

Running Head: FLOW AND EXERCISE-INDUCED FEELINGS

Latent Variable Modelling of the Relationship Between Flow  
and Exercise-induced Feelings: An Intuitive Appraisal Perspective

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## 1 Abstract

2 The present study examined the relationship between self-reported levels of Flow  
3 (Csikszentmihalyi, 1975) and the post-exercise feelings of Positive Engagement,  
4 Revitalisation, Tranquillity, and Physical Exhaustion (Gauvin & Rejeski, 1993) using  
5 responses from 1, 231 aerobic dance exercise participants. Vallerand's (1987)  
6 intuitive-reflective appraisal model of self-related affects and Csikszentmihalyi's  
7 (1975) conceptual framework for optimal experience served as the guiding theoretical  
8 frameworks. It was hypothesised that self-reported flow would be positively  
9 associated with revitalisation, tranquillity and positive engagement while statistical  
10 independence was expected for physical exhaustion. First, participants completed the  
11 Flow State Scale (Jackson & Marsh, 1996) and second, the Exercise-induced Feeling  
12 Inventory (Gauvin & Rejeski, 1993) immediately after an aerobic dance exercise  
13 class. Latent variable analyses showed that the higher-order Flow factor was  
14 positively associated with post-exercise Positive Engagement, Revitalisation, and  
15 Tranquillity, but not with Physical Exhaustion. Flow state explained 35% of the  
16 variance in Positive Engagement, 31% of the variance in Revitalisation, and 22% of  
17 the variance in Tranquillity. It is concluded that self-reported flow in aerobic dance  
18 exercise is moderately associated with the experience of positive post-exercise  
19 feelings. Physical educators may wish to employ interventions to facilitate the flow  
20 experience during lessons that involve structured exercise.

1 Key words: Optimal experience, structural equation modelling

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### Biographical Note

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1                   Latent Variable Modelling of the Relationship Between Flow  
2                   and Exercise-induced Feelings: An Intuitive Appraisal Perspective

3                   In recent years, there has been an increased interest in the study of subjective  
4 feelings associated with acute bouts of exercise (Bozoian, Rejeski, & McAuley, 1994;  
5 Gauvin & Rejeski, 1993; Markland, Emberton, & Tallon, 1997; McAuley &  
6 Courneya, 1994; Tuson & Sinyor, 1993). This interest has been intensifying as a  
7 result of two main factors. First, an informal consensus has emerged that such feelings  
8 facilitate the adoption of a physically active lifestyle (Dishman, 1982; Rejeski, 1992;  
9 Sallis & Hovell, 1990). Indeed, lifelong involvement in physical activity is associated  
10 with a range of physiological (Bouchard, Shephard, Stephens, Sutton, & McPherson,  
11 1990) and psychological benefits (Seragianian, 1993). Second, an understanding of the  
12 mechanisms through which exercise produces psychological benefits is important as it  
13 will enable public health practitioners to prescribe the appropriate exercise for  
14 therapeutic or preventive mental health purposes (Gauvin & Brawley, 1993).

15                   According to Gauvin and Rejeski (1993), the stimulative properties of exercise  
16 can produce distinct feelings generated by physiological changes during and after  
17 physical activity. Gauvin and Rejeski (1993) have developed the Exercise-induced  
18 Feeling Inventory (EFI) to quantify four types of subjective responses associated with  
19 acute bouts of physical activity. These are Revitalisation, Tranquillity, Physical  
20 Exhaustion, and Positive Engagement.

21 Intuitive-reflective Appraisal Model and Subjective Responses to Exercise

22                   In line with various cognitive theories of emotion, Vallerand (1987) has  
23 proposed an intuitive-reflective appraisal model for self-related affect in achievement  
24 situations. Vallerand's model has been deemed to be applicable in the exercise  
25 context as this context can be considered to be an achievement situation. This is

1 because the goal of the participants is to follow the routine demonstrated by the  
2 exercise leader and they can be clearly aware of the extent to which they are  
3 achieving their goal. This statement is also grounded in the concept of “flow”  
4 originally introduced by Csikszentmihalyi (1975, 1997) and operationalised in the  
5 sport and physical activity contexts by Jackson and Marsh (1996) with the Flow State  
6 Scale. In accordance with the operationalisation of the concept of flow, participants  
7 can receive clear feedback during the activity regarding the degree to which they  
8 achieve the goals set by the exercise leader.

9         According to Vallerand’s (1987) model, cognitive appraisal can determine  
10 emotion. Specifically, it is not the events themselves which determine emotion, rather  
11 the subjective appraisal of them. Vallerand (1987) has proposed two types of  
12 cognitive appraisal. These are the “intuitive” appraisal which is automatic in nature  
13 and the “reflective” appraisal which is deliberate in nature. Drawing from the context  
14 of sport, an example of intuitive appraisal is the knowledge during the match about  
15 how well one is performing. The same example can transfer to an exercise context in  
16 which the exercise participants can gauge how well they are performing by receiving  
17 immediate feedback from the activity itself regarding the degree to which they  
18 achieve their goals. It could be argued that the concept of intuitive appraisal  
19 corresponds with the concept of flow as both concepts involve knowledge of  
20 participants on the extent to which they are achieving their goals.

21         Reflective appraisal refers to a deliberate processing of information received  
22 from the internal environment (e.g., memory, bodily sensations produced by the  
23 activity) or the external environment. According to Vallerand (1987), the reflective  
24 appraisal can take several forms: (a) intellectualisation (Lazarus, 1966), (b) self,  
25 outcome, and social comparison processes (Suls & Mullen, 1983), (c) various

1 information processing functions (Markus & Zajonc, 1985), (d) mastery-related  
2 cognitions (Taylor, 1981), and (e) causal attributions (Weiner, 1979, 1985).

3         In agreement with Vallerand's (1987) propositions, Roth, Bachtler, and  
4 Fillingim (1990) have suggested that the content and focus of exercise participants'  
5 thought processes during an activity may influence the effects of exercise on mood.  
6 Roth et al. (1990) demonstrated that participation in exercise was associated with a  
7 decrease in tension and anxiety but not when exercise participants were concurrently  
8 subjected to mental stress. Specifically, the experimenters introduced the "digits  
9 backward test" as a test of intelligence. According to Nicholls (1989), such  
10 instructions generate a state of "ego involvement" which is grounded in social  
11 comparison processes - the second type of reflective appraisal posited by Vallerand  
12 (1987). Under ego-involvement, the focus of the participants' attention is not on the  
13 task but on the self. That is, under ego-involvement participants are not expected to be  
14 concerned with the experimental task but rather with the image they convey to the  
15 experimenters (e.g., how intelligent they appear). According to Nicholls (1989), a  
16 state of ego-involvement is associated with increased anxiety levels. This may explain  
17 the stable levels of anxiety observed after finishing the task for participants subjected  
18 to a mental stressor. The findings of Roth et al. support the validity of Vallerand's  
19 (1987) proposition regarding reflective appraisal in exercise settings. It is the  
20 cognitive appraisal of events which influences emotional reactions. These findings are  
21 relevant to the present investigation as they demonstrate the important role that the  
22 interpretation of the exercise experience can have upon subjective feelings in response  
23 to exercise.

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2 Flow Experience and Affective Responses

3           It is suggested that Csikszentmihalyi's (1975) theoretical framework regarding  
4 optimal experience during involvement in any activity is relevant when the perceived  
5 quality of the exercise experience is the topic of concern. Indeed, Csikszentmihalyi  
6 and Csikszentmihalyi (1988) have suggested that the construct of flow is relevant  
7 whenever the quality of human experience is at issue. Flow is defined by  
8 Csikszentmihalyi (1975) as an optimal psychological state. According to  
9 Csikszentmihalyi and Csikszentmihalyi (1988), there is a number of elements that  
10 comprise the flow experience. First, the participants perceive a balance between the  
11 skills they bring to the activity and the demands imposed by it; further, both are  
12 perceived to be at a high level. Second, the participants know what needs to be done;  
13 hence, the activity provides clear goals. Third, the participants know how well they  
14 are doing as the activity provides quick and unambiguous feedback. Further,  
15 concentration is totally focused on the task at hand. This has been explained in terms  
16 of the fact that, during flow, a state of harmony exists that prevents attention from  
17 being directed towards anything else but the activity (Csikszentmihalyi &  
18 Csikszentmihalyi, 1988). Also, when in flow, one experiences a sense of control over  
19 the outcomes of the activity. Further, time is not experienced in the usual sense but is  
20 distorted; one may feel that time passes very quickly or that the activity goes on and  
21 on. In addition, the concern with the self that is experienced in everyday life  
22 disappears resulting in a state of being free from self-consciousness. According to  
23 Jackson and Marsh (1996), "the absence of preoccupation with self does not mean the  
24 person is unaware of what is happening in mind or body, but rather is not focusing on  
25 the information normally used to represent to oneself who one is" (p. 19). Finally,

1 when all these elements are experienced in tandem, consciousness is in harmony and  
2 this makes the experience intrinsically rewarding. In other words, there is worth in  
3 participating in the activity for its own sake, rather than for reasons that are external  
4 to the activity. In essence, the activity is highly enjoyable.

5 Csikszentmihalyi and LeFevre (1989) examined if the affect and potency of 78  
6 adult workers was influenced by whether they experienced flow. Using the  
7 Experience Sampling Method, they obtained self-reports of positive affect and  
8 potency from each participant throughout each day for a week. Positive affect was  
9 measured with items such as “happy-sad” and “cheerful-irritable” whereas potency  
10 was measured with items such as “alert-drowsy”, “active-passive”, and “excited-  
11 bored”. They concluded that the quality of the experience (i.e., affect and potency)  
12 changed dramatically depending on whether the participants experienced flow whilst  
13 working.

14 Clarke and Haworth (1994) have also provided evidence for the association  
15 between flow experience and subjective feelings. They investigated the degree to  
16 which quality of experience as represented by the subjective feelings of enjoyment,  
17 interest, happiness, and relaxation differed across nine different types of experience in  
18 sixth-form college students. The differences between these types of experience (e.g.,  
19 channels of: flow, boredom, worry, etc.) were represented by differences in the  
20 combinations of varying levels of perceived challenge and skills in the situation. For  
21 example, the “flow” experience was defined in terms of a balance between challenges  
22 and skills while the experience of “control” was defined by skills being perceived as  
23 greater than the challenge. The results showed that high scores of enjoyment and  
24 happiness were reported by people in the control channel, whereas interest scores  
25 were high in the flow channel. In general, the flow experience as well as the control

1 experience were positively associated with subjective feelings indicating quality of  
2 experience.

3         Based on their operationalisation of enjoyment as flow, Kimiecik and Harris  
4 (1996) suggested that links should be expected between flow and positive affective  
5 responses in physical activity settings. Their argument was based on the assumption  
6 posited by cognitive theories of emotion which imply that cognitions influence  
7 emotion (Lazarus, 1984; Weiner, 1985; Vallerand, 1987). Therefore, Kimiecik and  
8 Harris (1996) suggest that flow is different in nature from an affective response  
9 because flow comprises a number of cognitive components such as the perception of  
10 balance between challenge and skills, clear goals, and intense concentration.  
11 Following their argument for operationalising enjoyment as an optimal psychological  
12 state (i.e., flow) rather than positive affect, they suggest that research be carried out to  
13 examine the fine relationships between flow and affective responses in physical  
14 activity contexts. The results of the studies reviewed as well as suggestions offered by  
15 Kimiecik and Harris (1996) strengthen the rationale for investigating the association  
16 between the flow experience and subjective feelings experienced in an exercise  
17 setting.

#### 18 Relationships Between Flow and Post-exercise Subjective Feelings

19         The purpose of the present study was to examine the relationship between self-  
20 reported levels of flow during participation in an aerobic dance exercise class and the  
21 post-exercise subjective feelings of Revitalisation, Tranquillity, Physical Exhaustion,  
22 and Positive Engagement. The theoretical rationale for expecting a relationship  
23 between flow and subjective post-exercise feelings is grounded within the theories  
24 proposed by Vallerand (1987), and Csikszentmihalyi (1975, 1997). According to  
25 Vallerand (1987) the intuitive appraisal regarding how well participants perform in

1 achievement situations can determine their affective reactions. This type of appraisal  
2 can take place during the activity. In the exercise context, the degree to which  
3 participants feel that they attain the goals set by the exercise leader will determine  
4 whether they will feel successful. It is suggested that when participants feel that they  
5 attain their goal, they will experience greater positive affect compared to those who  
6 feel that they have not attained their goal. The intuitive appraisal concept corresponds  
7 clearly with the concept of flow; that is, participants who experience flow get clear  
8 and immediate feedback from the activity that their goals are attained when skill  
9 equals challenge. Such feedback corresponds with knowledge that the participants do  
10 well without the need for more elaborate forms of cognitions. Taking into account that  
11 a positive intuitive appraisal can lead to positive affective reactions and that  
12 perceptions of flow underpin a positive intuitive appraisal, it is hypothesised that self-  
13 reported levels of flow will be associated with affective reactions.

14         Specifically, it was hypothesised that self-reported levels of flow will be  
15 positively associated with the degree to which the positive feelings of Revitalisation,  
16 Tranquillity, and Positive Engagement are experienced. That is, the flow experience  
17 corresponds with a sense of optimal performance in exercise participants. This sense  
18 of optimal performance corresponds with a positive intuitive appraisal of the degree  
19 to which the participant's goals are achieved which, in turn, is hypothesised to lead to  
20 positive affective reactions.

21         With regard to Physical Exhaustion, it is not possible to attach either a positive  
22 or negative connotation to this state. According to McAuley and Courneya (1994), the  
23 meaning which the exercise participants attach to feelings of fatigue may depend on a  
24 number of pre-existing individual conditions such as fitness level and exercise  
25 history. Some participants may view physical exhaustion as satisfying as this is an

1 indication that they have achieved their goal (e.g., to burn fat). Others may train  
2 harder than they should thus experiencing extreme fatigue and in this instance fatigue  
3 is likely to be labelled in a negative way. Data presented by Gauvin and Rejeski  
4 (1993) as well as McAuley and Courneya (1994) provided support for the proposed  
5 dual connotation that can be attached to physical exhaustion. Specifically, Gauvin and  
6 Rejeski (1993) report weak bivariate correlations between Physical Exhaustion and  
7 the rest of the positive feelings of the EFI while McAuley and Courneya (1994)  
8 reported weak correlations of Fatigue with the Psychological Well-being and  
9 Psychological Distress factors of the Subjective Exercise Experiences Scale. As the  
10 present study represents an initial attempt to examine the relationship between self-  
11 reported levels of flow and subjective feelings assessed by the EFI, moderators of the  
12 relationship between flow and subjective feelings were not examined. Therefore, no  
13 association was expected between flow and physical exhaustion.

#### 14 Significance of Present Study to Physical Education

15         The present study is relevant to a physical education context as the attainment  
16 of flow during a lesson would also be expected to correlate with positive feeling states  
17 after the lesson. Further, aerobic dance exercise is an integral part of health-related  
18 physical education. A number of researchers have examined the phenomenon of  
19 enjoyment in physical education (Goudas & Biddle, 1993; Gould & Horne, 1984;  
20 Placek, 1983; Placek & Dodds, 1988). However, there has been a dearth of research  
21 examining the specific consequences of engaging in an enjoyable activity. Goudas  
22 and Biddle (1993) recommended that further research be conducted to examine how  
23 the experience of enjoyment predisposes individuals to become physically active. An  
24 initial stage in this process is to investigate the post-activity feeling states associated  
25 with enjoyment. In the present study, enjoyment is represented by the flow

1 experience. Findings from this study will be broadly applicable to physical education  
2 as the physical education context combines the elements of exercise and achievement  
3 in the same way that they occur in an exercise context.

#### 4 Method

##### 5 Participants

6 Data were collected from 1, 231 aerobic dance exercise participants attending  
7 a number of health clubs in the London area, England. The age of the participants  
8 ranged from 18 to 70 years ( $M = 31.43$  yr.,  $SD = 9.13$  yr.). One hundred and twenty  
9 participants did not report their age and six participants did not report their gender. Of  
10 those who did report their gender, 211 were males and 1, 014 were females. The  
11 inequality in the number of participants from each gender reflects the popularity of  
12 aerobic dance exercise classes among females.

##### 13 Instrumentation

14 Flow State Scale. The Flow State Scale (FSS: Jackson & Marsh, 1996) was  
15 employed to assess the degree to which aerobic dance exercise participants reported  
16 that they experienced flow. Jackson and Marsh (1996) have argued that the FSS has  
17 been designed to assess flow in sport and physical activity settings; therefore, it was  
18 deemed appropriate to be used for the assessment of flow in an aerobic dance exercise  
19 setting. This 36-item instrument comprises nine subscales. These consist of four items  
20 each and are labelled “Challenge-Skill Balance” (e.g., “I was challenged, but I  
21 believed my skills would allow me to meet the challenge”), “Action-Awareness  
22 Merging” (e.g., “I made the correct movements without thinking about trying to do  
23 so”), “Clear Goals” (e.g., “I knew clearly what I wanted to do”), “Unambiguous  
24 Feedback” (e.g., “It was really clear to me that I was doing well”), “Concentration on  
25 Task at Hand” (e.g., “My attention was focused entirely on what I was doing”),

1 “Sense of Control” (e.g., “I felt in total control of what I was doing”), “Loss of Self-  
2 consciousness” (e.g., “I was not concerned with what others may have been thinking  
3 of me”), “Transformation of Time” (e.g., “It felt like time stopped while I was  
4 performing”), and “Autotelic Experience” (e.g., “I found the experience extremely  
5 rewarding”). Respondents were asked to indicate the extent to which they agreed with  
6 each statement on a 5-point Likert scale anchored by 1 (Strongly Disagree) and 5  
7 (Strongly Agree).

8 Initial psychometric examination of the FSS based on a sample of athletes  
9 showed satisfactory psychometric properties (Jackson & Marsh, 1996). For the  
10 present sample ( $N = 1, 231$ ), internal consistency coefficients using Cronbach’s alpha  
11 (Cronbach, 1951) were over .70 for all subscales except Transformation of Time  
12 which yielded an alpha of .65. The remaining coefficients were: Challenge-Skill  
13 Balance = .78, Action-Awareness Merging = .84, Clear Goals = .79, Unambiguous  
14 Feedback = .83, Total Concentration = .82, Sense of Control = .84, Loss of Self-  
15 consciousness = .80, and Autotelic Experience = .83.

16 Exercise-induced Feeling Inventory. The Exercise-induced Feeling Inventory  
17 (EFI: Gauvin & Rejeski, 1993) has been designed to assess subjective feelings  
18 associated with acute bouts of physical activity. A number of factors led to the  
19 decision to employ the EFI to assess subjective responses to exercise rather than other  
20 similar instruments. Specifically, the Profile of Mood States (POMS: McNair, Lorr, &  
21 Droppleman, 1971) was not used as (a) it is heavily oriented toward measuring  
22 negative states; (b) its construct validity with diverse samples of physically active  
23 adults is limited beyond college-aged populations and (c) the relevance of the items  
24 for the exercise context is questionable (McAuley & Courneya, 1994). The Positive  
25 and Negative Affect Schedule (PANAS: Watson, Clark, & Tellegen, 1988) was not

1 employed because its items are of questionable relevance to the stimulus properties of  
2 exercise (McAuley & Courneya, 1994). The Feeling Scale (FS: Rejeski, Best,  
3 Griffith, & Kenney, 1987) was not used owing to its reliance upon a single affect item  
4 which is oversimplistic (McAuley & Courneya, 1994) and its presumption of affect as  
5 bipolar and unidimensional which may be problematic from both conceptual and  
6 theoretical perspectives (Watson et al., 1988). Finally, the Subjective Exercise  
7 Experiences Scales (SEES; McAuley & Courneya, 1994) which tap the global aspect  
8 of psychological responses to exercise rather than the structural aspects of these  
9 global responses assessed by the EFI, was a viable option. The authors decided to  
10 investigate the detailed aspects of these responses with the intention of studying the  
11 global aspects of the exercise responses in the future.

12         The EFI consists of 12 items which capture the four feeling states of Positive  
13 Engagement (e.g., "enthusiastic", "happy", "upbeat"), Revitalisation (e.g., "refreshed",  
14 "energetic", "revived"), Tranquillity (e.g., "calm", "relaxed", "peaceful"), and Physical  
15 Exhaustion (e.g., "fatigued", "tired", "worn-out"). Respondents rate their feelings on a  
16 5-point Likert scale anchored by 0 (Do not feel) and 4 (Feel very strongly).  
17 Satisfactory psychometric properties were initially reported by Gauvin and Rejeski  
18 (1993). Using structural equation modelling techniques, they showed that the a priori  
19 four-factor model had a good fit to the data and alpha coefficients were satisfactory  
20 for all subscales. Alpha coefficients for the present sample (N = 1, 231) were  
21 satisfactory for the subscales of Positive Engagement = .72, Revitalisation = .77,  
22 Tranquillity = .78, and Physical Exhaustion = .81.

### 23 Procedures

24         Data collection took place at a number of health clubs in the London area,  
25 England. The classes targeted were aerobic dance exercise-to-music classes with an



1 exercise leader. The classes were of varying intensities and their duration was  
2 precisely 1 hr. The exercise participants were approached before the initiation of their  
3 class by the researchers together with their research assistants who asked them if they  
4 were willing to participate in a study to examine exercise participants' thoughts and  
5 feelings about their exercise participation. Participants who gave their verbal  
6 informed consent for participation completed demographic information before the  
7 start of their class. Immediately after the class, they completed the FSS followed by  
8 the EFI. Jackson and Marsh (1996) designed the FSS to be used immediately, or soon  
9 after, performance to assess flow state characteristics experienced during  
10 performance. The Experience Sampling Method (Csikszentmihalyi & Larson, 1992)  
11 was not used as participants would have been required to interrupt the class in order to  
12 report their flow experience.

### 13 Data Analysis

14 Structural equation modelling techniques were used for data analysis  
15 employing the EQS programme (Bentler, 1995). The steps followed in analysing the  
16 data were (a) examination of the distributional properties of the data and selection of  
17 an appropriate estimator, (b) examination of the adequacy of the measurement models  
18 using confirmatory factor analytic procedures (CFA), and (c) examination of the  
19 structural equation model representing the relationships between the constructs of  
20 interest.

21 The goodness-of-fit criteria used in the present study to evaluate the adequacy  
22 of the models were the  $\chi^2$  statistic, the Nonnormed Fit Index (NNFI), the  
23 Comparative Fit Index (CFI), the Goodness of Fit Index (GFI), and the Root Mean  
24 Squared Error of Approximation (RMSEA). The NNFI estimates the relative  
25 improvement of the target model over the independence model (i.e., the model which

1 specifies uncorrelated variables) per degree of freedom (Hoyle & Panter, 1995). Its  
2 value can fall outside the 0-1 range. The CFI is derived from a comparison of the  
3 model of interest with the independence model and can range between 0-1 (Byrne,  
4 1995). A cut-off point of .90 has typically been used for model evaluation based on  
5 the CFI (Hu & Bentler, 1995). However, according to Hu and Bentler (1995), the  
6 sampling distributions of overall fit indices are not known and evidence has emerged  
7 that the .90 cut-off point typically used for evaluation of fit indices may not always be  
8 appropriate under all modelling circumstances. For this reason, they have suggested  
9 that evaluation of standardised residuals can provide a more definitive indication of  
10 the fit of a model. Therefore, the average value of the absolute standardised residuals  
11 was evaluated as it has been suggested that this can provide dependable answers  
12 regarding the discrepancy between the observed and the model-reproduced  
13 covariances, despite the information provided by the chi-square statistic and the  
14 overall goodness-of-fit indexes (Hu & Bentler, 1995). Hence, an average of the  
15 absolute values of the residuals between the model-reproduced and the observed  
16 covariances of .03 means that the model can explain the covariances to within an  
17 average error of .03. In addition, the GFI indicates the relative amounts of variances  
18 and covariances accounted for by a model and is analogous to the traditional  $R^2$   
19 commonly used to summarise results of multiple regression analysis (Hoyle & Panter,  
20 1995). Also, the RMSEA indicates the extent of the discrepancy between the  
21 observed and the hypothesised models per degree of freedom. According to Browne  
22 and Cudeck (1993), RMSEA values of .05 or below generally indicate a close fit of  
23 the model in relation to the degrees of freedom. Values of .08 or below generally  
24 indicate a reasonable error of approximation. Finally, the 90% confidence interval of

1 the RMSEA was calculated to provide evidence of the stability of the model when  
2 estimated in other samples.

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## Results

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### Data Normality and Selection of an Estimator

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10 A statistical assumption which underlies use of structural equation modelling  
11 techniques is the multivariate normality of the data. Therefore, the univariate and  
12 multivariate kurtosis values of the variables were examined as they have implications  
13 for the validity of the Maximum Likelihood estimator presently employed (Hoyle &  
14 Panter, 1995). The univariate kurtosis values ranged from -0.82 to 1.86 (M kurtosis  
15 values across 48 items = 0.26, SD = 0.66). Also, the extent of multivariate non-  
16 normality was assessed using Mardia's coefficient of multivariate kurtosis (Mardia,  
17 1970). Results showed that the data displayed multivariate kurtosis (Normalised  
18 estimate = 117.11). For this reason the Sattora-Bentler Scaled  $\chi^2$  statistic was  
19 employed in the estimation of the model parameters as it takes into account the non-  
20 normality of the data.

21

### Evaluation of the Measurement Models

22

23 Flow State Scale. A confirmatory factor analysis was used to examine the a  
24 priori nine-factor FSS measurement model. The results showed a satisfactory fit of the  
25 model to the data with the overall fit indices very close to those reported by Jackson  
and Marsh (1996). The indices were: Unadjusted  $\chi^2$  (N = 1231) = 2626.03, Scaled  $\chi^2$   
= 2113.44, df = 558, p < .001, NNFI = .890, Robust CFI = .893, GFI = .886, RMSEA

1 = .055, 90% CI of the RMSEA = .053 - .057. Average Absolute Standardised Residual  
 2 = .03. All factor loadings were significant at the  $p < .05$  level with coefficients greater  
 3 than .5 except the Transformation of Time items which displayed two factor loadings  
 4 lower than .5 (item 3 = .46, item 4 = .38). Estimation of the hierarchical model  
 5 showed a reasonable fit of the model to the data: Unadjusted  $\chi^2$  ( $N = 1231$ ) =  
 6 3044.38, Scaled  $\chi^2 = 2433.43$ ,  $df = 585$ ,  $p < .001$ , NNFI = .876, Robust CFI = .873,  
 7 GFI = .870, RMSEA = .058, 90% CI of the RMSEA = .056 - .060. Average Absolute  
 8 Standardised Residuals = .04. The higher-order factor loadings were greater than .5  
 9 except the loadings for the Loss of Self-consciousness and Transformation of Time  
 10 scales which were lower than .5 (see Figure 1). The overall fit indices indicate that the  
 11 FSS hierarchical model had a reasonable fit to the data which is close to the overall  
 12 model fit reported by Jackson and Marsh (1996) based on athletes' responses.

13 A  $\chi^2$  difference test to examine if the nine factor model differed significantly  
 14 from the hierarchical model showed that the difference was significant ( $\chi^2$  difference  
 15 = 319.99,  $df$  difference = 27). However, examination of the fit indices showed that the  
 16 difference was not substantial (NNFIs of .890 vs. .876). These results provide support  
 17 for the tenability of the FSS measurement model in explaining exercise participants'  
 18 responses.

19 Exercise-induced Feeling Inventory. A confirmatory factor analysis was used  
 20 to test for the a priori four-factor structure of the EFI based on responses from a  
 21 sample of 1,231 aerobic dance exercise participants. The model specified four first-  
 22 order intercorrelated factors of Positive Engagement, Revitalisation, Tranquillity, and  
 23 Physical Exhaustion (Gauvin & Rejeski, 1993). The results showed that the model  
 24 had a good fit to the data: Unadjusted  $\chi^2 = 272.04$ , Scaled  $\chi^2 = 224.76$ ,  $df = 48$ ,  $p <$   
 25  $.001$ , NNFI = .946, Robust CFI = .960, GFI = .964, RMSEA = .062, 90% CI of the

1 RMSEA = .055 - .069. Average Absolute Standardised Residuals = .02. Examination  
 2 of the factor loadings showed that they were substantial in that all were greater than  
 3 .5. Overall, the EFI showed a good fit to the data.

#### 4 Associations Between Flow and Subjective Feelings

5 In order to examine the pattern of associations between the variance shared  
 6 among the nine first-order FSS factors and the four post-exercise feelings structural  
 7 equation modelling techniques were employed. The structural model tested  
 8 represented the relationships between Flow and the feeling states of Positive  
 9 Engagement, Revitalisation, Tranquillity, and Physical Exhaustion. It was  
 10 hypothesised that Flow would be positively associated with Positive Engagement,  
 11 Revitalisation, Tranquillity, and Physical Exhaustion. According to Byrne (1994),  
 12 owing to the fact that structural equation models are of a confirmatory nature “ . . .  
 13 relationships among all variables in the hypothesised model must be grounded in  
 14 theory or empirical research or both” (p. 138). Based on theoretical predictions  
 15 discussed in the Introduction section, unidirectional arrows were specified from the  
 16 higher-order Flow factor towards the four feeling states to examine the association  
 17 between the variables.

18 \_\_\_\_\_  
 19 Insert Figure 1 about here  
 20 \_\_\_\_\_

21 Examination of the overall fit indices showed that the fit of the model to the  
 22 data was reasonable: Unadjusted  $\chi^2$  ( $N = 1231$ ) = 5406.55, Satorra-Bentler Scaled  $\chi^2$   
 23 ( $N = 1231$ ) = 4441.20,  $df = 1067$ ,  $p < .001$ , NNFI = .84, CFI = .84, Robust CFI = .84,  
 24 GFI = .83, RMSEA = .05, 90% CI of the RMSEA = .056 - .059. Average of  
 25 Standardised Residuals = .04. Despite the fact that the overall fit indices were lower

1 than .90, the average of the standardised residuals showed that the hypothesised  
 2 correlation matrix explained the observed correlation matrix within an error of .04.  
 3 Here, the residual index is discussed in the context of a correlation matrix as the EQS  
 4 provides these residuals in their standardised form.

5 The standardised structural coefficients showed that, in accordance with the  
 6 research hypotheses, there were moderate to strong positive associations between the  
 7 higher-order Flow factor and the factors of Positive Engagement (beta = .59,  $p < .05$ ),  
 8 Revitalisation (beta = .55,  $p < .05$ ) and Tranquillity (beta = .46,  $p < .05$ ). A very weak  
 9 negative association emerged between Flow and Physical Exhaustion (beta = -.12,  
 10  $p < .05$ ). Flow explained 35% of the Positive Engagement variance, 31% of the  
 11 Revitalisation variance, and 22% of the Tranquillity variance. However, the variance  
 12 explained in Physical Exhaustion was close to zero (see Figure 1).

### 13 Discussion

14 The present study examined the relationship between self-reported levels of  
 15 Flow (Csikszentmihalyi, 1975) and the post-exercise subjective feelings of Positive  
 16 Engagement, Revitalisation, Tranquillity, and Physical Exhaustion (Gauvin &  
 17 Rejeski, 1993) in aerobic dance exercise. In support of the research hypotheses, it was  
 18 found that Flow demonstrated a moderate positive association with Positive  
 19 Engagement, Revitalisation, and Tranquillity but was not associated with Physical  
 20 Exhaustion. The present findings lend support to Vallerand's (1987) propositions in  
 21 an exercise context. According to Vallerand, the intuitive appraisal of events can  
 22 determine self-related affect. Perceptions of goal attainment correspond with a  
 23 positive intuitive appraisal. If exercise participants feel that their goals are attained,  
 24 they will exhibit positive affect. The clear receipt of feedback that one's goal is

1 attained is a component of the flow experience (Csikszentmihalyi &  
2 Csikszentmihalyi, 1988; Jackson & Marsh, 1996).

3         The non-association that emerged between Flow and Physical Exhaustion is  
4 attributed to the possibility that physical exhaustion may be perceived either as being  
5 a pleasant or an unpleasant sensation. That is, even if two persons report high scores  
6 on the Physical Exhaustion scale, one may feel satisfied through feeling physically  
7 exhausted while the other may attach a negative connotation to such a feeling. Indeed,  
8 the nature of fatigue as either a positive or negative state has been a subject of  
9 discussion in exercise psychology literature (see McAuley & Courneya, 1994). There  
10 is much evidence to suggest that music which is enjoyed by the participants can lead  
11 to reduced perceived exertion during exercise (see Karageorghis & Terry, 1997 for  
12 review) and this may influence perceptions of fatigue immediately post exercise  
13 (Karageorghis, 1998). According to McAuley and Courneya (1994), certain pre-  
14 existing individual conditions may determine if fatigue is experienced as “good” or  
15 “bad”. Such conditions may be the participant’s fitness level and exercise history.  
16 Therefore, future research should examine the moderating influence of these factors  
17 on the nature of the relationship between flow and subjective interpretation of feelings  
18 of physical exhaustion.

19         Based on the initial evidence that emerged from the present study regarding  
20 the relationship between self-reported levels of flow and post-exercise feelings,  
21 exercise leaders such as physical educators may wish to enhance the flow experience  
22 of exercise participants for two reasons. First, because such an optimal experience is  
23 likely to promote positive post-exercise feelings which in turn are likely to promote  
24 adherence to physical activity (Dishman, 1982; Rejeski, 1992; Sallis & Hovell, 1990).  
25 Second, the achievement of flow in an exercise environment is a desired outcome in

1 its own right since flow is an enjoyable state and a source of motivation for those  
2 engaged in physical activity (Jackson, 1996). To date, there has not been any research  
3 to examine the factors which may promote or disrupt the flow experience during  
4 exercise.

5 Owing to the fact that exercise shares some similarities with sport in terms of  
6 physical demands, Jackson's (1995) findings regarding factors reported by athletes  
7 which may promote flow in sport may be pertinent to the exercise setting. Therefore,  
8 based on Jackson's findings, it is suggested by the present authors that the exercise  
9 leader should consider the following measures to promote flow among participants:  
10 (a) satisfy participants' needs for self-determination, competence, and relatedness  
11 (Vallerand, 1997); (b) build confidence and a positive mental attitude through positive  
12 concurrent feedback (see Orlick, 1998); (c) maintain focus through appropriate  
13 keywords (see Nideffer, 1992); and (d) promote cohesion within the exercise group  
14 (see Carron & Hausenblas, 1998). In addition to such recommendations, the work by  
15 Karageorghis and his associates (Karageorghis, 1998, 1999; Karageorghis & Terry,  
16 1997) indicates that appropriately selected music for exercise can promote the  
17 experience of flow.

18 The implications of the present findings for physical educators are similar to  
19 those for exercise leaders; however, there are some specific actions that physical  
20 educators can take to promote the occurrence of flow among school pupils. First, the  
21 encouragement of pupils to set personal goals which are attainable, challenging, and  
22 well-defined will promote the experience of flow (i.e., challenge-skill balance).  
23 Second, giving pupils a choice from time to time in the activities that they engage in  
24 will increase the possibilities that they will experience an increased sense of choice  
25 which, in turn, will make the activity more enjoyable (i.e., autotelic experience).



1 Third, using skill learning techniques which are perceived by pupils as being fun to  
2 engage in will more likely encourage them to persist in mastering the tasks involved  
3 (i.e., sense of control).

4 It should be noted that such recommendations should be interpreted in light of  
5 the following: (a) there has not been a qualitative investigation to identify factors  
6 which may promote flow in an exercise setting or in physical education and (b) the  
7 cross-sectional design employed in the present study does not allow for causal  
8 relationships to be inferred. The present results are interpreted as being correlational  
9 in nature. The lack of a “time-ordered cross-sectional design” (Menard, 1991) is  
10 resultant from the inherent difficulty of assessing flow during exercise. Using the  
11 methods which have been traditionally used to assess flow in non-sport and exercise  
12 environments (i.e., the Experience Sampling Method: Csikszentmihalyi & Larson,  
13 1992) may be problematic owing to the intrusive nature of such assessment (Jackson,  
14 1992). According to Jackson (1992), the two main difficulties associated with the  
15 measurement of flow in sport using “beepers” or remote control buzzers are that: first,  
16 flow experience is interrupted and second; it is unlikely that participants engaged in  
17 an activity of a continuous nature will permit a pause in performance to provide  
18 indications of flow. These two problems also pervade the assessment of flow during  
19 aerobic dance exercise owing to the continuous nature of this activity.

20 In sum, the present study demonstrated that self-reported levels of flow are  
21 positively associated with the post-exercise feelings of revitalisation, tranquillity, and  
22 positive engagement. Future research should attempt to further understand the  
23 mechanisms through which exercise participation generates these feeling states. The  
24 understanding of such processes may facilitate the structuring of exercise programmes  
25 to maximise the likelihood of the experience of these feeling states. Such exercise

1 experiences may have a double benefit. First, to increase the likelihood of exercise  
2 participants adhering to lifelong physical activity. Second, to maximise the mental  
3 health benefits derived from exercise participation, thus contributing to improved  
4 quality of life. Finally, replication of the design employed in the present study in a  
5 physical education context appears to be both warranted and timely. Such research  
6 would shed light on the relationship between enjoyment of a physical education  
7 lesson and subjective states post activity, thus, giving physical educators useful  
8 information regarding the structuring of lessons.

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#### Figure Captions

17 Figure 1. Latent variable structural equation model representing associations of Flow  
18 with Exercise-induced Feeling States.

19 All parameter estimates are standardised and significant at the  $p < .01$  level.

20

21 Footnote. The arrows from the higher-order flow factor to the nine Flow State Scale  
22 factors and the four Exercise-induced Feeling Inventory factors represent  
23 relationships whose magnitude is indicated by the standardised structural coefficients  
24 (above the arrows). The figures in circles represent measurement error for each of the  
25 coefficients.



