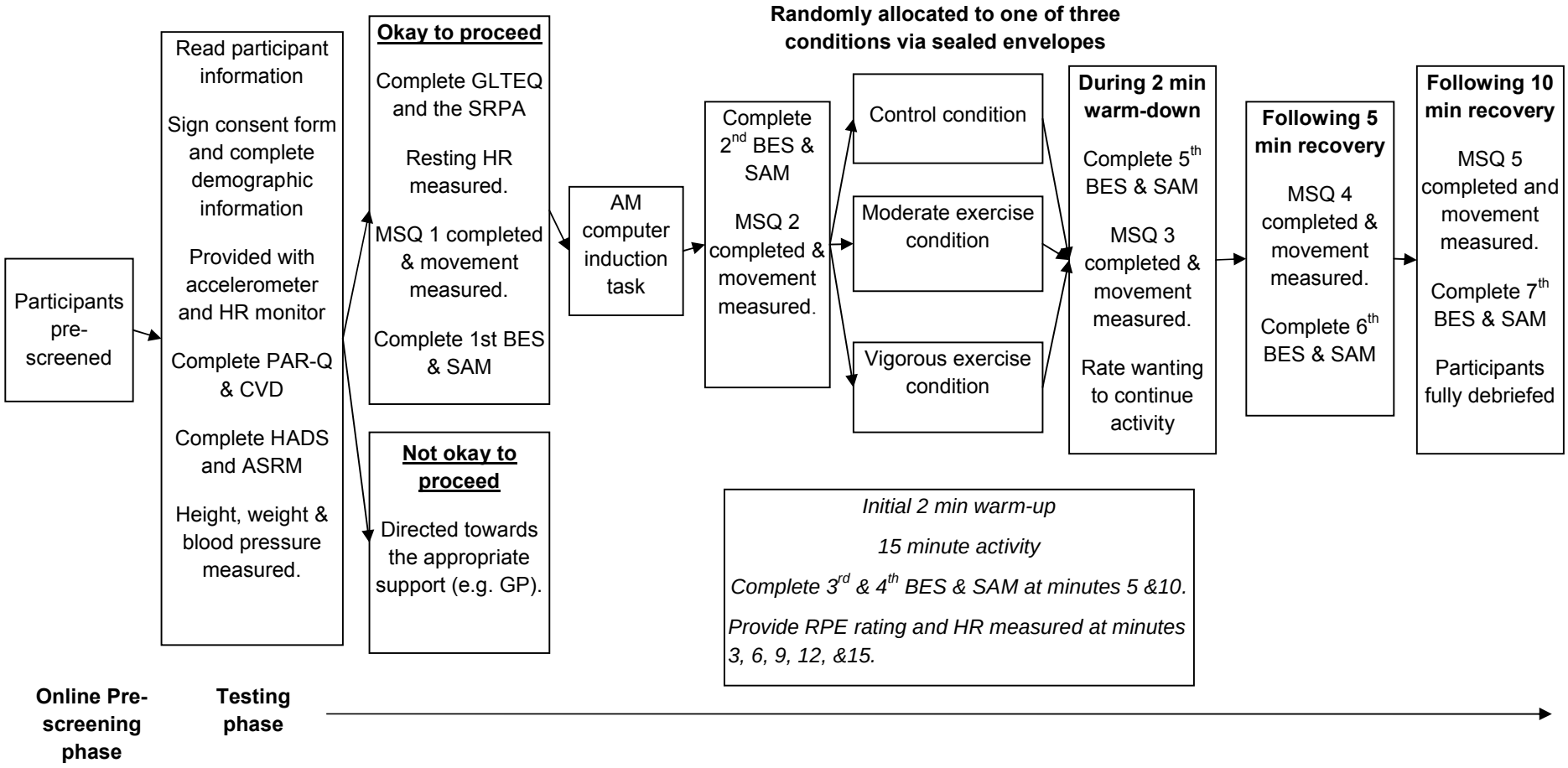
Appendix H

Mood Induction Task Instructions

During this computer task, you will see a series of statements presented one letter at a time on the screen. I would like you to read each word of each sentence in your head as it appears and then attempt to respond to the feeling suggested by each statement. Try to think of yourself as definitely being and moving into that state. When you're ready to begin, click the mouse once, and the study will begin. And remember, as soon as words start to come up on the screen, you should be reading them.

Appendix I

Procedure Flow Chart



Appendix J

Ethics

Ethical considerations. The following ethical issues were considered.

Will the research involve any of the following people?

Children under 16 years Yes/**No**

Persons with special needs Yes/**No**

Persons with mental health disorders Yes/**No**

Persons who are detained Yes/**No**

If 'yes' to any of the above please describe:

Will feedback/debriefing be provided **Yes**/No/NA

Will subjects have the right to withdraw **Yes**/No*/NA

Will records remain confidential **Yes**/No*/NA

Will anonymity be ensured **Yes**/No*/NA

Will the study involve deception Yes*/**No**/NA

Will invasive procedures be included Yes*/**No**/NA

If '*' to any of the above, please elaborate:

Risk matrix. A risk matrix was developed detailing the ethical issues that were anticipated in the study and how these issues were managed in accordance with the British Psychological Society's Code of Ethics and Conduct (2006).

Risk Matrix

Identified Risk	Management of Risk	Level of Risk, (in light of management)
Informed consent	Obtain signed consent forms from each participant prior to the start of the experiment.	Low
Freedom from coercion	Make clear within description that participation is solely for research purposes and no treatment is provided as part of the study.	Low
Maintaining confidentiality and	Use participant codes, not names Use password protected computers	Low

anonymity	Any hard copies of data to be stored in secure, lockable cabinets.	
Breaking confidentiality (e.g. due to risk of harm to self or others)	Ensure participants are aware of limitations of maintaining confidentiality Discuss any issues arising with research supervisor(s).	Low-medium
Loss of data	Ensure electronic data is backed up and a hard copy of raw data is kept Store data securely.	Low
Emotional distress over the course of the research	Management plan identified and judged by Exeter University Ethics Committee.	Low
Physical Risk for exercise	First aid trained individual present in the building at all times. Participants asked to supply current fitness levels and fully informed about the nature of the study. CRV and PAR-Q completed prior to exercise to make sure the participants can cope with the demands of the study. Period of recovery following the exercise.	Low-medium
Weighing of participants	Ensure participants understand that this is part of the procedure and obtain signed consent forms from each participant prior to the start of the experiment. Highlight confidentiality of results to participants	Low-Medium
Debriefing	Participants to be fully debriefed at the end of the study about the nature of the research.	Low
Suitability and management of the research process	Trainee is supported by research supervisors. Research proposal is evaluated for scientific quality and feasibility by the DClinPsy research team. Any potential problems or risks identified will be addressed before the project is passed Research consultancy is available to obtain independent feedback regarding concerns raised by the review.	Low
Feasibility of the project	Considered by trainee and research supervisors in planning stage of project	Low

	Evaluated by DClin research team and judged to be feasible.	
Failure to recruit enough participants	Continually monitored and discussed with supervisors If problems are being experienced, solutions to be discussed at earliest possible time.	Low-medium
Sufficient resources to conduct the research	Power calculations have allowed consideration of the number of participants Material resources have been identified as part of the research process and evaluated for feasibility. Time resources allocated in DClinPsy Programme evaluated as sufficient to carry out research.	Low

Ethical documentation.

Ethical approval letter.

Psychology Research Ethics Committee

Psychology, College of Life & Environmental Sciences

Washington Singer Laboratories
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Exeter
EX4 4QG

Telephone +44 (0)1392 724611
Fax +44 (0)1392 724623
Email Marilyn.evans@exeter.ac.uk

To: **Joe Lowenstein**
From: **Cris Burgess**
CC: **Kim Wright & Adrian Taylor**
Re: **Application 2011/535 Ethics Committee**
Date: **24th Jan 2012**

The School of Psychology Ethics Committee has now discussed your application, ***2011/535*** – **A study investigating the affects of different types of exercise on the maintenance of approach motivation levels using a population anaogous to individuals with bipolar disorder .** The project has been approved in principle for the duration of your study.

The agreement of the Committee is subject to your compliance with the British Psychological Society Code of Conduct and the University of Exeter procedures for data protection (http://www.ex.ac.uk/admin/academic/datapro/). In any correspondence with the Ethics Committee about this application, please quote the reference number above.

I wish you every success with your research.

Cris Burgess
Chair of Psychology Research Ethics Committee

Email requesting amendments.

From: Burgess, Cris
Sent: 18 March 2012 21:19
To: Lowenstein, Joseph
Subject: RE: Re: Application 2011/535 Ethics Committee

Dear Joe,

Thank you for the follow-up and just as well! Your previous messages ended up in my junkmail folder. Very sorry, I have no idea why.

I've now had a chance to read the details of your amendment and I'm happy for you to go ahead with the modifications you describe. I wish you all the best with your ongoing research.

Best regards,
Cris.

Dr Cris Burgess
Senior Lecturer in Psychology

Education Manager – Undergraduate Psychology
Programme Director, BSc in Psychology
Chair, Psychology Research Ethics Committee
Exams Officer and Chair, Undergraduate Board of Examiners

Psychology, College of Life & Environmental Sciences
University of Exeter

From: Lowenstein, Joseph

Sent: 16 March 2012 15:17
To: Burgess, Cris
Subject: FW: Re: Application 2011/535 Ethics Committee

Dear Cris,

Apologies for a third email but I wanted to make sure you had received the previous emails in relation to changes to my ethics application. I am keen to gain approval for these relatively small changes prior to testing next week.

Many thanks,

joe

Joe Lowenstein
Trainee Clinical Psychologist

From: Lowenstein, Joseph
Sent: 09 March 2012 14:43
To: Burgess, Cris
Subject: FW: Re: Application 2011/535 Ethics Committee

Dear Cris,

Apologies but I didn't know if you had received my email below sent on 28th Feb. thanks,

Joe Lowenstein
Trainee Clinical Psychologist

From: Lowenstein, Joseph
Sent: 28 February 2012 20:20
To: Burgess, Cris
Subject: Re: Application 2011/535 Ethics Committee

Hi Cris,

Re: Application 2011/535 Ethics Committee

I would like to make a brief amendment to my ethics application which was approved recently. I would like to add in two further measures to assess the participants current mood both of which are attached. These are:

The Hospital anxiety and Depression Scale (HADS) – A 14 item measure that assesses current levels of anxiety and depression.
Altman Self-Rating Mania Scale (ASRM) - A 5-item self rating mania scale, designed to assess the presence and/or severity of manic symptoms.

This will not affect the participant information previously approved because participants are already told “When you started the testing, you completed a number of questionnaires. These were used to get a measure of your overall mood, the amount of exercise you have done recently and your current fitness levels”

In terms of risk, if any of the participants score higher than the clinical cut off scores (7 for the HADS and 6 for the ASRM) then the Mood Disorders Center Risk Protocol will be followed and they will be referred to the appropriate support service such as the university counselling service or their GP however this is not expected to be likely.

If you have any further questions please do not hesitate to contact me.

thanks,

Joe Lowenstein

Email requesting further amendments.

_____

From: Burgess, Cris
Sent: 22 August 2012 13:44
To: Lowenstein, Joseph
Subject: RE: Application 2011/535 Ethics Committee

Hi Joe,

Thank you for letting me know, that is no problem as long as you have all the appropriate permissions.

Cheers,
Cris.

_____

Dr Cris Burgess
Senior Lecturer

Education Manager, Undergraduate Psychology
Programme Director, BSc Psychology/BA Psychology
Chair, Psychology Research Ethics Committee
Exams Officer and Chair, Psychology Board of Examiners

T: 01392 724627

_____

-----Original Message-----
From: Lowenstein, Joseph
Sent: 18 July 2012 10:00
To: Burgess, Cris

Subject: Application 2011/535 Ethics Committee

Dear Cris,

I would like to make a brief amendment to my ethics application which currently has approval. The change is in relation to the population I would like to recruit from. I would like to also test Exeter college students along with the undergraduates I am currently testing. I would not be testing anyone under the age of 18 so no increased consent would be needed however my supervisor felt that I should run this by you prior to making contact with them.

If you have any further questions please do not hesitate to contact me.

thanks,

Joe Lowenstein
Trainee Clinical Psychologist

Appendix K

Participant Information

Exercise and its Effect on Mood Levels

Participant Information

Purpose of Study

The purpose of the study is to look at how different types of exercise affect different people's mood state. Different types of activities can affect our moods in different ways, and this can vary between different people.

What the Study Involves

This study involves two parts. The first part involves a computer task in which you will be shown a number of statements and asked to read them. The second part involves three conditions which all involve a 15 minute activity. You will only be asked to take part in one condition and this will be randomly allocated. The activity will be either a cycling activity or a reading activity. Throughout the study you will be asked to complete a number of questionnaires and at the start your height and weight will be measured. Your heart rate will be monitored throughout the and you will be asked to provide information during the study of how hard you feel you are exercising and how you feel. Also, you will be asked to provide some demographic information such as age, gender and current exercise activities.

Confidentiality

All information that you provide is completely anonymous and will be kept strictly confidential. For example, all your information will be identified by a code only. The consent form below which requires your name will be stored separately so it cannot be matched to the other information you give. Confidentiality may be broken only when required by the law or professional guidelines for psychologists, for example when there is indication of a significant risk of harm to you or someone else.

Withdrawal/premature completion

You have the right to withdraw your results from this study at any point and your participation is completely voluntary. Although you will be asked to complete questionnaires without omitting items, if you do not wish to answer a question you may omit it.

Potential Risks and Ethical Consideration

Some of the questionnaires ask about personal information that you may not wish to provide. Although you will be asked to complete questionnaires without omitting items, if you do not wish to answer a question you may omit any questions you feel too uncomfortable answering. As part of the study you will be asked to do a task that may make you feel more excited and elevated in mood.

The experiment may involve physical exertion and therefore may be challenging. If at any point you feel dizzy or short of breath you are asked to stop exercising immediately. There will always be a first aid trained individual present during the testing. If you know of any reason why it may not be safe for you to engage in exercise, including vigorous exercise (at an intensity that leaves you unable to hold a conversation at the same time) it is very important that you let the researcher know before commencing the study.

Remember that you are free to leave and withdraw your consent at any point without it affecting your course credits, if you are claiming these as remuneration.

Invitation to ask further questions

If you have any questions regarding the study please ask the experimenter before completing the consent form. Should you have any questions or concerns after completion of the study please contact Joe Lowenstein, doctoral student in clinical psychology on jasl201@exeter.ac.uk. You may also contact the academic supervisor, Dr Kim Wright, on K.A.Wright@exeter.ac.uk.

Appendix L

Informed Consent

Participant Number_____

Exercise and its effects on approach motivation levels

Informed consent

I give my informed consent to participate in this study on exercise and its effect on approach motivation levels.

I have read and understood the consent form and participant information. Upon checking the box below, I give my informed consent.

Name: _____ Date: _____

I give my consent to the above study ☐

Questions or concerns about the study can be addressed to the Chair of the Ethics Committee, School of Psychology, University of Exeter.

Appendix M

Debriefing Sheet

Exercise and its Effect on Approach Motivation Levels

Debriefing Sheet

The Purpose of the Study

The purpose of the study is to look at how different types of exercise affect a person's levels of approach motivation. Approach motivation can be defined as the energization of behaviour by, or the direction of behaviour toward, positive stimuli (objects, events, possibilities). So put simply, it is the process involved when a person takes action towards anything that gives them happiness, pleasure, or joy. This can include things like spending time with a loved one, eating a favourite food or exercising to name a few. Its basic adaptive function is to ensure that organisms obtain resources (e.g. food, shelter, companionship) and is therefore essential to survival of the individual and the species.

Certain intensities of exercise are thought to have an effect on a person's approach motivation levels by possibly impacting on their affect. This study is looking to examine these effects.

The Procedure

Prior to the start of this study, you completed a questionnaire online which provides a measure of a personality style associated with fearlessness, disinhibition, increased risk-taking and elated mood.

When you started the testing, you completed a number of questionnaires. These were used to get a measure of your overall mood, the amount of exercise you have done recently and your current fitness levels. You also completed a number of questionnaires wearing a watch. This was done to

measure if you were having any feelings of increased energy, creativity or power and the amount you moved around.

Then you completed a computer task. During this task you read a number of statements that were designed to be increasingly exciting. The purpose of this task was to evoke feelings of excitement and approach motivation.

Following the computer task you completed further questionnaires and then did one of the experimental conditions. Depending on which condition you participated in, you were asked to do a different type of activity for 15 minutes and provide several ratings of your mood. This was done to see if the condition you participated in had any effect on your mood levels. If you were in an exercise condition, you were also asked to judge your current exercise effort a number of times. This was to make sure you were exercising at the right level.

Following the experimental condition you were asked to provide a number of further mood ratings and your movement was again measured. This was done to see if the condition you participated in had any effect on your mood and your movement.

Whilst this study was not designed to induce distress, should you experience distress or upset at any point in connection with this study then please contact the experimenter (details given below) to discuss any aspect of the study or your response to it. You can also contact the research supervisor (see below).

Thank you for your participation in this study.

Experimenter's contact details: Joe Lowenstein on jasl201@exeter.ac.uk
Supervisor's contact details: Kim Wright on K.A.Wright@exeter.ac.uk

Appendix N

Expanded Results

Assumptions of normality. Prior to the main analysis, the data was checked for normality. Histograms for each measure were visually examined and the data was considered be normally distributed.

Baseline data. One-way ANOVAs were run on all baseline data to ensure that the three conditions did not differ significantly. Variables found to be significantly different across conditions were gender $F(2, 58) = 3.80$, $p = .028$, fitness scores $F(2, 58) = 3.82$, $p = .028$, BES scores $F(2, 58) = 3.33$, $p = .043$, thought speed $F(2, 58) = 3.29$, $p = .044$, and SAMS valence scores $F(2, 58) = 10.46$, $p < .001$. These were therefore used as covariates during subsequent analyses.

One-way ANOVA of baseline data across conditions.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Age	Between Groups	2.743	2	1.371	.099	.906
	Within Groups	806.110	58	13.898		
	Total	808.852	60			
Gender	Between Groups	1.661	2	.831	3.803	.028
	Within Groups	12.667	58	.218		
	Total	14.328	60			
Marital_Status	Between Groups	2.248	2	1.124	.484	.619
	Within Groups	134.702	58	2.322		
	Total	136.951	60			
Level_Education	Between Groups	.201	2	.101	.361	.699
	Within Groups	16.160	58	.279		
	Total	16.361	60			
Ethnicity	Between Groups	57193.862	2	28596.931	2.442	.096
	Within Groups	679341.286	58	11712.781		
	Total	736535.148	60			
Exercise_Preference1	Between Groups	26.878	2	13.439	.463	.632
	Within Groups	1597.967	55	29.054		
	Total	1624.845	57			
Exercise_Preference2	Between Groups	62.646	2	31.323	.739	.484
	Within Groups	1610.964	38	42.394		
	Total	1673.610	40			
Exercise_Preference3	Between Groups	32.350	2	16.175	.224	.805
	Within Groups	505.750	7	72.250		
	Total	538.100	9			
HPS_TOTAL	Between Groups	6.670	2	3.335	.068	.934
	Within Groups	2833.219	58	48.849		
	Total	2839.889	60			

BMI	Between Groups	.404	2	.202	.048	.953
	Within Groups	242.066	58	4.174		
	Total	242.470	60			
HADS_TOTAL	Between Groups	.075	2	.038	.025	.975
	Within Groups	87.138	58	1.502		
	Total	87.213	60			
ASRM_TOTAL	Between Groups	4.903	2	2.451	.691	.505
	Within Groups	205.786	58	3.548		
	Total	210.689	60			
GLTEQ_Total	Between Groups	695.873	2	347.937	.575	.566
	Within Groups	35069.438	58	604.645		
	Total	35765.311	60			
SRPA_Total	Between Groups	24.457	2	12.229	3.822	.028
	Within Groups	185.581	58	3.200		
	Total	210.038	60			
Resting_HR	Between Groups	605.054	2	302.527	2.125	.129
	Within Groups	8258.422	58	142.387		
	Total	8863.477	60			
MSQ1_Pre_Computer_TOTAL	Between Groups	518.415	2	259.208	2.131	.128
	Within Groups	7055.388	58	121.645		
	Total	7573.803	60			
MSQ1_Speed_of_Thoughts	Between Groups	13.209	2	6.605	3.299	.044
	Within Groups	116.102	58	2.002		
	Total	129.311	60			
BES1_TOTAL	Between Groups	38.892	2	19.446	3.334	.043
	Within Groups	338.321	58	5.833		
	Total	377.213	60			
SAM1_A	Between Groups	11.191	2	5.596	10.457	.000
	Within Groups	31.038	58	.535		
	Total	42.230	60			
SAM1_B	Between Groups	4.158	2	2.079	1.057	.354
	Within Groups	114.071	58	1.967		
	Total	118.230	60			
Actiwatch1_Pre_AVERAGE	Between Groups	.142	2	.071	2.650	.079
	Within Groups	1.556	58	.027		
	Total	1.698	60			

Condition validity. In order to establish the validity of the three conditions, a one-way ANOVA was conducted to see if there were significant differences between the three conditions in HR and RPE ratings during the activity. The results indicated that there was a significant effect of condition on the RPE levels $F(2, 58) = 699.72$, $p < .001$, and HR $F(2, 58) = 117.13$, $p < .001$.

One-way ANOVA of RPE and HR across conditions.

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
RPE_Average	Control	21	6.1143	.36095	.07877	5.9500	6.2786	6.00	7.20
	Moderate	20	11.9700	1.22479	.27387	11.3968	12.5432	10.00	15.00
	Vigorous	20	15.4000	.58400	.13059	15.1267	15.6733	14.80	16.60
	Total	61	11.0787	3.96758	.50800	10.0625	12.0948	6.00	16.60
HR_Average	Control	21	75.2000	7.92263	1.72886	71.5937	78.8063	61.40	91.40
	Moderate	20	133.8400	14.67939	3.28241	126.9698	140.7102	96.00	154.60
	Vigorous	20	142.3900	20.93453	4.68110	132.5923	152.1877	117.20	168.80
	Total	61	116.4557	33.89079	4.33927	107.7759	125.1356	61.40	168.80

ANOVA

				Sum of Squares	df	Mean Square	F	Sig.
RPE_Average	Between Groups	(Combined)		906.915	2	453.457	699.711	.000
		Linear Term	Unweighted	883.275	1	883.275	1362.944	.000
			Weighted	887.144	1	887.144	1368.914	.000
			Deviation	19.771	1	19.771	30.507	.000
	Within Groups			37.588	58	.648		
	Total			944.502	60			
HR_Average	Between Groups	(Combined)		55238.724	2	27619.362	117.130	.000
		Linear Term	Unweighted	46246.058	1	46246.058	196.124	.000
			Weighted	46808.457	1	46808.457	198.509	.000
			Deviation	8430.267	1	8430.267	35.752	.000
	Within Groups			13676.406	58	235.800		
	Total			68915.130	60			

Manipulation check.

Repeated t-tests pre and post laboratory induction.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	MSQ1_Pre_Computer_TOTAL	58.26	61	11.235	1.439
	MSQ2_Post_Computer_TOTAL	65.20	61	13.439	1.721
Pair 2	MSQ1_Speed_of_Thoughts	4.25	61	1.468	.188
	MSQ2_Speed_of_Thoughts	5.41	61	1.774	.227

Pair 3	BES1_TOTAL	22.52	61	2.507	.321
	BES2_TOTAL	18.79	61	3.436	.440
Pair 4	Actiwatch1_Pre_AVERAGE	-.3531	61	.16822	.02154
	Actiwatch2_Post_Computer_AVERAGE	-.3215	61	.16316	.02089
Pair 5	SAM1_A	6.21	61	.839	.107
	SAM2_A	6.77	61	.883	.113
Pair 6	SAM1_B	4.21	61	1.404	.180
	SAM2_B	4.97	61	1.958	.251

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	MSQ1_Pre_Computer_TOTAL - MSQ2_Post_Computer_TOTAL	-6.934	7.300	.935	-8.804	-5.065	-7.419	60	.000
Pair 2	MSQ1_Speed_of_Thoughts - MSQ2_Speed_of_Thoughts	-1.164	1.463	.187	-1.539	-.789	-6.215	60	.000
Pair 3	BES1_TOTAL - BES2_TOTAL	3.738	2.235	.286	3.165	4.310	13.060	60	.000
Pair 4	Actiwatch1_Pre_AVERAGE - Actiwatch2_Post_Computer_AVERAGE	-.03167	.19915	.02550	-.08267	.01934	-1.242	60	.219
Pair 5	SAM1_A - SAM2_A	-.557	.742	.095	-.747	-.367	-5.866	60	.000
Pair 6	SAM1_B - SAM2_B	-.754	1.422	.182	-1.118	-.390	-4.142	60	.000

Manipulation check by condition. A one-way ANOVA was conducted to see if there were significant differences in the mean changes of the measures between the three conditions. The results indicated that there was a significant effect of condition on changes in mania symptoms $F(2, 58) = 4.29$, $p = .018$, thought speed $F(2, 58) = 4.15$, $p = .021$, BES $F(2, 58) = 9.31$, $p < .001$, valence $F(2, 58) = 3.42$, $p = .039$, and arousal , $F(2, 58) = 3.56$, $p = .035$. This reported difference was proposed to be due to chance because the random assignment to condition occurred after the manipulation task. Therefore, these changes scores were used as covariates within the appropriate analyses (e.g. valence change score used as a covariate within analyses of valence scores).

One-way ANOVA of measure changes pre and post laboratory induction across conditions.

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
MSQ_change	Control	21	3.86	9.286	2.026	-.37	8.08	-16	17
	Moderate	20	6.90	5.875	1.314	4.15	9.65	-4	23
	Vigorous	20	10.20	4.618	1.033	8.04	12.36	5	18
	Total	61	6.93	7.300	.935	5.06	8.80	-16	23
Thought_speed_change	Control	21	1.05	1.802	.393	.23	1.87	-2	4
	Moderate	20	.60	.754	.169	.25	.95	-1	2
	Vigorous	20	1.85	1.387	.310	1.20	2.50	0	4
	Total	61	1.16	1.463	.187	.79	1.54	-2	4
BES_Change	Control	21	2.67	1.560	.340	1.96	3.38	1	6
	Moderate	20	3.35	2.641	.591	2.11	4.59	1	9
	Vigorous	20	5.25	1.552	.347	4.52	5.98	3	8
	Total	61	3.74	2.235	.286	3.17	4.31	1	9
Actiwatch_Change	Control	21	-.0162	.20390	.04449	-.1090	.0766	-.40	.19
	Moderate	20	.0864	.24602	.05501	-.0288	.2015	-.24	.72
	Vigorous	20	.0273	.12350	.02762	-.0305	.0851	-.18	.26
	Total	61	.0317	.19915	.02550	-.0193	.0827	-.40	.72
SAM_Valence_Change	Control	21	.2381	.76842	.16768	-.1117	.5879	-1.00	1.00
	Moderate	20	.8000	.76777	.17168	.4407	1.1593	-1.00	2.00
	Vigorous	20	.6500	.58714	.13129	.3752	.9248	-1.00	1.00
	Total	61	.5574	.74217	.09503	.3673	.7475	-1.00	2.00
SAM_Arousal_Change	Control	21	.7143	1.45406	.31730	.0524	1.3762	-3.00	2.00
	Moderate	20	.2000	1.60918	.35982	-.5531	.9531	-2.00	3.00
	Vigorous	20	1.3500	.93330	.20869	.9132	1.7868	.00	3.00
	Total	61	.7541	1.42192	.18206	.3899	1.1183	-3.00	3.00

ANOVA

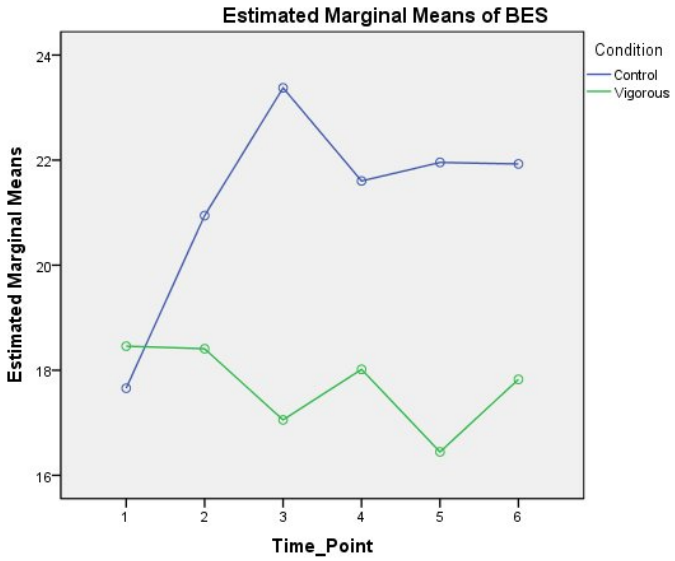
				Sum of Squares	df	Mean Square	F	Sig.
MSQ_change	Between Groups	(Combined)		412.166	2	206.083	4.291	.018
		Linear Term	Unweighted	412.131	1	412.131	8.581	.005
			Weighted	411.944	1	411.944	8.577	.005
			Deviation	.222	1	.222	.005	.946

	Within Groups			2785.571	58	48.027		
	Total			3197.738	60			
Thought_speed_change	Between Groups	(Combined)		16.058	2	8.029	4.147	.021
		Linear Term	Unweighted	6.595	1	6.595	3.406	.070
			Weighted	6.375	1	6.375	3.292	.075
			Deviation	9.683	1	9.683	5.001	.029
	Within Groups			112.302	58	1.936		
	Total			128.361	60			
BES_Change	Between Groups	(Combined)		72.837	2	36.418	9.306	.000
		Linear Term	Unweighted	68.364	1	68.364	17.470	.000
			Weighted	67.863	1	67.863	17.342	.000
			Deviation	4.974	1	4.974	1.271	.264
	Within Groups			226.967	58	3.913		
	Total			299.803	60			
Actiwatch_Change	Between Groups	(Combined)		.108	2	.054	1.385	.259
		Linear Term	Unweighted	.019	1	.019	.495	.485
			Weighted	.021	1	.021	.525	.472
			Deviation	.088	1	.088	2.244	.140
	Within Groups			2.271	58	.039		
	Total			2.380	60			
SAM_Valence_Change	Between Groups	(Combined)		3.490	2	1.745	3.424	.039
		Linear Term	Unweighted	1.738	1	1.738	3.410	.070
			Weighted	1.787	1	1.787	3.506	.066
			Deviation	1.703	1	1.703	3.341	.073
	Within Groups			29.560	58	.510		
	Total			33.049	60			
SAM_Arousal_Change	Between Groups	(Combined)		13.276	2	6.638	3.564	.035
		Linear Term	Unweighted	4.140	1	4.140	2.223	.141
			Weighted	3.969	1	3.969	2.131	.150
			Deviation	9.307	1	9.307	4.996	.029
	Within Groups			108.036	58	1.863		
	Total			121.311	60			

Appendix O

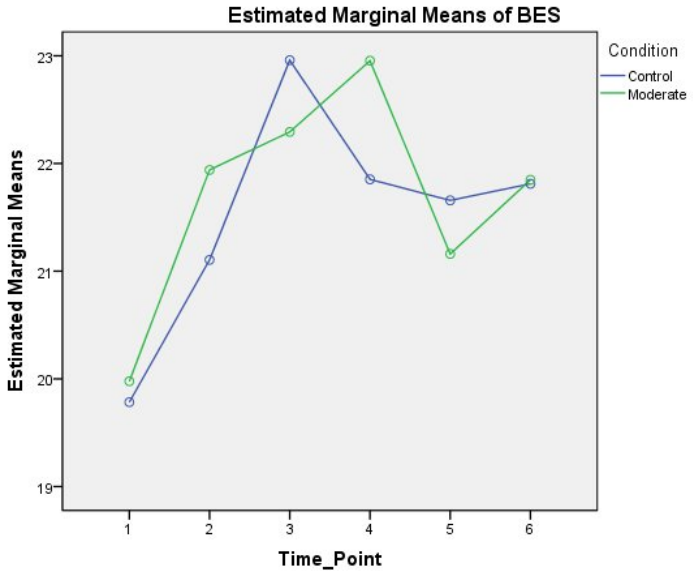
Approach Motivation

Mixed design ANCOVA of approach motivation comparing vigorous and control conditions



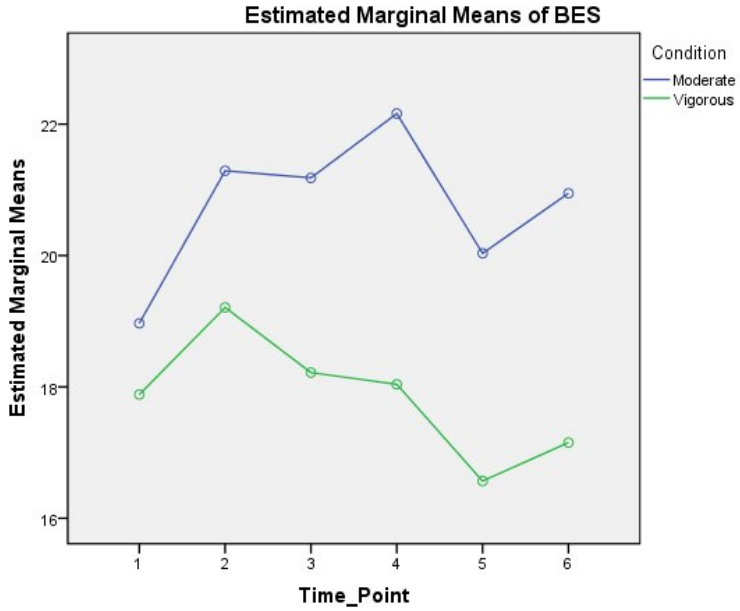
Covariates appearing in the model are evaluated at the following values: Gender = .54, SRPA_Total = 12.82, SAM1_A = 6.51, MSQ1_Speed_of_Thoughts = 4.02, BES_Change = 3.93, HPS_TOTAL = 13.5790

Mixed Design ANCOVA of approach motivation levels comparing control and moderate conditions



Covariates appearing in the model are evaluated at the following values: Gender = .73, SRPA_Total = 12.08, SAM1_A = 6.07, MSQ1_Speed_of_Thoughts = 4.15, BES_Change = 3.00, HPS_TOTAL = 13.7822

Mixed design ANCOVA of approach motivation comparing vigorous and moderate conditions

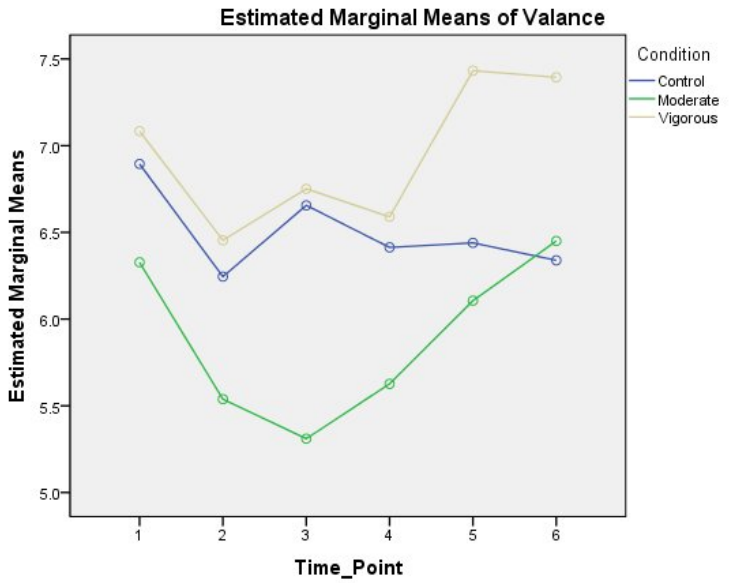


Covariates appearing in the model are evaluated at the following values: Gender = .60, SRPA_Total = 12.62, SAM1_A = 6.05, MSQ1_Speed_of_Thoughts = 4.58, BES_Change = 4.30, HPS_TOTAL = 13.9873

Appendix *P*

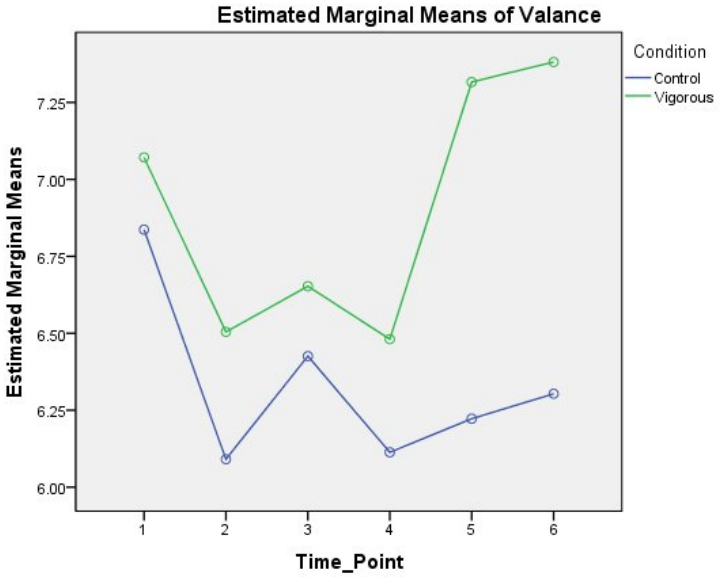
Valence

Mixed design ANCOVA of valence



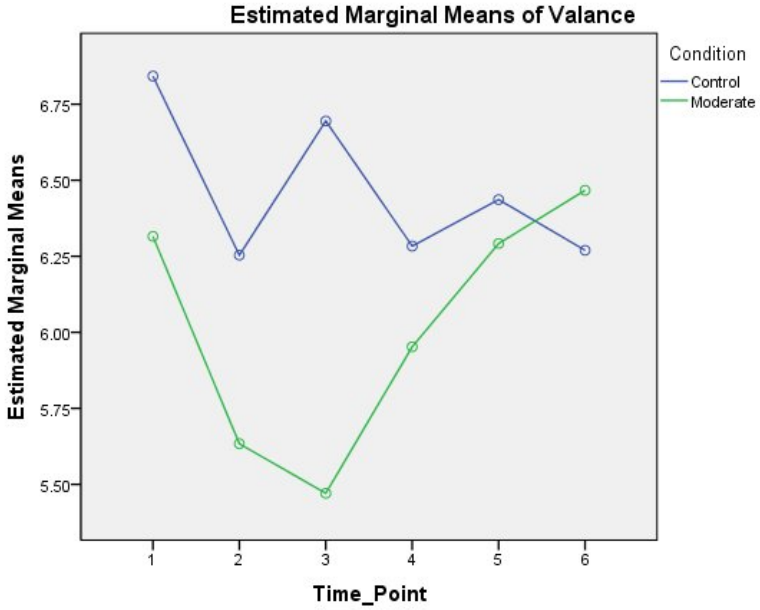
Covariates appearing in the model are evaluated at the following values: Gender = .62, SRPA_Total = 12.51, MSQ1_Speed_of_Thoughts = 4.25, SAM_Valance_Change = .5574, BES1_TOTAL = 22.52, HPS_TOTAL = 13.7811

Mixed design ANCOVA of valence comparing vigorous and control conditions



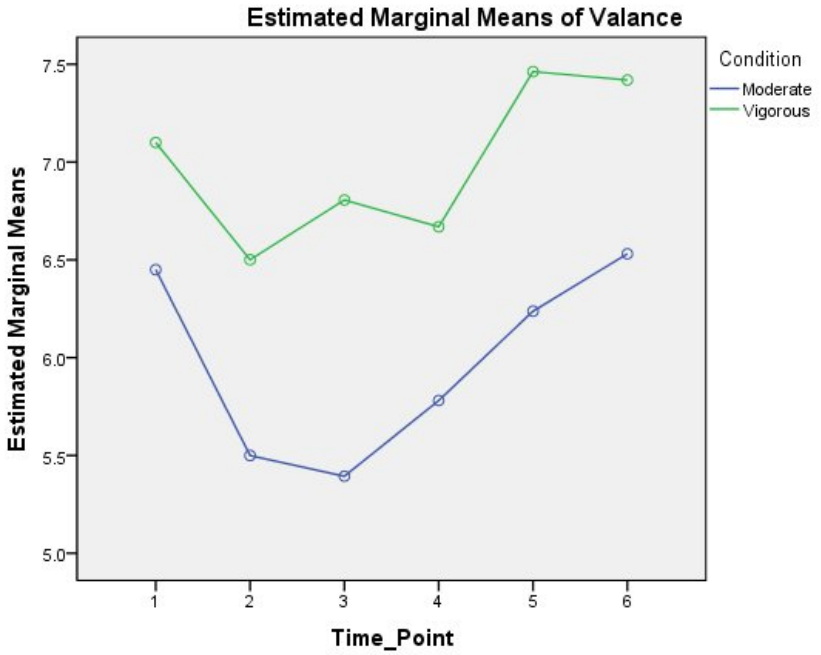
Covariates appearing in the model are evaluated at the following values: Gender = .54, SRPA_Total = 12.82, SAM_Valance_Change = .4390, BES1_TOTAL = 21.98, HPS_TOTAL = 13.5790, MSQ1_Speed_of_Thoughts = 4.02

Mixed design ANCOVA of valence comparing control and moderate conditions



Covariates appearing in the model are evaluated at the following values: Gender = .73, SRPA_Total = 12.08, SAM_Valance_Change = .5122, BES1_TOTAL = 22.88, HPS_TOTAL = 13.7822, MSQ1_Speed_of_Thoughts = 4.15

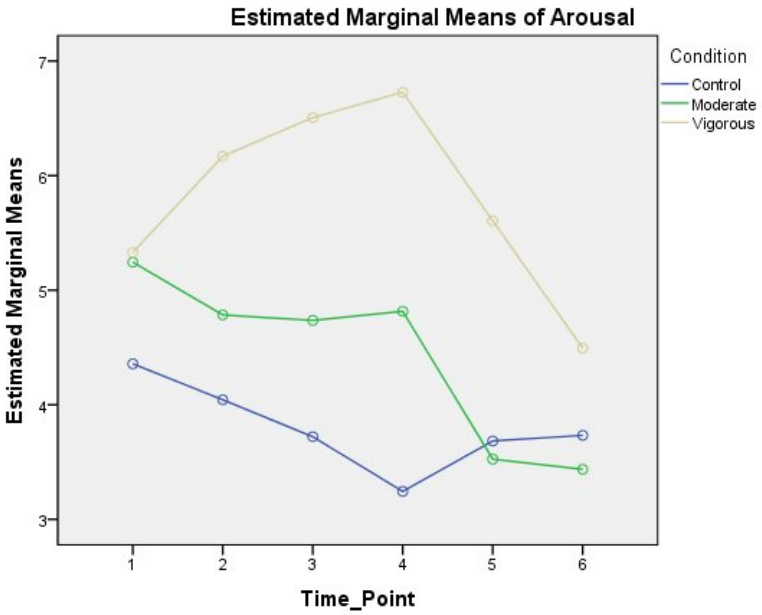
Mixed design ANCOVA of valence comparing vigorous and moderate conditions



Covariates appearing in the model are evaluated at the following values: Gender = .60, SRPA_Total = 12.62, SAM_Valance_Change = .7250, BES1_TOTAL = 22.73, HPS_TOTAL = 13.9873, MSQ1_Speed_of_Thoughts = 4.58

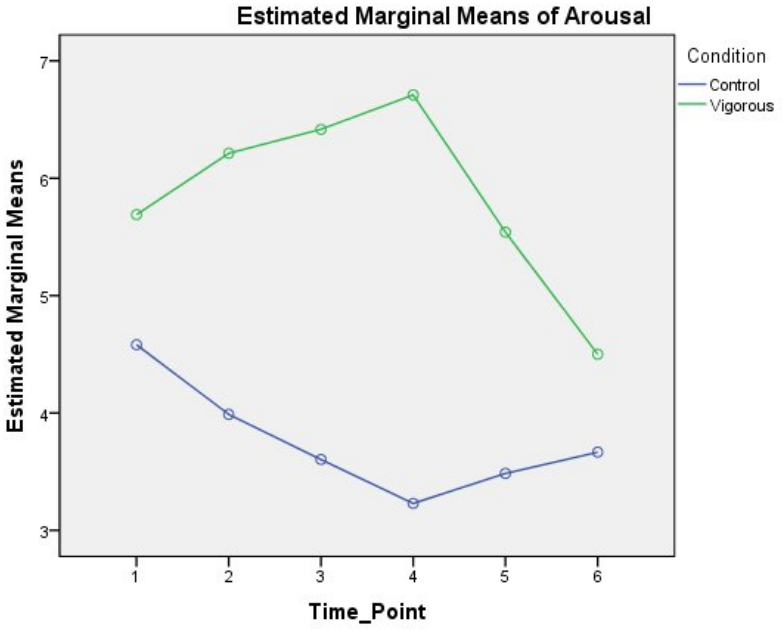
Arousal

Mixed design ANCOVA of arousal



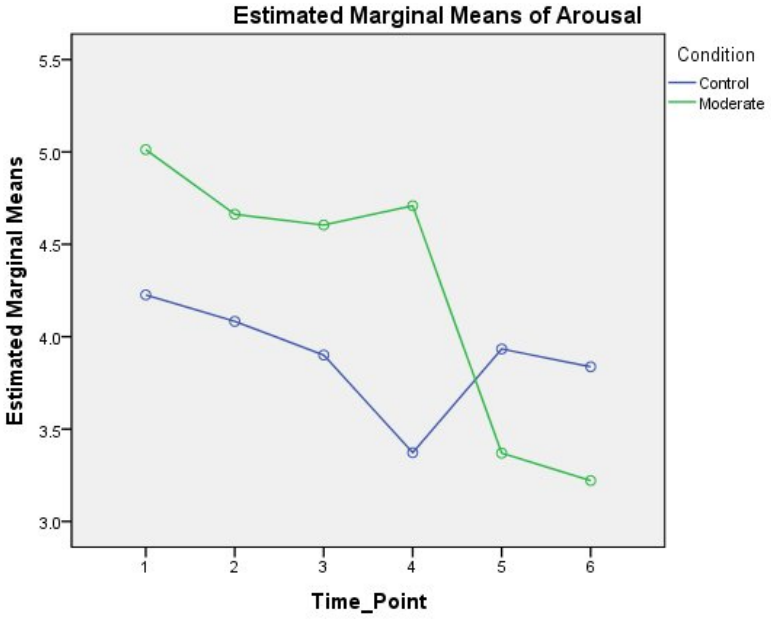
Covariates appearing in the model are evaluated at the following values: Gender = .62, SRPA_Total = 12.51, MSQ1_Speed_of_Thoughts = 4.25, BES1_TOTAL = 22.52, SAM_Arousal_Change = .7541, SAM1_A = 6.21, HPS_TOTAL = 13.7811

Mixed design ANCOVA of arousal comparing vigorous and control conditions



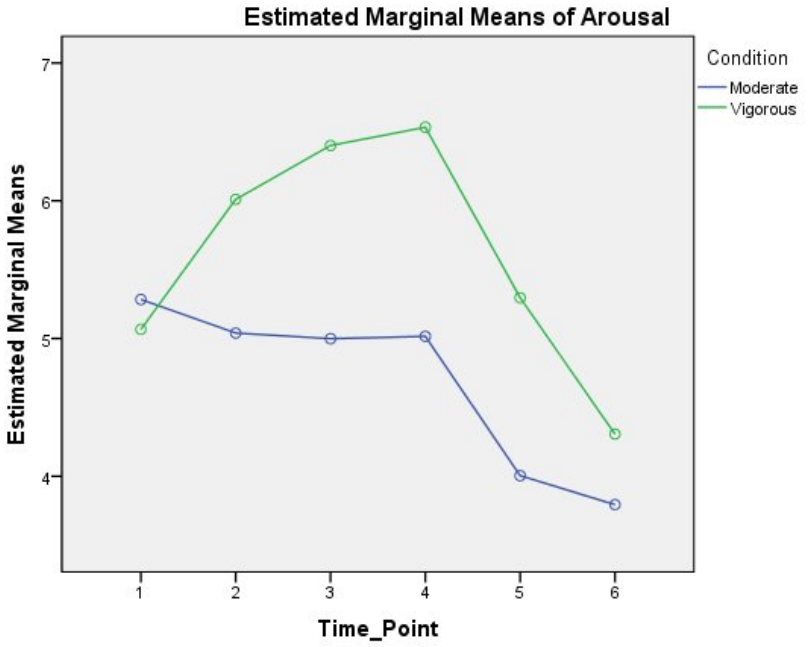
Covariates appearing in the model are evaluated at the following values: Gender = .54, SRPA_Total = 12.82, BES1_TOTAL = 21.98, HPS_TOTAL = 13.5790, MSQ1_Speed_of_Thoughts = 4.02, SAM1_A = 6.51, SAM_Arousal_Change = 1.0244

Mixed design ANCOVA of arousal comparing control and moderate conditions



Covariates appearing in the model are evaluated at the following values: Gender = .73, SRPA_Total = 12.08, BES1_TOTAL = 22.88, HPS_TOTAL = 13.7822, MSQ1_Speed_of_Thoughts = 4.15, SAM1_A = 6.07, SAM_Arousal_Change = .4634

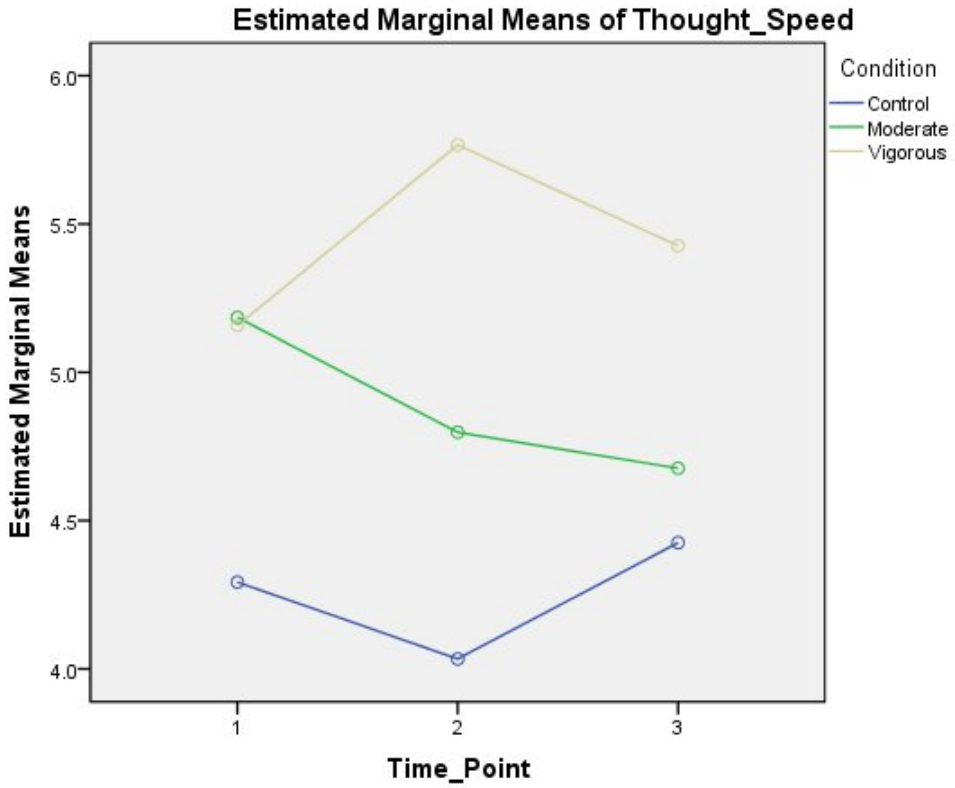
Mixed design ANCOVA of arousal comparing vigorous and moderate conditions



Covariates appearing in the model are evaluated at the following values: Gender = .60, SRPA_Total = 12.62, BES1_TOTAL = 22.73, HPS_TOTAL = 13.9873, MSQ1_Speed_of_Thoughts = 4.58, SAM1_A = 6.05, SAM_Arousal_Change = .7750

Appendix Q

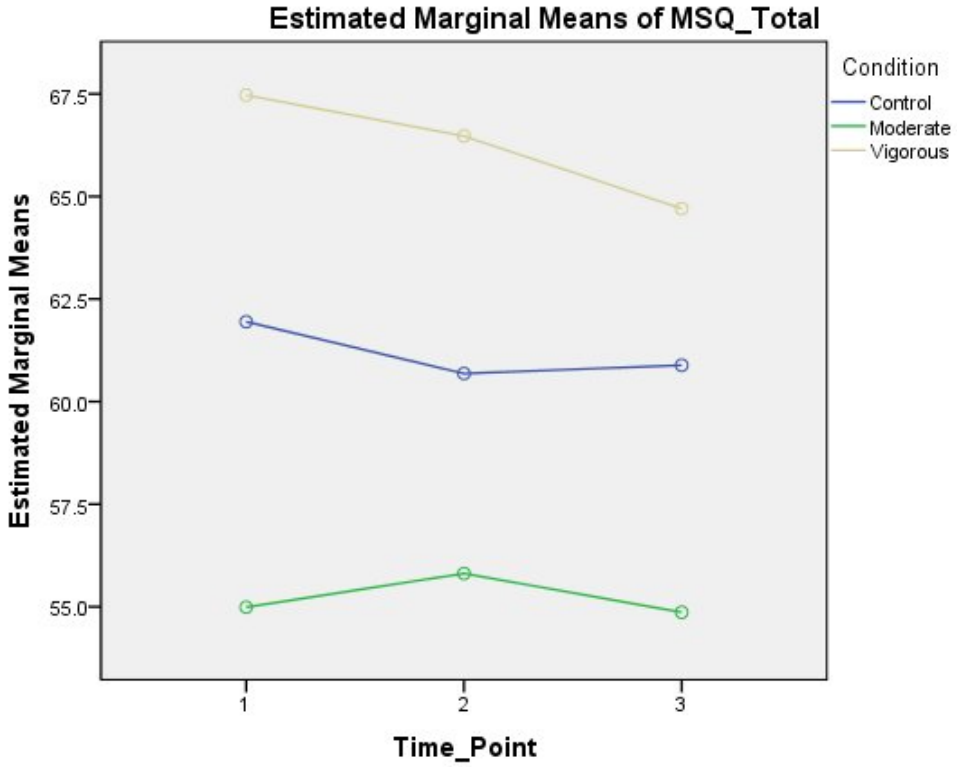
Mixed Design ANCOVA of Thought Speed Post Exercise



Covariates appearing in the model are evaluated at the following values: Gender = .62, SRPA_Total = 12.51, BES1_TOTAL = 22.52, SAM1_A = 6.21, HPS_TOTAL = 13.7811, Thought_speed_change = 1.1639

Appendix R

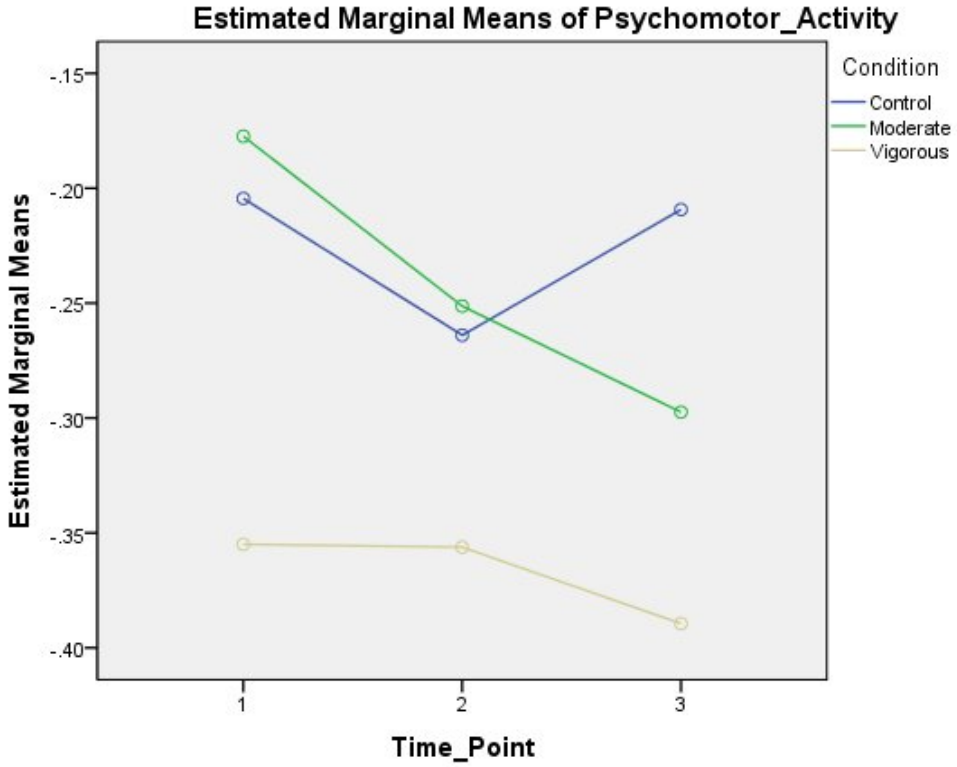
Mixed Design ANCOVA of Total Mania Symptoms Post Exercise



Covariates appearing in the model are evaluated at the following values: Gender = .62, SRPA_Total = 12.51, MSQ1_Speed_of_Thoughts = 4.25, BES1_TOTAL = 22.52, SAM1_A = 6.21, MSQ_change = 6.93, HPS_TOTAL = 13.7811

Appendix S

Mixed Design ANCOVA of Psychomotor Activity Post Exercise



Covariates appearing in the model are evaluated at the following values: Gender = .62, SRPA_Total = 12.51, MSQ1_Speed_of_Thoughts = 4.25, BES1_TOTAL = 22.52, SAM1_A = 6.21, HPS_TOTAL = 13.7811

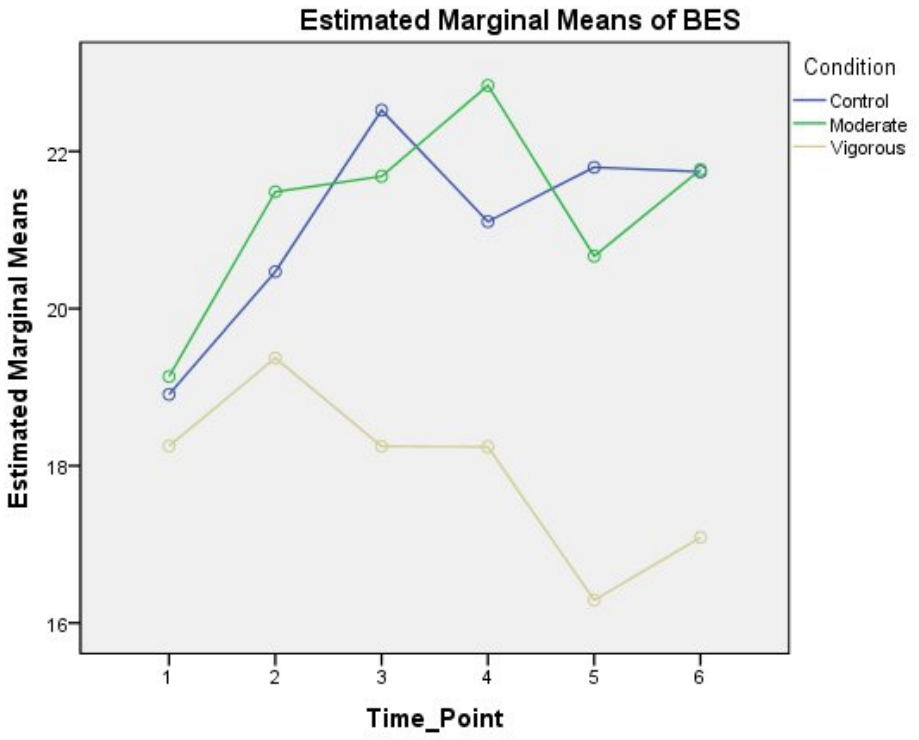
Appendix T

HPS Scores

HPS scores were organised into two categories (low and high) with high being a score above the sample median of 13 and low being a scores below the sample median.

Approach Motivation

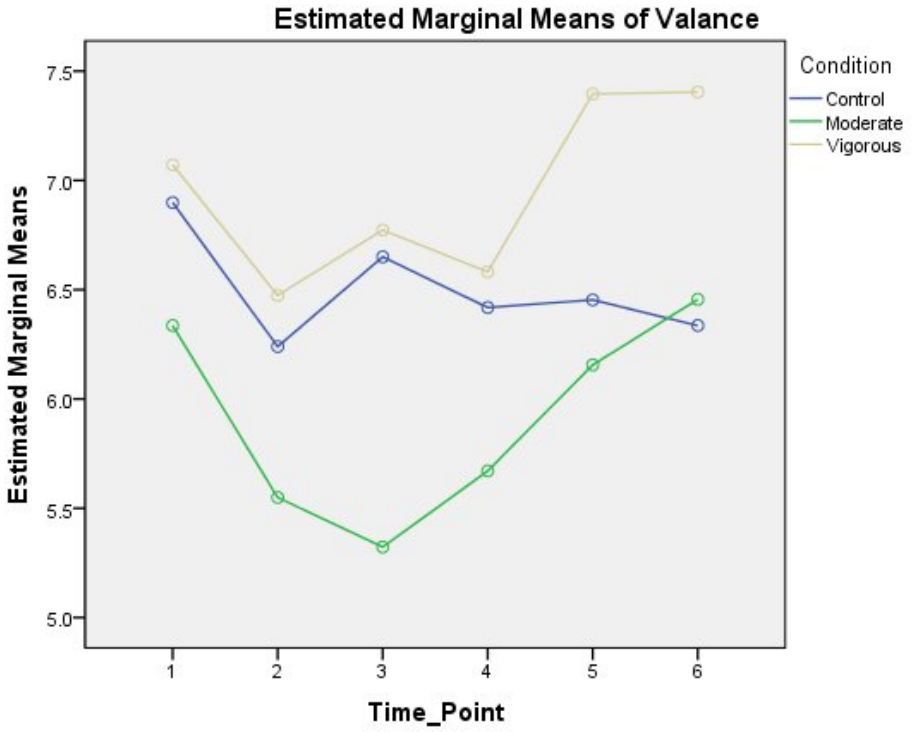
Mixed Design ANCOVA of AM Levels including HPS x Condition x Time Interaction



Covariates appearing in the model are evaluated at the following values: Gender = .62, SRPA_Total = 12.51, HPS_TOTAL = 13.7811, MSQ1_Speed_of_Thoughts = 4.25, SAM1_A = 6.21, BES_Change = 3.7377

Valence

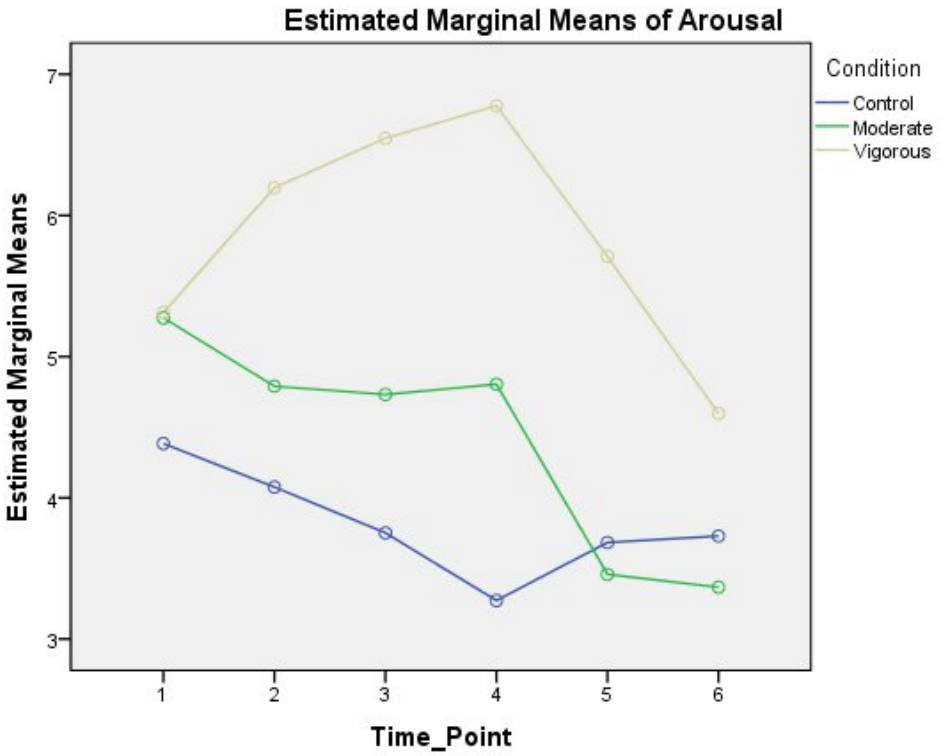
Mixed Design ANCOVA of valence including HPS x Condition x Time Interactions



Covariates appearing in the model are evaluated at the following values: Gender = .62, SRPA_Total = 12.51, MSQ1_Speed_of_Thoughts = 4.25, BES1_TOTAL = 22.52, SAM_Valance_Change = .5574, HPS_TOTAL = 13.7811

Arousal

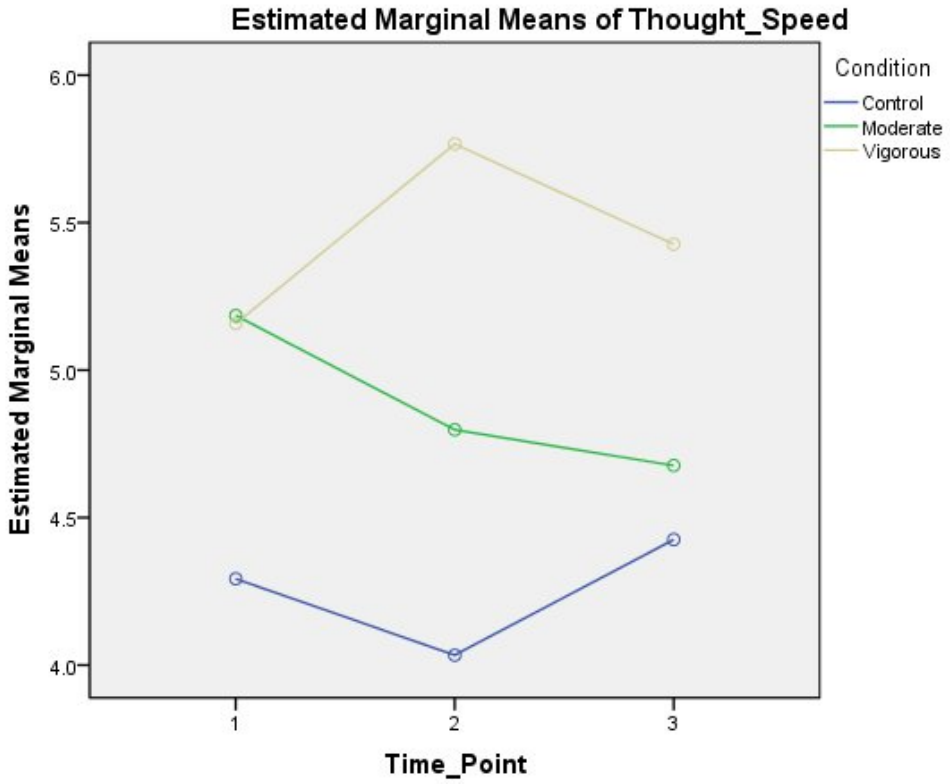
Mixed design ANCOVA of arousal including HPS x Condition x Time Interactions



Covariates appearing in the model are evaluated at the following values: Gender = .62, SRPA_Total = 12.51, MSQ1_Speed_of_Thoughts = 4.25, BES1_TOTAL = 22.52, HPS_TOTAL = 13.7811, SAM1_A = 6.21, SAM_Arousal_Change = .7541

Thought Speed

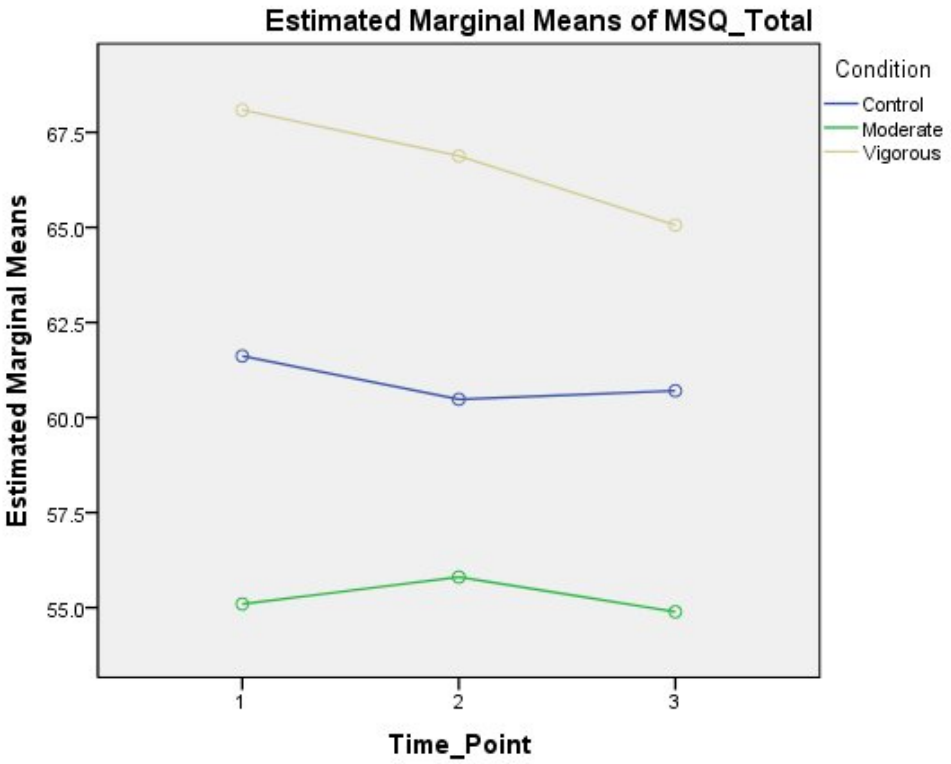
Mixed Design ANCOVA of Thought Speed Including HPS x Condition x Time Interaction



Covariates appearing in the model are evaluated at the following values: Gender = .62, SRPA_Total = 12.51, BES1_TOTAL = 22.52, SAM1_A = 6.21, HPS_TOTAL = 13.7811, Thought_speed_change = 1.1639

Mania Symptoms

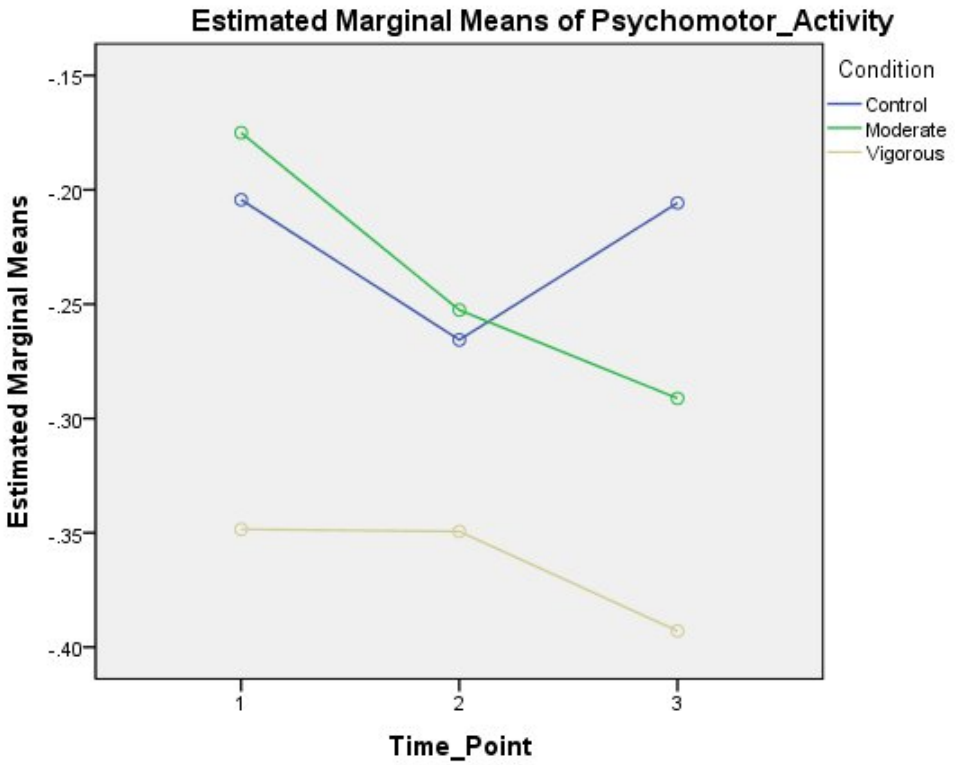
Mixed design ANCOVA of mania symptoms including HPS x Condition x Time interaction.



Covariates appearing in the model are evaluated at the following values: Gender = .62, SRPA_Total = 12.51, BES1_TOTAL = 22.52, SAM1_A = 6.21, HPS_TOTAL = 13.7811, MSQ1_Speed_of_Thoughts = 4.25, MSQ_change = 6.9344

Psychomotor Activity

Mixed design ANCOVA of psychomotor activity including HPS x Condition x Time interaction.



Covariates appearing in the model are evaluated at the following values: Gender = .62, SRPA_Total = 12.51, BES1_TOTAL = 22.52, SAM1_A = 6.21, MSQ1_Speed_of_Thoughts = 4.25, HPS_TOTAL = 13.7811

Appendix U

Kendall's Tau Correlation Between HPS scores and Time Taken for AM levels to Return to Baseline

Correlations

			HPS_TOTAL	Time_Taken_BES_Return
Kendall's tau_b	HPS_TOTAL	Correlation Coefficient	1.000	.012
		Sig. (1-tailed)	.	.453
		N	61	61
	Time_Taken_BES_Return	Correlation Coefficient	.012	1.000
		Sig. (1-tailed)	.453	.
		N	61	61

Appendix V

Hierarchical Modelling Regression Between HPS scores and Wanting to Continue with the Activity

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	HPS_TOTAL, Condition	.	Enter
2	HPSxCondition	.	Enter

a. All requested variables entered.

b. Dependent Variable: MSQ3_Continue_with_Activity

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.236[a]	.056	.005	2.332
2	.297[b]	.088	.012	2.323

a. Predictors: (Constant), HPS_TOTAL, Condition

b. Predictors: (Constant), HPS_TOTAL, Condition, HPSxCondition

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.914	2	5.957	1.096	.345[a]
	Residual	201.186	37	5.437		
	Total	213.100	39			
2	Regression	18.848	3	6.283	1.164	.337[b]
	Residual	194.252	36	5.396		
	Total	213.100	39			

a. Predictors: (Constant), HPS_TOTAL, Condition

b. Predictors: (Constant), HPS_TOTAL, Condition, HPSxCondition

c. Dependent Variable: MSQ3_Continue_with_Activity

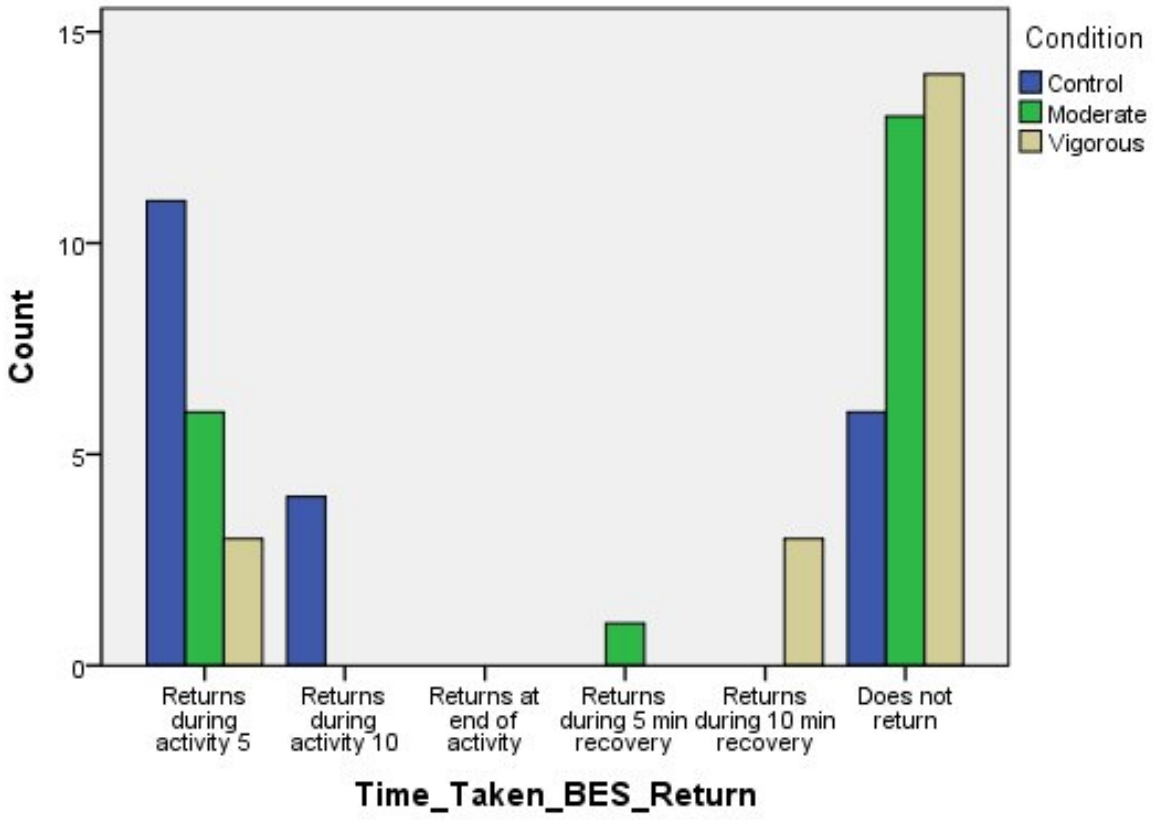
Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.094	1.442		2.840	.007
	Condition	.036	.738	.008	.049	.962
	HPS_TOTAL	.086	.058	.237	1.480	.147
2	(Constant)	7.048	2.975		2.369	.023
	Condition	-1.826	1.799	-.396	-1.015	.317
	HPS_TOTAL	-.124	.194	-.341	-.639	.527
	HPSxCondition	.133	.117	.716	1.134	.264

a. Dependent Variable: MSQ3_Continue_with_Activity

Appendix W

Graph of Time Taken for AM Levels to Return to Baseline



Appendix X

Previous Research Using the HPS

Study	Mean	Standard Deviation	Range
Furnham, Batey, Anand and Manfield (2008)	21.6	7.92	Not reported
Jones and Day (2008)	15.84	8.5	Not reported
Rawlings, Barrantes-Vidal, Claridge, McCreery and Galanos (2000)	16.22	9.30	Not reported
Durbin, Schalet. Hayden, Simpson and Jordan (2009)	15.67	7.93	2 - 41
Thomas and Bentall, (2002)	18.85	8.5	Not reported
Udachina and Mansell (2007)	17.31	6.88	Not reported

Appendix Y

Further Research

In line with the reported comments raised by participants in Wright et al. (2011), it would be interesting to look at the impact of different precipitating mood states at the outset of the exercise as well as the impact of different contexts (outside versus inside) on the maintenance of AM levels. Finally, rhythmicity would be a further important area to investigate further looking at the impact of rhythmical exercise such as swimming or running in comparison to non-rhythmical exercise like weight training. As reported by some participants within the study by Wright et al. (2011), it might be expected that rhythmical exercise may provide an internal structure or an inherent rhythm which may reduce approach motivation levels.

Appendix Z

Dissemination Plan.

To ensure that the research findings are disseminated to all parties involved in this research, a number of steps shall be followed. All participants who took part in the research and agreed to receive feedback about the results will be sent a letter explaining the findings of the study. It is hoped that the findings will be written up for publication in a peer-reviewed journal, such as the International Journal of Sport and Exercise Psychology (Impact factor 2.7, 2012) and a poster submitted to the British Association of Sport and Exercise Sciences.

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