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

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Abstract

The present study examined the relationship between self-reported levels of flow and the post-exercise feelings of positive engagement, revitalization, tranquillity and physical exhaustion using responses from 1231 aerobic dance exercise participants. Vallerand's intuitive-reflective appraisal model of self-related affect and Csikszentmihalyi's conceptual framework for optimal experience served as the guiding theoretical frameworks. It was hypothesized that self-reported flow would be positively associated with revitalization, tranquillity and positive engagement, while statistical independence was expected for physical exhaustion. First, participants completed the Flow State Scale and, second, the Exercise-induced Feeling Inventory, immediately after an aerobic dance exercise class. Latent variable analyses showed that the higher-order flow factor was positively associated with post-exercise positive engagement, revitalization and tranquillity, but not with physical exhaustion. Flow state explained 35 percent of the variance in positive engagement, 31 percent of the variance in revitalization and 22 percent of the variance in tranquillity. It is concluded that self-reported flow in aerobic dance exercise is moderately associated with the experience of positive post-exercise feelings. Physical educators may wish to employ interventions to facilitate the flow experience during lessons that involve structured exercise.

Key words: Optimal experience, structural equation modelling

Biographical Note

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

According to Gauvin and Rejeski (1993), the stimulative properties of exercise can produce distinct feelings generated by physiological changes during and after physical activity. Gauvin and Rejeski have developed the Exercise-induced Feeling Inventory (EFI) to quantify four types of subjective responses associated with acute bouts of physical activity. These are revitalization, tranquillity, physical exhaustion and positive engagement.

Intuitive-reflective Appraisal Model and Subjective Responses to Exercise

In line with various cognitive theories of emotion, Vallerand (1987) has proposed an intuitive-reflective appraisal model for self-related affect in achievement situations. Vallerand’s model has been deemed to be applicable in the exercise context as this can be considered to be an achievement situation. This is because the goal of the participants is to follow the routine demonstrated by the exercise leader and they can be clearly aware of the extent to which they are achieving their goal. This statement is also grounded in the concept of 'flow' originally introduced by Csikszentmihalyi (1975, 1997) and operationalized in the sport and physical activity contexts by Jackson and Marsh (1996) with the Flow State Scale. In accordance with the operationalization of the concept of flow, participants can receive clear feedback during the activity regarding the degree to which they achieve the goals set by the exercise leader.

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

Reflective appraisal refers to a deliberate processing of information received from the internal environment (e.g. memory, bodily sensations produced by the activity) or the external environment. According to Vallerand (1987), the reflective appraisal can take several forms: (a) intellectualization (Lazarus, 1966), (b) self, outcome and social comparison processes (Suls and Mullen, 1983), (c) various information- processing functions (Markus and Zajonc, 1985), (d) mastery-related cognitions (Taylor, 1981) and (e) causal attributions (Weiner, 1979, 1985).

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

Flow Experience and Affective Responses

It is suggested that Csikszentmihalyi's (1975) theoretical framework regarding optimal experience during involvement in any activity is relevant when the perceived quality of the exercise experience is the topic of concern. Indeed, Csikszentmihalyi and Csikszentmihalyi (1988) have suggested that the construct of flow is relevant whenever the quality of human experience is at issue. Flow is defined by Csikszentmihalyi (1975) as an optimal psychological state. According to Csikszentmihalyi and Csikszentmihalyi (1988), a number of elements comprise the flow experience. First, the participants perceive a balance between the skills they bring to the activity and the demands imposed by it; further, both are perceived to be at a high level. Second, the participants know what needs to be done; hence, the activity provides clear goals. Third, the participants know how well they are doing as the activity provides quick and unambiguous feedback. Further, concentration is totally focused on the task at hand. This has been explained in terms of the fact that, during flow, a state of harmony exists that prevents attention from being directed towards anything but the activity (Csikszentmihalyi and Csikszentmihalyi, 1988). Also, when in flow, one experiences a sense of control over the outcomes of the activity. Further, time is not experienced in the usual sense but is distorted; one may feel that time passes very quickly or that the activity goes on and on. In addition, the concern with the self that is experienced in everyday life disappears, resulting in a state of being free from self-consciousness. According to Jackson and Marsh (1996: 19), 'the absence of preoccupation with self does not mean the person is unaware of what is happening in mind or body, but rather is not focusing on the information normally used to represent to oneself who one is'. Finally, when all these elements are experienced in tandem, consciousness is in harmony and this makes the experience intrinsically rewarding. In other words, there is worth in participating in the activity for its own sake, rather than for reasons that are external to the activity. In essence, the activity is highly enjoyable.

Csikszentmihalyi and LeFevre (1989) examined whether the affect and potency of 78 adult workers were influenced by their experience of flow. Using the

Experience Sampling Method, they obtained self-reports of positive affect and potency from each participant throughout each day for a week. Positive affect was measured with items such as ‘happy–sad’ and ‘cheerful–irritable’, whereas potency was measured with items such as ‘alert–drowsy’, ‘active–passive’ and ‘excited–bored’. They concluded that the quality of the experience (that is, affect and potency) changed dramatically depending on whether the participants experienced flow while working.

Clarke and Haworth (1994) have also provided evidence for the association between flow experience and subjective feelings. They investigated the degree to which quality of experience as represented by the subjective feelings of enjoyment, interest, happiness and relaxation differed across nine different types of experience in sixth-form college students. The differences between these types of experience (channels of flow, boredom, worry, etc.) were represented by differences in the combinations of varying levels of perceived challenge and skills in the situation. For example, the ‘flow’ experience was defined in terms of a balance between challenges and skills, while the experience of ‘control’ was defined by skills being perceived as greater than the challenge. The results showed that high scores of enjoyment and happiness were reported by people in the control channel, whereas interest scores were high in the flow channel. In general, the flow experience and the control experience were positively associated with subjective feelings indicating quality of experience.

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

Relationships Between Flow and Post-exercise Subjective Feelings

The purpose of the present study was to examine the relationship between self-reported levels of flow during participation in an aerobic dance exercise class and the post-exercise subjective feelings of revitalization, tranquillity, physical exhaustion and positive engagement. The theoretical rationale for expecting a relationship between flow and subjective post-exercise feelings is grounded within the theories proposed by Vallerand (1987) and Csikszentmihalyi (1975, 1997). According to Vallerand (1987) the intuitive appraisal regarding how well participants perform in achievement situations can determine their affective reactions. This type of appraisal can take place during the activity. In the exercise context, the degree to which participants feel that they attain the goals set by the exercise leader will determine whether they will feel successful. It is suggested that when participants feel that they attain their goal, they will experience greater positive affect compared to those who feel that they have not attained their goal. The intuitive appraisal concept corresponds clearly with the concept of flow; that is, participants who experience flow get clear and immediate feedback from the activity that their goals are attained when skill equals challenge.

Such feedback corresponds with knowledge that the participants do well without the need for more elaborate forms of cognition. Taking into account that a positive intuitive appraisal can lead to positive affective reactions and that perceptions of flow underpin a positive intuitive appraisal, it is hypothesized that self-reported levels of flow will be associated with affective reactions.

Specifically, it was hypothesized that self-reported levels of flow will be positively associated with the degree to which the positive feelings of revitalization, tranquillity and positive engagement are experienced. That is, the flow experience corresponds with a sense of optimal performance in exercise participants. This sense of optimal performance corresponds with a positive intuitive appraisal of the degree to which the participant’s goals are achieved, which, in turn, is hypothesized to lead to positive affective reactions.

With regard to physical exhaustion, it is not possible to attach either a positive or negative connotation to this state. According to McAuley and Courneya (1994), the meaning which the exercise participants attach to feelings of fatigue may depend on a number of pre-existing individual conditions, such as fitness level and exercise history. Some participants may view physical exhaustion as satisfying as this is an indication that they have achieved their goal (e.g. to burn fat). Others may train harder than they should, thus experiencing extreme fatigue, and in this instance fatigue is likely to be labelled in a negative way. Data presented by Gauvin and Rejeski (1993) as well as McAuley and Courneya (1994) provided support for the proposed dual connotation that can be attached to physical exhaustion. Specifically, Gauvin and Rejeski (1993) report weak bivariate correlations between physical exhaustion and the rest of the positive feelings of the EFI while McAuley and Courneya (1994) reported weak correlations of fatigue with the psychological well-being and psychological distress factors of the Subjective Exercise Experiences Scale. As the present study represents an initial attempt to examine the relationship between self- reported levels of flow and subjective feelings assessed by the EFI, moderators of the relationship between flow and subjective feelings were not examined. Therefore, no association was expected between flow and physical exhaustion.

Significance of Present Study to Physical Education

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

Method

Participants

Data were collected from 1231 aerobic dance exercise participants attending a number of health clubs in the London area in England. The age of the participants ranged from 18 to 70 years (M = 31.43 yr, SD = 9.13 yr); 120 participants did not report their age and six participants did not report their gender. Of those who did report their gender, 211 were males and 1014 were females. The inequality in the number of participants from each gender reflects the popularity of aerobic dance exercise classes among females.

Instrumentation

Flow State Scale. The Flow State Scale (FSS: Jackson and Marsh, 1996) was employed to assess the degree to which aerobic dance exercise participants reported that they experienced flow. Jackson and Marsh (1996) have argued that the FSS has been designed to assess flow in sport and physical activity settings; therefore, it was deemed appropriate to be used for the assessment of flow in an aerobic dance exercise setting. This 36-item instrument comprises nine subscales. These consist of four items each and are labelled ‘Challenge–Skill Balance’ (e.g. ‘I was challenged, but I believed my skills would allow me to meet the challenge’), ‘Action–Awareness Merging’ (e.g. ‘I made the correct movements without thinking about trying to do so’), ‘Clear Goals’ (e.g. ‘I knew clearly what I wanted to do’), ‘Unambiguous Feedback’ (e.g. ‘It was really clear to me that I was doing well’), ‘Concentration on Task at Hand’ (e.g. ‘My attention was focused entirely on what I was doing’), ‘Sense of Control’ (e.g. ‘I felt in total control of what I was doing’), ‘Loss of Self-consciousness’ (e.g. ‘I was not concerned with what others may have been thinking of me’), ‘Transformation of Time’ (e.g. ‘It felt like time stopped while I was performing’) and ‘Autotelic Experience’ (e.g. ‘I found the experience extremely rewarding’). Respondents were asked to indicate the extent to which they agreed with each statement on a five-point Likert scale anchored by 1 (*Strongly disagree*) and 5 (*Strongly agree*).

Initial psychometric examination of the FSS based on a sample of athletes showed satisfactory psychometric properties (Jackson and Marsh, 1996). For the present sample (*N* = 1231), internal consistency coefficients using Cronbach's alpha (Cronbach, 1951) were over .70 for all subscales except Transformation of Time, which yielded an alpha of .65. The remaining coefficients were: Challenge–Skill Balance = .78, Action–Awareness Merging = .84, Clear Goals = .79, Unambiguous Feedback = .83, Total Concentration = .82, Sense of Control = .84, Loss of Self-consciousness = .80 and Autotelic Experience = .83.

Exercise-induced Feeling Inventory. The Exercise-induced Feeling Inventory (EFI: Gauvin and Rejeski, 1993) has been designed to assess subjective feelings associated with acute bouts of physical activity. A number of factors led to the decision to employ the EFI to assess subjective responses to exercise rather than other similar instruments. Specifically, the Profile of Mood States (POMS: McNair et al., 1971) was not used, as (a) it is heavily oriented toward measuring negative states; (b) its construct validity with diverse samples of physically active adults is limited beyond college-aged populations and (c) the relevance of the items for the exercise context is questionable (McAuley and Courneya, 1994). The Positive and Negative Affect Schedule (PANAS: Watson et al., 1988) was not employed because its items are of questionable relevance to the stimulus properties of exercise (McAuley and Courneya, 1994). The Feeling Scale (FS: Rejeski et al., 1987) was not used owing to its reliance upon a single affect item which is oversimplistic (McAuley and Courneya, 1994) and its presumption of affect as bipolar and unidimensional which may be problematic from both conceptual and theoretical perspectives (Watson et al., 1988). Finally, the Subjective Exercise Experiences Scales (SEES; McAuley and Courneya, 1994), which tap the global aspect of psychological responses to exercise rather than the structural aspects of these global responses assessed by the EFI, were a viable option. The authors decided to investigate the detailed aspects of these responses with the intention of studying the global aspects of the exercise responses in the future.

The EFI consists of 12 items which capture the four feeling states of Positive Engagement (‘enthusiastic’, ‘happy’, ‘upbeat’), Revitalization (‘refreshed’, ‘energetic’, ‘revived’), Tranquillity (‘calm’, ‘relaxed’, ‘peaceful’), and Physical Exhaustion (‘fatigued’, ‘tired’, ‘worn-out’). Respondents rate their feelings on a five-point Likert scale anchored by 0 (*Do not feel*) and 4 (*Feel very strongly*). Satisfactory psychometric properties were initially reported by Gauvin and Rejeski (1993). Using structural equation modelling techniques, they showed that the a priori four-factor model had a good fit to the data and alpha coefficients were satisfactory for all subscales. Alpha coefficients for the present sample (N = 1231) were satisfactory for the subscales of Positive Engagement = .72, Revitalization = .77, Tranquillity = .78 and Physical Exhaustion = .81.

Procedures

Data collection took place at a number of health clubs in the London area. The classes targeted were aerobic dance exercise-to-music classes with an exercise leader. The classes were of varying intensities and their duration was precisely one hour. The exercise participants were approached before the initiation of their class by the researchers together with their research assistants who asked them if they were willing to participate in a study to examine exercise participants’ thoughts and feelings about their exercise participation. Participants who gave their verbal informed consent to participation completed demographic information before the start of their class. Immediately after the class, they completed the FSS and then the EFI. Jackson and Marsh (1996) designed the FSS to be used immediately or soon after performance to assess flow state characteristics experienced during performance. The Experience

Sampling Method (Csikszentmihalyi and Larson, 1992) was not used as participants would have been required to interrupt the class in order to report their flow experience.

Data Analysis

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

The goodness-of-fit criteria used in the present study to evaluate the adequacy of the models were the X^2 statistic, the Nonnormed Fit Index (NNFI), the Comparative Fit Index (CFI), the Goodness of Fit Index (GFI), and the Root Mean Squared Error of Approximation (RMSEA). The NNFI estimates the relative improvement of the target model over the independence model (the model which specifies uncorrelated variables) per degree of freedom (Hoyle and Panter, 1995). Its value can fall outside the 0–1 range. The CFI is derived from a comparison of the model of interest with the independence model and can range between 0 and 1 (Byrne, 1995). A cut-off point of .90 has typically been used for model evaluation based on the CFI (Hu and Bentler, 1995). However, according to Hu and Bentler (1995), the sampling distributions of overall fit indices are not known and evidence has emerged that the .90 cut-off point typically used for evaluation of fit indices may not always be appropriate under all modelling circumstances. For this reason, they have suggested that evaluation of standardized residuals can provide a more definitive indication of the fit of a model.

Therefore, the average value of the absolute standardized residuals was evaluated, as it has been suggested that this can provide dependable answers regarding the discrepancy between the observed and the model-reproduced covariances, despite the information provided by the chi-square statistic and the overall goodness- of-fit indexes (Hu and Bentler, 1995). An average of the absolute values of the residuals between the model-reproduced and the observed covariances of .03 means that the model can explain the covariances to within an average error of .03. In addition, the GFI indicates the relative amounts of variances and covariances accounted for by a model and is analogous to the traditional R^2 commonly used to summarize results of multiple regression analysis (Hoyle and Panter, 1995). The RMSEA also indicates the extent of the discrepancy between the observed and the hypothesized models per degree of freedom. According to Browne and Cudeck (1993), RMSEA values of .05 or below generally indicate a close fit of the model in relation to the degrees of freedom. Values of .08 or below generally indicate a reasonable error of approximation. Finally, the 90 percent confidence interval of the RMSEA was calculated to provide evidence of the stability of the model when estimated in other samples.

Results

Data Normality and Selection of an Estimator

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

Evaluation of the Measurement Models

Flow State Scale. A confirmatory factor analysis was used to examine the a priori nine-factor FSS measurement model. The results showed a satisfactory fit of the model to the data with the overall fit indices very close to those reported by Jackson and Marsh (1996). The indices were: Unadjusted X^2 (N = 1231) = 2626.03, Scaled X^2 = 2113.44, df = 558, $p < .001$, NNFI = .890, Robust CFI = .893, GFI = .886, RMSEA = .055, 90% CI of the RMSEA = .053 - 057. Average Absolute Standardised Residual = .03. All factor loadings were significant at the $p < .05$ level with coefficients greater than .5 except the Transformation of Time items which displayed two factor loadings lower than .5 (item 3 = .46, item 4 = .38). Estimation of the hierarchical model showed a reasonable fit of the model to the data: Unadjusted X^2 (N = 1231) = 3044.38, Scaled X^2 = 2433.43, df = 585, $p < .001$, NNFI = .876, Robust CFI = .873, GFI = .870, RMSEA = .058, 90 percent CI of the RMSEA = .056–.060. Average Absolute Standardised Residuals = .04. The higher-order factor loadings were greater than .5 except the loadings for the Loss of Self-consciousness and Transformation of Time scales which were lower than .5 (see Figure 1). The overall fit indices indicate that the FSS hierarchical model had a reasonable fit to the data, which is close to the overall model fit reported by Jackson and Marsh (1996) based on athletes' responses.

A X^2 difference test to examine if the nine-factor model differed significantly from the hierarchical model showed that the difference 319.99, df difference = 27).

However, examination of the fit indices showed that the difference was not substantial (NNFIs of .890 vs .876). These results provide support for the tenability of the FSS measurement model in explaining exercise participants' responses.

Exercise-induced Feeling Inventory. A confirmatory factor analysis was used to test for the a priori four-factor structure of the EFI based on responses from a sample of 1231 aerobic dance exercise participants. The model specified four first-order intercorrelated factors of Positive Engagement, Revitalization, Tranquillity and Physical Exhaustion (Gauvin and Rejeski, 1993). The results showed that the model had a good fit to the data: Unadjusted $X^2 = 272.04$, Scaled $X^2 = 224.76$, $df = 48$, $p < .001$, NNFI = .946, Robust CFI = .960, GFI = .964, RMSEA = .062, 90% CI of the RMSEA = .055–.069. Average Absolute Standardised Residuals = .02. Examination of the factor loadings showed that they were substantial in that all were greater than .5. Overall, the EFI showed a good fit to the data.

Associations Between Flow and Subjective Feelings

In order to examine the pattern of associations between the variance shared among the nine first-order FSS factors and the four post-exercise feelings, structural equation modelling techniques were employed. The structural model tested represented the relationships between flow and the feeling states of Positive Engagement, Revitalization, Tranquillity and Physical Exhaustion. It was hypothesized that Flow would be positively associated with Positive Engagement, Revitalization, Tranquillity and Physical Exhaustion. According to Byrne (1994: 138), owing to the fact that structural equation models are of a confirmatory nature, 'relationships among all variables in the hypothesised model must be grounded in theory or empirical research or both'. Based on theoretical predictions discussed in the

Introduction section, unidirectional arrows were specified from the higher-order flow factor towards the four feeling states to examine the association between the variables.

Insert Figure 1 about here

Examination of the overall fit indices showed that the fit of the model to the data was reasonable: Unadjusted X^2 (N = 1231) = 5406.55, Satorra-Bentler Scaled X^2 (N = 1231) = 4441.20, df = 1067, $p < .001$, NNFI = .84, CFI = .84, Robust CFI = .84, GFI = .83, RMSEA = .05, 90% CI of the RMSEA = .056–.059. Average of Standardised Residuals = .04. Despite the fact that the overall fit indices were lower than .90, the average of the standardised residuals showed that the hypothesised correlation matrix explained the observed correlation matrix within an error of .04. Here, the residual index is discussed in the context of a correlation matrix, as the EQS provides these residuals in their standardised form.

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

Discussion

The present study examined the relationship between self-reported levels of flow (Csikszentmihalyi, 1975) and the post-exercise subjective feelings of positive engagement, revitalization, tranquillity and physical exhaustion (Gauvin and Rejeski, 1993) in aerobic dance exercise. In support of the research hypotheses, it was found that flow demonstrated a moderate positive association with positive engagement, revitalization and tranquillity, but was not associated with physical exhaustion. The present findings lend support to Vallerand's (1987) propositions in an exercise context. According to Vallerand, the intuitive appraisal of events can determine self-related affect. Perceptions of goal attainment correspond with a positive intuitive appraisal. If exercise participants feel that their goals are attained, they will exhibit positive affect. The clear receipt of feedback that one's goal is attained is a component of the flow experience (Csikszentmihalyi and Csikszentmihalyi, 1988; Jackson and Marsh, 1996).

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

Based on the initial evidence that emerged from the present study regarding the relationship between self-reported levels of flow and post-exercise feelings, exercise leaders such as physical educators may wish to enhance the flow experience of exercise participants for two reasons. First, such an optimal experience is likely to promote positive post-exercise feelings, which in turn are likely to promote adherence to physical activity (Dishman, 1982; Rejeski, 1992; Sallis and Hovell, 1990). Second, the achievement of flow in an exercise environment is a desired outcome in its own right since flow is an enjoyable state and a source of motivation for those engaged in physical activity (Jackson, 1996). To date, there has not been any research to examine the factors which may promote or disrupt the flow experience during exercise.

Owing to the fact that exercise shares some similarities with sport in terms of physical demands, Jackson's (1995) findings regarding factors reported by athletes which may promote flow in sport may be pertinent to the exercise setting. Therefore, based on Jackson's findings, it is suggested by the present authors that the exercise leader should consider the following measures to promote flow among participants: (a) satisfy participants' needs for self-determination, competence and relatedness (Vallerand, 1997); (b) build confidence and a positive mental attitude through positive concurrent feedback (see Orlick, 1998); (c) maintain focus through appropriate keywords (see Nideffer, 1992); and (d) promote cohesion within the exercise group (see Carron and Hausenblas, 1998). In addition to such recommendations, the work by

Karageorghis and his associates (Karageorghis, 1998, 1999; Karageorghis and Terry, 1997) indicates that appropriately selected music for exercise can promote the experience of flow.

The implications of the present findings for physical educators are similar to those for exercise leaders; however, there are some specific actions that physical educators can take to promote the occurrence of flow among school pupils. First, the encouragement of pupils to set personal goals which are attainable, challenging and will promote the experience of flow (that is, challenge–skill balance). Second, giving pupils a choice from time to time in the activities that they engage in will increase the possibilities that they will experience an increased sense of choice which, in turn, will make the activity more enjoyable (that is, autotelic experience). Third, using skill-learning techniques which are perceived by pupils as being fun to engage in will more likely encourage them to persist in mastering the tasks involved (that is, sense of control).

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

In sum, the present study demonstrated that self-reported levels of flow are positively associated with the post-exercise feelings of revitalization, tranquillity and positive engagement. Future research should attempt to further understand the mechanisms through which exercise participation generates these feeling states. The understanding of such processes may facilitate the structuring of exercise programmes to maximize the likelihood of the experience of these feeling states. Such exercise experiences may have a double benefit. First, they may increase the likelihood of exercise participants adhering to lifelong physical activity. Second, they may maximize the mental health benefits derived from exercise participation, thus contributing to improved quality of life. Finally, replication of the design employed in the present study in a physical education context appears to be both warranted and timely. Such research would shed light on the relationship between enjoyment of a physical education lesson and subjective states post-activity, thus giving physical educators useful information regarding the structuring of lessons.

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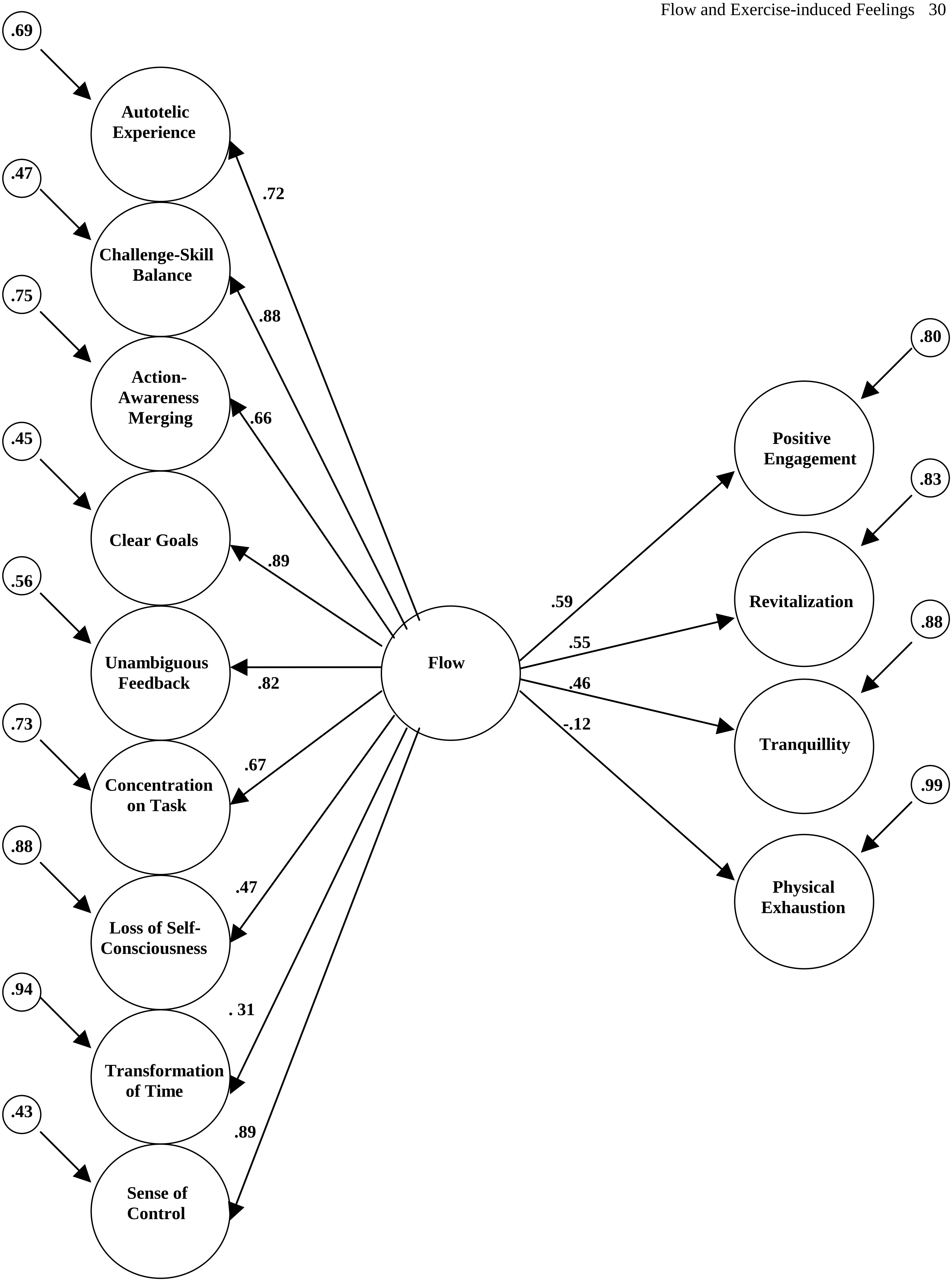
Figure Captions

Figure 1. Latent variable structural equation model representing associations of flow with exercise-induced feeling states. All parameter estimates are standardized and significant at the $p < .01$ level. The arrows from the higher order flow factor to the nine Flow State Scale factors and the four Exercise-induced Feeling Inventory factors represent relationships whose magnitude is indicated by the standardized structural coefficients (above the arrows). The figures in circles represent measurement error for each of the coefficients.

Footnote. The arrows from the higher-order flow factor to the nine Flow State Scale factors and the four Exercise-induced Feeling Inventory factors represent relationships whose magnitude is indicated by the standardised structural coefficients (above the arrows). The figures in circles represent measurement error for each of the coefficients.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Autotelic Experience
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Challenge-Skill Balance
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Action-Awareness Merging
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Clear Goals
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Unambiguous Feedback
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Concentration on Task
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Loss of Self-Consciousness
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Transformation of Time
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Sense of Control
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Flow
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Positive Engagement
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Revitalization
.88
Tranquillity
.99
Physical Exhaustion