Hierarchical confirmatory factor analysis of the Flow State Scale in exercise

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Abstract:

In this study, we examined the factor structure and internal consistency of the Flow State Scale using responses of exercise participants. This self-report questionnaire consists of nine subscales designed to assess flow in sport and physical activity. It was administered to 1231 aerobic dance exercise participants. Confirmatory factor analyses were used to test three competing measurement models of the flow construct: a single-factor model, a nine-factor model and a hierarchical model positing a higher-order flow factor to explain the intercorrelations between the nine first-order factors. The single-factor model showed a poor fit to the data. The nine-factor model and the hierarchical model did not show an adequate fit to the data. All subscales of the Flow State Scale displayed acceptable internal consistency ($\alpha > 0.70$), with the exception of transformation of time ($\alpha = 0.65$). Collectively, the present results do not provide support for the tenability of the single-factor, nine-factor or hierarchical measurement models in an exercise setting.

Keywords: Flow State Scale, optimal experience, structural equation modelling.

Introduction:

Evidence of the benefits of physical activity (International Society of Sport Psychology, 1992; Weyerer and Kupfer, 1994; Biddle, 1995; Leon and Norstrom, 1995; Shephard, 1995; Mutrie, 1997) and of the high rates of withdrawal from exercise programmes (Brawley and Rodgers, 1993; Dishman, 1994) has prompted detailed investigation of those factors that influence adherence to exercise. According to Jackson (1996), flow experience (see Csikszentmihalyi, 1975, 1990, 1993, 1997; Csikszentmihalyi and Csikszentmihalyi, 1988) during exercise can lead to high enjoyment, which, in turn, appears to play an important role in exercise adherence (Martin and Dubbert, 1982; Dishman *et al.*, 1985; Wankel, 1985); empirical research has substantiated this prediction (Ryan *et al.*, 1997). Hence, an understanding of factors that promote flow states in exercise will inform the strategies of exercise practitioners who are interested in promoting enjoyment and adherence to exercise. In addition, Kimiecik and Harris (1996) suggested that flow leads to positive affective reactions, which they equate with enjoyment. Their suggestion is based on a conceptualization of flow as an optimal psychological state that comprises several cognitive components, such as clear goals, intense concentration and a perception of a balance between the challenge and the skill of the participant. Therefore, understanding the psychology of optimal performance during exercise participation is desirable for those interested in promoting the enjoyment of exercise, positive affective experiences and adherence.

Many researchers have tried to elucidate the precise nature of flow experiences (Jackson, 1992, 1995, 1996; Jackson and Roberts, 1992; Kimiecik and Stein, 1992; Stein *et al.*, 1995; Jackson *et al.*, 1998). There is a consensus that flow is a state in which one is totally absorbed in the task, leading to optimal physical and mental functioning. It is seen as an altered state of awareness in which one feels deeply involved in the activity and where mind and body operate harmoniously. Jackson and Marsh (1996) developed the Flow State Scale (FSS), a self-report questionnaire designed to assess flow in sport and physical activity settings. This scale consists of subscales that assess the following flow elements:

Challenge-skill balance: a sense of balance between the perceived demands of the activity and the skills of the participant.

Action-awareness merging: a deep involvement when the activity feels spontaneous and automatic.

Clear goals: the extent to which participants know exactly what they are going to do.

Unambiguous feedback: the feedback inherent in the activity that allows participants to know that they are performing well.

Concentration on task at hand: a total focus on the activity by the participant.

Sense of control: control over the demands of the activity without conscious effort.

Loss of self-consciousness: a sense of not being concerned with oneself while engaging in the activity. According to Jackson and Marsh (1996), a person still knows what is happening in mind and body, but does not use the information normally used to represent oneself.

Transformation of time: the sense of time being distorted, whether speeded up or slowed down; hence, it is experienced differently from normal.

Autotelic experience: an enjoyable experience that is intrinsically rewarding.

Ostensibly, the activity is enjoyable in its own right and is not engaged in for the derivation of external rewards and benefits. The aforementioned flow elements are experienced when a sport or exercise participant is said to be in flow.

Several studies that examined flow across a variety of contexts have demonstrated that flow is an optimal and thoroughly enjoyable experience (Mannell *et al.*, 1988; Csikszentmihalyi and Lefevre, 1989; Scanlan *et al.*, 1989; Jackson, 1992, 1996). It is important that such investigations are extended to exercise, given the potential ramifications for the enhancement of physical and mental health. Jackson *et al*. (1998) have suggested that experiencing flow states frequently when involved in a specific activity promotes the desire to perform the activity for its own sake. In other words, the activity becomes autotelic (Csikszentmihalyi, 1975, 1990); that is, the reasons for participation are grounded in the *process* of involvement in the activity and not in attaining goals that are external to the activity. It appears that attaining flow during exercise may promote intrinsic motivation, which, in turn, has been shown to enhance persistence in participation (Ryan *et al*., 1997; Vallerand and Losier, 1999).

An understanding of the elements that constitute flow state in exercise will assist exercise leaders in adopting practices that promote flow. For example, an exercise leader in cooperation with an exercise participant can promote the element of challenge-skill balance with a careful selection of the task. Exercise leaders can promote the elements of clear goals and unambiguous feedback. They can clarify the goals that the participant is to achieve while feedback can be received both automatically during the activity (i.e. internal feedback) and from the exercise leader (i.e. external feedback). Finally, the element of the experience being autotelic (i.e. enjoyable for its own sake) can be promoted if the participant perceives the task to be challenging and he or she experiences a sense of choice in participating in the activity (Vallerand, 1997).

Jackson and Marsh (1996) provided satisfactory initial evidence for the psychometric properties of the Flow State Scale based on the responses of 394 athletes from the USA and Australia. They used confirmatory factor analyses to test three alternative factor structures: first, a model positing a single first-order factor representing a unidimensional flow construct; secondly, a model positing nine intercorrelated first-order factors; and, thirdly, a model positing a higher-order factor explaining the intercorrelations between the nine first order factors. The second and third models assume a multidimensional flow construct. Jackson and Marsh's (1996) results showed that the model positing a first order factor demonstrated a poor fit to the data, rejecting the notion that flow is unidimensional. The two remaining models provided a reasonably good fit to the data, with the nine first-order correlated factors model providing a slightly better fit than the hierarchical model (non-normed fit index of 0.904 *vs* 0.892).

Examination of the first-order factor loadings showed that all loadings were adequate (i.e. >0.5; see Jackson and Marsh, 1996). Also, an examination of the higher-order factor loadings showed that the highest loading was for the sense of control factor, with the challenge-skill balance, clear goals and concentration factors next highest. Transformation of time and loss of self-consciousness had the lowest loadings. The fact that a considerable number of the first-order factors had non-negligible residual variances led Jackson and Marsh (1996) to conclude that using nine Flow State Scale scores can better represent the variance in responses than a global flow score. Furthermore, the internal consistency coefficients for all subscales were satisfactory ($\alpha > 0.70$).

The aim of the present study was to examine the factor structure, the integrity of the item-factor loadings and the internal consistency of the subscales of the Flow State Scale based on responses from aerobic dance exercise participants. There are at least two reasons to confirm empirically the appropriateness of the factor structure of the Flow State Scale for exercise. First, the attainment of flow in exercise has been considered a motivating factor, as flow can lead to high enjoyment (Jackson, 1996). Therefore, given that theory, measurement, empirical research and practice are inextricably linked

(Marsh, 1997), the validity of the Flow State Scale must first be established for exercise before the advancement of theory-driven research and intervention strategies in this context. Secondly, although Jackson and Marsh (1996) have stated that the Flow State Scale is an appropriate measure to assess the construct of state flow in sport and physical activity, only 5% of participants from their sample were drawn from aerobic dance exercise. Therefore, the findings they reported for the factor structure of the Flow State Scale are more applicable to sport participants than exercise participants.

To test the relationships between the variables of the Flow State Scale, three measurement models were tested using confirmatory factor analysis. First, a single-factor model specifying that all scale items load on a single flow factor; this model tests the hypothesis that flow is a unidimensional construct. Secondly, a measurement model with nine first-order inter-correlated factors, where items will load only on the factor they are intended to define; this model tests the hypothesis that flow is a multidimensional construct. Thirdly, a hierarchical model in which a higher-order factor will explain the intercorrelations between the nine first-order factors; this model tests the hypothesis that the variance in Flow State Scale responses can be explained in terms of a higher-order flow factor. Based on theory and previous research (Jackson and Marsh, 1996), we expected the nine-factor and the hierarchical models to demonstrate a good fit to the data, but the single-factor model to display a poor fit to the data. In addition, we expected all scale items to have high factor loadings on the factors they intend to define and, consequently, high alpha coefficients should emerge for all the subscales.

Methods:

Participants

Data were collected from 1231 aerobic dance exercise participants aged 18-70 years (mean ±*s*: 31.4 ±9.1 years) at three large health and fitness clubs in west and central London in England. They were mainly of Caucasian or Afro-Caribbean origin. Altogether, 123 participants did not report their age and six did not report their sex; of those who did, 211 were males and 1014 were females.

Instrumentation: Flow State Scale

The Flow State Scale (Jackson and Marsh, 1996) assesses the extent to which participants experience a flow state. This 36-item instrument has nine subscales of four items each, 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 indicate the extent to which they agree with each statement on a 5-point Likert scale anchored by 1 = `strongly disagree' and 5 = `strongly agree'.

Procedures

The participants were approached by the research team just before the start of the aerobics class and asked to participate in a study that was to examine their thoughts and feelings during the forthcoming class. They first completed an informed consent form confirming their agreement to participate in the study. Confidentiality of responses was assured and the participants were reminded of their right to discontinue at any time. In accordance with the recommendations of Jackson and Marsh (1996), the participants completed the Flow State Scale immediately after finishing their class. They completed the questionnaire at their own discretion, with the research team available to answer any questions. The research team consisted of two senior researchers and three assistants, all of whom were trained in the administration of the scale. To keep the data collection procedures consistent across the data collection sites, the senior researchers accompanied the assistants at all times.

Data analysis

Structural equation modelling techniques were employed to analyse the data using the EQS software (Bentler, 1995). The steps to the data analysis were as follows: (a) examination of the invariance of the Flow State Scale covariance matrices across the sexes to establish whether we should combine the data of the males and females; (b) examination of the distributional properties of the variables and selection of an appropriate estimator; (c) examination of three alternative measurement models of the scale responses using confirmatory factor analytic procedures; and (d) examination of the internal consistency indices of the nine subscales using Cronbach's alpha coefficient (Cronbach, 1951).

Following the recommendations of Hoyle and Panter (1995) regarding evaluation of model fit, absolute and incremental fit indices were used to assess the adequacy of the models. Absolute indices assess the degree to which the covariances specified by the model match the observed covariances. The greater the match between the covariances, the closer the value is to zero. The absolute fit index used was the χ^2 statistic, as it is also appropriate for the comparison of nested models (e.g. nine-factor *vs* hierarchical). However, the χ^2 statistic is sensitive to sample size; that is, with a large sample, even a model with a small misspecification is likely to be rejected (Hu and Bentler, 1995). For this reason, two incremental indices were also used to assess the fit of the model. Incremental indices assess the degree to which the specified model is better than a model that specifies no covariances. The incremental fit indices used were the non-normed fit index and the comparative fit index. In addition, the standardized root mean squared residual and the root mean squared error of approximation were used to examine the residuals (i.e. the difference between the observed and the implied covariance matrices). Finally, the 90% confidence interval associated with the root mean squared error of approximation is an index of its stability in other samples.

These four indices were some of those suggested by Hu and Bentler (1999) to be useful when evaluating model fit. Of the indices suggested by Hu and Bentler, only these four are provided by the EQS software. According to Hu and Bentler, the cut-off value required before one can conclude a relatively good fit between the hypothesized model and the observed data should be close to 0.95 for the non-normed fit index and comparative fit index, close to 0.08 for the standardized root mean squared residual and close to 0.06 for the root mean squared error of approximation. These indices were used to evaluate the adequacy of the fit of the models.

Results:

Invariance of the sex covariance matrices

To examine whether the Flow State Scale covariance matrices for males and females were invariant, a model was specified based on constraining all the elements of the scale covariance matrices for males and females as invariant. Examination of the model fit was based on the non-normed fit index (NNFI), the comparative fit index (CFI), the standardized root mean squared residual (SRMR) and the root mean squared error of approximation (RMSEA) (see Hu and Bentler, 1999). A good fit for this model would suggest that the covariance matrices are invariant across the sexes and it would justify combining the male and female data for the remaining analyses. The fit indices showed that the data fitted the model adequately (χ^2 = 1127, d.f. = 666, P < 0.001; NNFI = 0.959, CFI = 0.979, SRMR = 0.055, RMSEA = 0.024, 90% confidence interval for RMSEA = 0.021-0.026); consequently, the male and female data were combined for the remaining analyses.

Distribution of the variables

After combining the data for the males and females, the distributional properties of the variables were examined to determine the extent of multivariate non-normality in the data. The univariate skewness values of the Flow State Scale items ranged from -1.03 to 0.32 (skewness across 36 items =-0.54 ±0.28, n = 1231), while the univariate kurtosis values ranged from -0.62 to 1.86 (kurtosis across 36 items = 0.39 ±0.66, n = 1231). Also, the extent of multivariate non-normality was assessed using Mardia's (1970) coefficient of multivariate kurtosis. The results showed that the data displayed multivariate normality, as Mardia's coefficient was 333 for 36 scale items. This value is smaller than the cut-off point of 1368 suggested by the formula $p(p+2)$ for estimating the limit of departure from multivariate normality. In this formula, p equals the number of observed variables (see Bollen, 1989). In addition, examination of the skewness and kurtosis values of the individual items showed that the item responses were, in general, normally distributed. This led us to use the maximum likelihood method of estimation in the data analysis, as it is appropriate when the data are normally distributed.

Confirmatory factor analyses

The adequacy of the factor structure of the Flow State Scale was examined using confirmatory factor analysis. Three alternative models were examined to assess their effectiveness in representing Flow State Scale responses.

Single-factor model. This model specified all Flow State Scale items loading on one first-order factor. Such a model tests a unidimensional conceptualization of the flow construct; that is, it tests the assumption that all items measure a single construct, rejecting the theory that flow consists of nine distinct elements (e.g. challenge-skill balance, clear goals, etc.). Examination of the fit indices showed that the model had a poor fit to the data, as the non-normed fit index, comparative fit index and root mean squared error of approximation did not reach the desirable cut-off values (see Table 1). This suggests that the 36 items of the Flow State Scale assess more than just a single construct. Consistent with the results of Jackson and Marsh (1996), the poor fit of the single-factor model demonstrates that responses cannot be adequately explained using a single scale score.

Table 1: Fit indices for confirmatory factor analyses of Flow State Scale models (n = 1231)

	One first-order	Nine first-order	One higher-order
χ^2	8346	2626	3044
d.f.	594	558	585
P	0.001	0.001	0.001
χ^2			
	-	5720	418
d.f. diff.	-	36	27
NNFI	0.614	0.890	0.876
CFI	0.636	0.903	0.885
SRMR	0.083	0.051	0.061
RMSEA	0.103	0.055	0.058
90% CI RMSEA	0.101-0.105	0.053-0.057	0.056-0.060

Abbreviations: χ^2=chi-square statistic, NNFI=non-normed fit index, CFI=comparative fit index, SRMR=standardized root mean squared residual, RMSEA=root mean squared error of approximation, 90% CI=90% confidence interval, d.f.=degrees of freedom.

Nine-factor model. In this model, items were allowed to correlate only with the factor they were proposed to define while their loading on the remaining factors was fixed at zero. The nine factors were allowed to correlate freely. A good fit for this model would imply that different items measure theoretically distinct components of the flow experience. This model did not show an adequate fit to the data, as two out of the four indices – the non-normed fit index and the comparative fit index – did not reach the desirable cut-off values (see Table 1). All factor loadings were greater than 0.5, providing evidence of the integrity of the item-factor relationships, with the exception of the third and fourth transformation of time items (see Table 2). All factor loadings were significant at $P < 0.01$. Almost all magnitudes of the factor intercorrelations were greater than 0.5, except those involving either the loss of self-consciousness or the transformation of time factors (see Table 3). These correlations were weaker than the rest. It might be that the factor responsible for the less than adequate fit of this model is the transformation of time factor, owing to the weak items involved.

Table 2: Standardized factor loadings and error terms for the nine-factor Flow State Scale measurement model (n = 1231)

	Item			
	1	2	3	4
Challenge-skill balance				
Factor loading	0.51	0.77	0.75	0.73
Error term	0.86	0.63	0.66	0.68
Action-awareness merging				
Factor loading	0.67	0.75	0.83	0.81
Error term	0.74	0.66	0.56	0.59
Clear goals				
Factor loading	0.66	0.74	0.71	0.66
Error term	0.75	0.67	0.70	0.75
Unambiguous feedback				
Factor loading	0.71	0.74	0.74	0.78
Error term	0.70	0.67	0.67	0.63
Total concentration				
Factor loading	0.75	0.52	0.86	0.85
Error term	0.66	0.85	0.50	0.53
Sense of control				
Factor loading	0.73	0.74	0.77	0.77
Error term	0.68	0.67	0.64	0.63
Loss of self-consciousness				
Factor loading	0.76	0.60	0.66	0.80
Error term	0.65	0.80	0.75	0.60
Transformation of time				
Factor loading	0.67	0.74	0.46	0.39
Error term	0.74	0.68	0.89	0.92
Autotelic experience				
Factor loading	0.77	0.67	0.76	0.77
Error term	0.64	0.74	0.65	0.63

Note: All parameter estimates are in a standardized form and are statistically significant at $P < 0.001$. There are four items in each of the nine subscales.

Hierarchical model. The hierarchical model posited that a higher-order factor would explain the intercorrelations between the nine first-order factors. Such a model is assumed to be nested under the nine-factor model inasmuch as it attempts to explain the responses to the Flow State Scale in a more parsimonious way. A good fit for this model means that the variance in responses can be statistically represented by one factor – the higher-order flow factor. The hierarchical model did not show an adequate fit to the data as two of four fit indices – the non-normed fit index and the comparative fit index – did not approach the desirable cut-off value of 0.95 (see Table 1). However, the derived index values were as expected because the higher-order model is more constrained than the nine-factor model and was expected to display lower fit indices. The present results show that a higher-order flow factor does not adequately account for the interrelationships between the first order scale factors. Examination of the higher-order loadings (i.e. the relationships between the first-order factors and the higher-order factor) showed that the sense of control, clear goals, challenge-skill balance and unambiguous feedback factors were the most closely related to the global flow factor (see Table 3). The transformation of time and loss of self-consciousness factors showed the weakest relationships to global flow. These factors displayed the largest associated disturbance terms which represent the amounts of the true (non-error) factor variance that is not accounted for by the higher-order factor. It would appear that the weak correlation of these two factors with the higher-order factor might be the source of the inadequate fit of this model. That is, the concept of a higher-order factor necessitates high intercorrelations among all the first order factors. Hence, the low intercorrelations of these two first-order factors with the remaining first-order factors inhibits the use of the higher-order factor in summarizing the intercorrelations among the first-order factors. A χ^2 difference test to compare the nine-factor model and the hierarchical model showed that the two models differed significantly (χ^2 difference = 418, difference in degrees of freedom = 27, $P < 0.001$). The nine-factor model was statistically better but the substantive difference between the models was small (NNFI = 0.890 *vs* 0.876; CFI = 0.903 *vs* 0.885; SRMR = 0.051 *vs* 0.061; RMSEA = 0.055 *vs* 0.058).

Table 3: Factor intercorrelations based on the nine-factor Flow State Scale measurement model, higher-order factor loadings and internal consistency estimates (n = 1231)

Factor	Challenge	Action	Goals	Feedback	Concentration	Control	Loss	Time	Enjoy
Challenge	(0.78)								
Action	0.64	(0.84)							
Goals	0.78	0.61	(0.78)						
Feedback	0.81	0.61	0.82	(0.82)					
Concentration	0.51	0.40	0.59	0.50	(0.82)				
Control	0.82	0.64	0.82	0.76	0.69	(0.84)			
Loss	0.33	0.36	0.42	0.36	0.39	0.48	(0.79)		
Time	0.22	0.25	0.23	0.22	0.31	0.18	0.25	(0.65)	
Enjoy	0.66	0.29	0.62	0.51	0.58	0.56	0.33	0.35	(0.83)
Higher-order factor loadings									
Flow	0.89	0.68	0.91	0.86	0.66	0.92	0.47	0.28	0.65
Disturbances	0.45	0.73	0.42	0.51	0.75	0.39	0.88	0.96	0.75

Notes:

1. Challenge=challenge-skill balance, action=action-awareness merging, goals=clear goals, feedback=unambiguous feedback, concentration=total concentration, control=sense of control, loss=loss of self-consciousness, time=transformation of time, enjoy=autotelic (enjoyable) experience.

2. All parameter estimates are in a standardized form and are statistically significant at $P < 0.01$.
3. Internal consistency coefficients (alphas) are presented in parentheses along the top diagonal.
4. Disturbances represent the amount of true (non-error) variance not accounted for by the higher-order factor.

Internal consistency estimates

Internal consistency estimates for the nine subscales of the Flow State Scale using Cronbach's (1951) alpha showed that all the coefficients were greater than 0.70, with the exception of transformation of time (see Table 3).

Discussion:

The present study was designed to assess the factor structure, the integrity of the item-factor loadings and the internal consistency of the Flow State Scale (Jackson and Marsh, 1996) using responses from aerobic dance exercise participants. In contrast to the findings of Jackson and Marsh (1996), which were based largely on the responses of athletes, the present results do not provide adequate support either for the nine first-order factors model or for the hierarchical model. In addition, the single-factor model displayed an inadequate fit as expected. This contrast may be due in part to the use of more rigorous cut-off criteria in the present study, a decision based upon the recent recommendations of Hu and Bentler (1999).

The present results suggest that the variance in responses to the Flow State Scale by aerobic dance exercise participants cannot be adequately represented by a single flow score. In addition, when taking into account the considerable residual variances (i.e. disturbances) in the transformation of time and loss of self-consciousness factors in the hierarchical model (i.e. that part of the factor variances which is not explained by the higher-order factor), it is clear that an adequate representation of the variance in responses requires use of the nine scale factors in data analysis rather than the higher-order factor (Jackson and Marsh, 1996). Furthermore, according to Jackson and Marsh (1996), the considerable variance in a few first-order factors which cannot be explained by the higher-order factor means that some external criterion variables can be better explained by the first-order factors than the higher-order factor. Ostensibly, the effectiveness of using the higher-order factor in explaining theoretically relevant external criterion variables will be limited, as it will not adequately represent the true variance in scale responses.

The strength of the associations of the transformation of time and loss of self-consciousness with the remaining flow components concurs with findings by Jackson and Marsh (1996) and previous research based on athletes' experiences (Jackson, 1992; Jackson and Roberts, 1992). The low association between the transformation of time factor and the remaining flow components may be attributed to the relatively low internal consistency displayed by the transformation of time items, something that is also evident from the low factor loadings displayed by the third and fourth factor items. Therefore, further empirical study is required to improve the psychometric integrity of this subscale. However, a second plausible explanation is that, as the workout was conducted synchronously with music, the rhythmic elements of the music may have regulated the participants' sense of time (see Karageorghis and Terry, 1997; Karageorghis *et al.*, 1999). Flow can be attained while exercising synchronously without a distorted sense of time as conceptualized in the context of flow theory. A similar type of experience was also reported by elite athletes interviewed regarding their perceptions of flow state during performance in their sport (Jackson, 1996). Several athletes reported that the time dimension was inappropriate to their task demands. For example, some swimmers used their stroke tempo to obtain feedback about their performance; they were fully aware of the time factor. A final plausible explanation is that performing synchronously with the music may enhance flow, particularly if the participants enjoy the music (see Rhodes *et al.*, 1988; Karageorghis and Terry, 1999a). There is evidence to suggest that music improves the stylistic elements of movement (Chen, 1985; Spilthoorn, 1986), increases alpha brain wave activity (Wales, 1986; Burk, 1989) and enhances mood state (Karageorghis and Terry, 1997, 1999b), all of which are precursors of both flow and successful performance (Collins *et al.*, 1991; Jackson, 1992, 1995; Catley and Duda, 1997). Furthermore, anxiety related to keeping time may decrease flow. This can be explained by Csikszentmihalyi' s (1990) model of flow, which illustrates how anxiety ensues when challenge is high and skills are low. Attempts to maintain movements in time to music result in worry related to (a) keeping time, (b) the exertion that is being externally determined by the tempo of the music and (c) following the choreography of the aerobics instructor while possibly being evaluated by members of the exercise group.

The moderate associations observed between the loss of self-consciousness and the other Flow State Scale factors might suggest that it is difficult for some of the exercise participants to experience loss of self-consciousness because they may be concerned with social evaluation (Csikszentmihalyi, 1997). Self-consciousness is more likely to intensify when individuals are engaging in a group activity, as their bodies are in view of onlookers as well as other members of the group. This means that the correlation between loss of self-consciousness and the remaining factors may vary systematically according to the extent to which exercise participants may display the characteristic of public self-consciousness. This dimension was also not relevant to the flow experience of some of the elite athletes interviewed by Jackson (1996). This may be explained by the distinction made by Csikszentmihalyi (1990) between `being aware of self' and `being self-conscious' or self-evaluative. That is, when experiencing flow, one is very likely to be aware of self but, concurrently, not self-evaluative. Overall, the present results display a similarity with those of Jackson (1996) for the degree to which all the flow elements should be in operation for flow to be experienced. It would appear that not all flow elements are experienced to the same extent during participation in physical activity in which timing is important for optimal performance and body awareness is heightened when compared with non-physical activity.

The adequacy of the item-factor loadings is demonstrated in that most items related to their intended factor to a considerable extent. However, this was not the case with the third and fourth transformation of time items that displayed low factor loadings and contributed to the low internal consistency coefficient of the subscale.

A shortcoming of the present study that should be taken into account when interpreting the findings is the lack of information about sample characteristics, such as whether the classes differed in intensity or duration, and possible differences in participants' experience in aerobic dance classes. However, we argue that such information is not absolutely necessary for the purpose of the present study. The aim of the study was not to assess the flow experienced by the exercise participants while examining potential moderating variables; rather, our aim was to examine the convergent and discriminant validity of the items of the Flow State Scale.

In conclusion, we found that the nine-factor and the hierarchical models did not represent adequately the responses of aerobic dance exercise participants to the Flow State Scale. Satisfactory internal consistency indices have been demonstrated for all the subscales except transformation of time. This may compromise the effectiveness of the subscale in assessing the intended construct. The present results suggest that future empirical work should seek to improve the transformation of time subscale and to re-examine the improved factor structure of the Flow State Scale in exercise.

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