Journal of Leisure Research
2000, Vol. 32, No. 2, pp. 247-261

Validation of the Flow Theory in an On-Site Whitewater Kayaking Setting

Christopher D. Jones
Utah Valley State College

Steven J. Hollenhorst
University of Idaho

Frank Perna
West Virginia University

Steve Selin
West Virginia University

The validation of the flow theory in an on-site whitewater setting is examined. A-priori hypotheses emphasized 3 concerns: (1) the relationship between a four channel model of flow and specific levels of flow indicators, (2) differences in the explanatory power of the four channel model and an original model of flow, and (3) the relationship between river difficulty and the frequencies of four channels (flow, anxiety, apathy, and boredom). On-site experiences of 52 whitewater kayakers were assessed with a series of single page questionnaires administered in the Cheat River Canyon in West Virginia. Sampling techniques involved a modification of the Experience Sampling Method using eight measurement intervals of varying levels of river difficulty. Data were analyzed at the level of experience (n = 409). A-priori hypothesis testing, based on the results of statistical analyses (ANOVA, linear regression, and Chi-square test of association), supported the validation of the flow theory. This validation was demonstrated by the significant relationship between a four channel model and subjective experiences, the positivity of experience during a state of flow, the explanatory power of the four channel model, and differences in channel frequencies across river stages. Patterns of results which were contrary to expectation indicate similarities in subjective experiences between flow and anxiety channels, suggesting that whitewater kayakers may have positive experiences even when their abilities are exceeded by the difficulty of the river.

KEYWORDS: *Flow, experience sampling, four channel model, ecological validity*

Introduction

To explore the immediate states of mind of participants in intrinsic and challenging activities, Csikszentmihalyi (1975) proposed the concept of flow, which was originally defined as a psychological state that occurs when an

---

This study was a portion of a doctoral dissertation for the first author. Correspondence concerning this article should be addressed to Christopher D. Jones, Department of Physical Education and Recreation, Utah Valley State College, Orem, UT, 84058.

individual perceives a balance of challenge and skill. The original theory of flow postulates that the overall positivity of the subjective experience, as represented by flow indicators such as positive affect, arousal, concentration, involvement, intrinsic motivation, and others, is a function of this balance. During the theory's conceptual development, intrinsically motivating outdoor adventure activities (i.e., rock climbing) were emphasized as having the potential for many of the "deepest" flow experiences. Despite this emphasis, further theoretical development of the flow model has neglected to include a quantitative methodology suitable to outdoor adventure settings.

Partially because of methodological difficulties in sampling adventure recreators, empirical studies concerning the flow construct have emphasized daily activities (i.e., work, school, organized sports). Several daily activity studies have questioned models and methods of operationalizing the flow construct because their results indicate that the flow model only accounts for a small degree of the variance in predicting indicators (Ellis, Voelkl, Morris, 1994; Moneta & Csikszentmihalyi, 1996). These indicators represent the positivity of subjective states according to the theoretical elements discussed by Csikszentmihalyi (1975, 1990). Thus, attempts to validate the theory in the daily setting have not been convincing. The purpose of this paper is to validate the flow theory in an on-site adventure setting.

The Four Channel Model and Differences in Subjective Experience

The original model of flow assumed that a state of flow occurred with the literal challenge-skill match while nonflow occurred during an absence of this match. This model was tested in the daily setting using the Experience Sampling Method (ESM) which requires that subjects fill out a brief questionnaire when randomly beeped (generally 7 per day) throughout a one week period (Csikszentmihalyi & Larson, 1987). ESM studies within a daily setting failed to confirm that the literal match of challenge-skill (flow/nonflow) could significantly predict indicators (Csikszentmihalyi & Csikszentmihalyi, 1988).

A reformulated model, the four channel model, was developed to improve the original model and attempt to validate the theory based on the following assumptions: (1) flow occurs when perceived challenge and skill are above an individual's personal average, (2) anxiety occurs when an individual's average perceived challenge is greater than skill, (3) boredom occurs when an individual's average perceived skill exceeds challenge, and (4) apathy occurs when both the perceived challenge and skill are below the personal average. Consistent with theoretical expectations, repeated evaluations of the four channel model in daily settings have revealed that subjective experiences are significantly more positive in the flow channel than the remaining three channels (Massimini & Carli, 1986). Despite these positive findings among daily studies, a lack of validation remains concerning the prediction of differences between channels in on-site adventure settings.

More recently, several validation studies have focused on the construct validity of flow and the variance explained in daily experience by the reformulated model. The four channel model assumes that flow is categorized with higher levels of challenge than the original model. Despite this differentiation, the results of daily studies often remain less supportive of the four channel model than would be theoretically expected. For example, in a study of retired adults, Mannell, Zuzanek, & Larson (1988) found that the highest levels of intrinsically rewarding flow were related to extrinsically motivating daily activities (i.e., work). Additionally, studies of nursing home residents by Voelkl (1990) and Ellis et al. (1994) have reported that only 4.4% and 6%, respectively, of the variance in affect was explained by the reformulated model. Despite the lack of explanatory power of the reformulated model in the daily setting, little is known about the model's ability to predict subjective experiences in the adventure setting.

Flow Indicators

Daily studies of the flow phenomenon have evaluated the positivity of the subjective experience as represented by a number of common indicators. The majority of recent daily studies of flow have adopted different sets of indicators depending on the type of activity and experimental setting (Stein et al., 1995; Mannell et al., 1988). Currently, indicators have not been widely applied or standardized for studies conducted in the outdoor recreation setting.

A number of indicators used in flow studies include those discussed by Csikszentmihalyi (1975, 1988, 1990) who has described the flow experience in terms of nine dimensions. These dimensions include the balance between challenge and skill, and the following eight dimensions which he theorizes to depend on the challenge/skill balance: merging of action and awareness, clear goals, unambiguous feedback, concentration on the task at hand, sense of control, loss of self-consciousness, transformation of time, and the autotelic experience. Previous studies have consistently demonstrated the four channel model's ability to significantly predict these indicators (Massimini & Carli, 1986). Furthermore, scale development assessing the dimensionality of flow has supported the construct validity of these elements (Jackson & Marsh, 1996).

Additional indicators have been predicted by the reformulated model in a study of daily leisure experiences conducted by Kubey and Csikszentmihalyi (1990). They describe the indicators of emotion, cognition, affect, activation, cognitive efficiency, and intrinsic motivation as representing the respondent's subjective experience during daily activities. Furthermore, Mannell, et al. (1988) assessed the construct validity of flow assessing seven components of the optimal leisure state: concentration, competence, physical awareness, potency, mood states, tension, freedom of choice, and intrinsic motivation.

Setting Differences By Challenge

Differences in setting have been suggested as the reason why some daily studies have not validated the flow theory using the reformulated model. For example, results of a recent study by Moneta and Csikszentmihalyi (1996) revealed that violations of the flow model may be caused by setting differences based on the degree of inherent challenge (achievement settings vs. casual-social). The possibility of setting differences has important implications for validating the four channel model. By random chance, studies of "normal" daily life are likely to capture events which are more common and less challenging (e.g., watching TV).

Beyond the challenge-skill match, perceptions of risk (as a type of challenge) balanced with levels of perceived competence have been theorized to promote optimal experiences at different stages of outdoor adventure settings (Martin & Priest, 1986). For example, Priest and Bunting's (1993) evaluation of a whitewater canoeing class revealed that after individuals were exposed to the first major rapid, mean perceptions of risk and competence were a close match, categorized as peak adventure. In contrast, pre-trip and pre-first rapid assessments revealed perceived risks to be higher than competence and these experiences were categorized as misadventure. Thus, setting differences by challenges encountered were found to be factors in determining the frequency of optimal experience.

The Present Study

In the above discussion, the development and origins of the flow theory and its relevance to the outdoor adventure setting were presented. While the flow theory has been widely tested in the daily setting, there remains a need for validation in the adventure setting. To validate the theory, several theoretical expectations are presented. First, based on the results of previous validation studies (Stein et al., 1995 & others), which demonstrate the four channel model's ability to predict indicators, the positivity of the subjective experience should increase when the perceived challenge and skill both exceed the individual average. Second, based on previous studies, the four channel model should explain more of the variance in indicators than the original model (Ellis et al., 1994). Third, based on discussions of setting differences and the ecological validity (see methods section) of the ESM, it is expected that a four channel model (see Figure 1) will perform according to theoretical expectation in a variety of challenging and nonchallenging settings. Therefore, with regard to the above expectations, a-priori hypotheses are threefold:

(H_1) The four channel model will be related to flow indicators, with the level of these indicators highest during flow experiences.
(H_2) The explanatory power of the four channel model will be greater than that of the original model.
(H_3) Flow and anxiety will occur more frequently than apathy and boredom at difficult sections of the river.

Methodology

The Research Setting

The study was conducted on the Canyon section of the Cheat River near Albright, West Virginia, on May 3, 1997. This time of year was chosen because water flows attract large numbers of national and international whitewater paddlers. The Cheat Canyon is a relatively long stretch of whitewater (11 miles) and has rapids that range in difficulty from Class I to Class V rapids. The water level was approximately 3 feet at the gauge during this study, signifying a moderate difficulty level. In addition to the wide range of challenge, the skill level of boaters (on this section of the river) is known to vary widely. The variations in skill and challenge levels in the Cheat Canyon made it the ideal whitewater kayaking setting to assess the flow model.

Sampling

Csikszentmihalyi and Larson (1987) and others have shown that the ESM is a valid and reliable method of assessing flow. Therefore, the method of sampling is based on the ESM but modified to match the setting. The ESM generally requires carrying electronic beepers which are used to randomly interrupt subjects 7 times per day for a week. However, the invasiveness of the ESM in a physical activity context was a possible hindrance (Stein, et al., 1995; Jackson & Marsh, 1996). This constraint is compounded by the fact that most individuals are uncomfortable wearing an electronic beeper during physical activities and they may be more comfortable when prompted by research assistants (Kirshnit, Ham, & Richards, 1989). In addition, frequent interruptions and lengthy questionnaires have resulted in attrition and nonresponse among flatwater kayakers and canoeists (Borrie, 1995). Minimizing interruptions during the whitewater experience is of critical importance in this study; questionnaires were abbreviated and the number of measurement intervals were fewer than is typical for ESM studies.

Furthermore, when modifying the ESM, one must be concerned with the issue of interaction between the treatment and the experimental setting, or ecological validity assumed by the ESM (Keiss & Bloomquist, 1985). To ensure ecological validity, this study must still capture the variation in subjective experience that occurs in the natural setting. The degree of randomness assumed in daily ESM studies would not capture the variation in challenge and likely the variation in subjective experience that is involved in paddling a whitewater river. Based on the study setting, the current method required a more systematic scheduling of measurement intervals.

Kayakers were asked to respond at 8 intervals during the course of the trip down the Cheat River: (1) the put-in, (2) New Wave Rapids—III, (3) Big Nasty Rapids—V, (4) a flatwater section—I, (5) High Falls Rapids V, (6) Pete Morgan's Rapids—V, and (7) Fossil Falls—II, and (8) the take-out (Roman numerals represent ratings on the International Scale of Whitewater Difficulty). These stages of the river trip were specifically chosen to ensure

variations in the level of challenge in order represent the ecological validity of an on-site river trip and the expected experiences within four channels (flow, anxiety, apathy, boredom).

Subjects were approached at the put-in where and asked to participate in a study concerning their experience in the Cheat Canyon and were offered a twenty dollar certificate (sponsored by a local outfitter). A systematic sample was taken with every third kayaker approached between the hours of 8:00 am and noon. Fifty-two kayakers agreed to complete a 20 item questionnaire at each of the 8 designated points. Subjects were anchored to shore by research assistants and asked to fill out questionnaires on the deck of the kayak. Questionnaires cued subjects to respond to the specific activity and location (i.e., While preparing to put on the river a moment ago. . . , While preparing to leave the take-out. . . , While paddling through Pete Morgan's Rapids a moment ago. . .). Subjects were then asked a number of items which assessed the skill-challenge context and flow indicators. A total of 409 experience observations were collected from the 52 subjects (98% compliance). Data were analyzed at the experience level with each experience observation being the unit of analysis.

Measurement and Analysis

Predictors. A nominal variable categorized into four channels (flow, anxiety, apathy, and boredom), based on the balance of challenge and skill (see Figure 1), was used to predict indicators. Perceived challenge and skill were represented by the typical items, "Challenges of the activity" and "Your skills in the activity" and measured with two 10-point Likert-type scales.

For purposes of assessing the original model, a nominal variable of flow/nonflow based on the literal match of perceived challenge and skill was used to predict indicators. For purposes of assessing the four channel model, flow was operationalized when challenge and skill both exceeded the individual's average challenge and average skill, consecutively. Using the same individual average as a means for comparison, anxiety was operationalized when challenge exceeded skill, boredom when skill exceeded challenge, and apathy when both were below the average.

Dependent Measures. The indicators in this study were adapted from Csikszentmihalyi's (1975, 1990) elements of flow, Jackson and Marsh's (1996) dimensions of flow, and components representing the immediate conscious leisure experience (Mannell et al., 1988). To minimize interruptions and as consistent with recent studies, single item measures were used to represent indicators (Moneta & Csikszentmihalyi, 1996). Multi-item scales would require lengthy questionnaires to be administered on eight occasions within a three hour trip and, thus, were likely to bias responses (see Sampling section).

The indicators in this study were selected because they were theoretically related to the activity of whitewater kayaking. Previous flow studies have used similar but somewhat different sets of indicators because various types of

activities generate different subjective experiences (see Flow Indicators section; Chalip, et al., 1984; Kubey & Csikszentmihalyi, 1990). While attempting to minimize the number of items and the length of subject interruptions, the selection of indicators among the questionnaires in the above studies was evaluated by the authors (of whom several are expert kayakers) to consider the practicality of assessing subjective experiences during the activity of kayaking. For example, when considering items (cheerful-irritable, happy-sad) often used to represent the indicator of affect, cheerfulness was assumed to be more commonly experienced during daily activities than during the activity of whitewater kayaking.

Operational measures representing indicators consisted of the following: perception of the transformation of time, intrinsic motivation, involvement, merging of action and awareness, concentration on the task at hand, paradox of control, and (lack of) physical awareness all measured with 10-point Likert-type scales (slow–fast, not at all–very much). Other indicators included affect, activation, and (absence of) tension measured with three 7-point semantic differential items (happy–sad, energetic–tired, relaxed–tense).

Statistical tests. Experience sampling data often breech a number of stringent statistical assumptions (Larson & Delespaul, 1990). Therefore, more basic statistical procedures (univariate tests-ANOVA and descriptive procedures) are preferred to multivariate procedures (Kimiciek & Stein, 1992). H_1 was addressed with one-way ANOVA, a typical procedure to assess the reformulated model (Ellis et al., 1994; Massimini & Carli, 1990; Stein, et al., 1995), and post-hoc comparisons [modified Fisher's LSD (Bonferroni)]. H_2 was evaluated with a hierarchical approach to determine the explanatory power of the flow models regarding the prediction of indicators. A series of linear regressions followed by a Fisher's z transformation were used determine the difference in variance accounted for between models. These procedures were based on recent analyses concerned with the effectiveness of the flow model in predicting indicators (Ellis et al., 1994; Moneta & Csikszentmihalyi, 1996). In a final analysis, H_3 was addressed with a Chi-square test of association and crosstabs procedure to compare the percentage of experiences within each channel to the difficulty class of the river stage. This procedure has been commonly used to assess the flow model within the context of different activity settings (Massimini & Carli, 1990; Freeman, 1993).

For purposes of assessing the four channel model, responses were converted to within-subject z-scores to control for individual response bias. The challenge-skill context was used to determine channels (flow, anxiety, apathy, and boredom) within the four channel model and the conditions of flow/nonflow in the original model. Assessing the original model involved operationalizing flow/nonflow with the literal match of raw scores for challenge-skill. In contrast, the four channel model was operationalized using the balance of z-scores for challenge-skill (see Figure 1). Prior to using linear regression, z-scores from each of the four channels were transformed into dummy coded variables.

To maintain consistency and because data was analyzed at the experience level, it may seem more appropriate to compare the original and four channel models using *z*-scores as the basis for analyses in both models. However, the use of *z*-scores within the original model prevents the possibility of a literal match of challenge-skill and, thus, would have prevented the ability to test the assumptions of the original model. Furthermore, the use of raw scores in both models compromises the control for response bias, a typical concern when evaluating experience level data using the four channel model.

Results

Relationship Between Channels and Indicators

H_1 stated that a significant relationship would be found between channels and indicators with levels of these indicators highest within the flow channel. Differences in subjective experiences existed among the flow, anxiety, apathy, and boredom channels for 9 of the 10 indicators (see Table 1). Consistent with H_1, kayakers found that time passed more quickly in the flow channel than in boredom and apathy. The apathy context was lower in intrinsic motivation than the flow context. Furthermore, subjects were more involved in the activity during flow than during apathy and boredom. Kayakers performed more spontaneously and automatically (indicating a merg-

TABLE 1
Relationship of Channels of Flow, Anxiety, Boredom, and Apathy to Flow Indicators (Cheat Canyon, May, 1997)

Flow Indicators	Flow (n = 111)	Anxiety (n = 104)	Boredom (n = 90)	Apathy (n = 77)	Model F
Time Perception	$.41_a$	$.30_a$	$-.48_b$	$-.46_b$	29.23**
Intrinsic Motivation	$.23_a$	$.00_{ab}$	$.01_{ab}$	$-.38_b$	4.57**
Involvement	$.27_a$	$.28_a$	$-.44_b$	$-.23_b$	13.08**
Merging of Action and Awareness	$.13_{ab}$	$-.25_c$	$.34_a$	$-.24_{bc}$	8.49**
Concentration on the Task at Hand	$.41_a$	$.25_a$	$-.46_b$	$-.40_b$	24.19**
Paradox of Control	$.12_a$	$-.48_b$	$.46_c$	$-.06_a$	19.88**
(Lack of) Physical Awareness	.05	.06	−.07	−.05	.38
Affect	$.20_a$	$-.09_{ab}$	$-.23_b$	$.13_{ab}$	3.99*
Activation	$-.04_{ab}$	$.21_a$	$.00_b$	$-.24_{ab}$	3.27*
Absence of Tension	$.32_a$	$.06_a$	$-.08_b$	$-.42_c$	9.38**

Note. Values represent mean *z* scores. Row means with disparate subscripts are significantly different (based on modified Fisher's LSD (Bonferroni), $p < .05$).
*$p < .05$.
**$p < .01$.

ing of action and awareness) in the flow state than in the anxiety state. Paddlers' concentration was higher in flow than in boredom or apathy. Less control was experienced in the anxiety state compared to the flow state. Boaters were happier during states of flow than while experiencing boredom. Finally, kayakers were more relaxed in the flow context as opposed to the contexts of boredom and apathy. Inconsistent with H_1, perceived control over situations on the river was highest in the boredom context, as opposed to anxiety, apathy, or flow contexts. Furthermore, the similarity in means between the flow and anxiety channels for seven of the ten indicators suggested that even if the challenge of the rapid exceeded the skill of the paddler, the positivity of the experience in the anxiety state was no different from the flow state.

Explanatory Power of Flow Models

H_2 concerned the explanatory power of the four channel model compared to the original model. Overall, the results of linear regression and Fisher's Z transformation confirmed H_2. As can be seen in Table 2, the four channel model significantly explained more of the variance for 7 of 10 indicators ($p < .01$), whereas the original model only predicted a total of two

TABLE 2
Effects of Channels of Flow, Anxiety, Apathy, and Boredom on Flow Indicators (Cheat Canyon, May, 1997)

	Four Channel Model (z scores)		Original Model (raw scores)	
Flow Indicators	F	R^2	F	R^2
Time Perception	29.23**	.19	16.36**	.04
Intrinsic Motivation	4.57**	.05	.06	.00
Involvement	13.08**	.11	2.48	.01
Merging of Action and Awareness	8.49**	.07	.296	.00
Concentration on the Task at Hand	24.19**	.14	12.30**	.03
Paradox of Control	19.88**	.14	1.67	.00
(Lack of) Physical Awareness	.38	.00	.005	.00
Affect	3.99*	.03	.517	.00
Activation	3.27*	.03	.030	.00
Absence of Tension	9.38**	.08	.643	.00

Note. Differences in variance accounted between the two models was significantly different at the $p < .01$ level except for activation ($p < .05$), affect ($p < .10$), and lack of physical awareness based on Fisher's z transformation.
*$p < .05$.
**$p < .01$.

indicators. Moreover, the four channel model explains approximately 5 times the variance of the original model for the following indicators: time perception, intrinsic motivation, involvement, concentration, and control.

Frequency of Channels Among Trip Stages

H_3 stated that flow and anxiety channels would be more frequent during the more difficult stages of the whitewater trip. In support of H_3, Chi-square test of association revealed that flow and anxiety channels were more frequent at the most difficult rapids (Class V) while, in general, apathy and boredom channels were more frequent at the least difficult rapids (Class I-III & land intervals) [χ^2 (1, N = 333) = 44.72, $p < .05$; see Table 3].

In support of H_3, Class V rapids (Big Nasty, High Falls, and Pete Morgan's) were more often experienced as flow (41.4%) and anxiety (39.9%) followed by apathy (10.7%) and boredom (10.6%). Furthermore, this differ-

TABLE 3
Chi-Square Test of Association for Differences in Frequency of Channels by Difficulty of Stages (Cheat Canyon, May, 1997)

Measurement Stage	Whitewater Difficulty	Frequency and Percentage of Respondents Within Channels			
		Flow	Anxiety	Boredom	Apathy
put-in	n/a	2	17	11	19
		(4.1%)	(34.7%)	(22.4%)	(38.8%)
flatwater	I	8	5	21	13
		(17.0%)	(10.6%)	(44.7%)	(27.7%)
Fossil Falls	II	17	6	17	6
		(37.0%)	(13.0%)	(37.0%)	(13.0%)
New Wave	III	9	18	6	16
		(18.4%)	(36.7%)	(12.2%)	(32.7%)
Big Nasty	V	13	19	6	8
		(28.3%)	(41.3%)	(13.0%)	(17.4%)
High Falls	V	20	20	2	6
		(41.7%)	(41.7%)	(4.2%)	(12.5%)
Pete Morgan's	V	26	14	7	1
		(54.2%)	(29.2%)	(14.6%)	(2.1%)
take-out	n/a	16	5	20	8
		(32.7%)	(10.2%)	(40.8%)	(16.3%)
Total Frequency		111	104	90	77
	x^2 = 109.28	x^2 = 44.72			
	$p < .000$	$p < 000$			

Note. Two separate chi-square tests of association are reported consecutively above: (1) between chronological stages and four channel model, and (2) between Class V and Class I-III and land stages (by difficulty) and four channel model.

ence in channels by difficulty is evidenced by the fact that, when taken together, Class I-III and the put-in and take-out sections were experienced more frequently as boredom (31.4%) and apathy (25.7%) followed by flow (21.8%) and anxiety (21%).

While H_3 was not concerned with the put-in and take-out sections of the trip, observation and analysis of the change in experiences over the duration of the trip revealed a unique finding not accounted for in the flow theory (note that Table 3 is ordered by the difficulty of stages; see Sampling section for chronology of stages). When kayakers passed Pete Morgan's, the last difficult rapid, a residual number of flow experiences seemed to occur at the last trip stage. Given that the percentage of anxiety was relatively high during the first two stages of the trip, it is possible that experiences of anxiety were due to anticipation of more challenging sections of the river or an adjustment period of being in the water. Flow (33%) and boredom (41%) characterized experiences at the take-out in contrast to the put-in and first rapid (New Wave, Class III) experiences, characterized by apathy and anxiety. The fact that flow experiences increased from 4.1% at the put-in to 32.7% at the take-out while anxiety decreased from 34.7% at the put-in to 10.2% at the take-out suggests the possibility that anticipation of the river journey influenced whether or not the experience was one of flow or anxiety. In order to statistically determine a residual effect for the flow channel over the course of the trip, challenge was held constant by selecting rapids of the same class (Class V) that occurred relatively early and late in the trip and an additional Chi-square test of association was conducted. As seen in Table 3, the percent of experiences in flow changed over the duration of Class V encounters (28.3% to 54.2%) whereas anxiety and apathy decreased over the duration of Class V encounters [χ^2 (6, N = 142) = 13.42, $p < .05$].

Discussion

While the pattern of results in this study provided support for the validation of the flow theory in an on-site whitewater kayaking setting, several findings are important and unaccounted for in flow theory. In contrast to the theoretical differences discussed by Csikszentmihalyi and Csikszentmihalyi (1988, 1990) between the flow and anxiety constructs, the results of this study revealed that flow and anxiety channels are experienced similarly during extreme adventure. This finding is consistent with a number of sports studies and theoretical models of adventure which report that anxiety levels can be experienced positively before exceeding a threshold at which optimality declines, thus, implying a link between the four channel model of flow and models of optimal arousal (Ewert & Hollenhorst, 1989; Silva & Weinberg, 1984). Furthermore, the result of similarity in subjective experience between flow and anxiety channels is consistent with the findings of ESM studies which revealed that optimal conditions of wilderness canoeing and whitewater paddling were often stressful yet experienced positively (Borrie, 1995; Hood, 1977).

A second finding of importance is a residual positive effect of flow and, inversely, a negative effect of anxiety over the duration of the river trip. This result suggests that these states may have changed according to anticipation of future river challenges. Anxiety experiences may not necessarily be a function of the task at hand but also anticipation of future tasks. Anxiety is highest before the difficult rapids (even when difficulty is lowest) and declines dramatically after the last difficult rapid (Pete Morgan's; see Table 3). In contrast, the frequency of flow experiences is highest immediately after the last difficult rapid. Flow gains a residual effect increasing gradually during the river trip and remains more frequent at low difficulty stages at the end of the trip as compared to the beginning less difficult stages. Since flow experiences were much more frequent at the take-out as compared to the put-in, it seems that benefits from the flow experience may be taken away from the river into everyday life. These results point to the possibility that flow experiences are not as immediate as once thought and are cumulative in nature. When kayakers engaged the most difficult whitewater challenges (Class V) there was a similar frequency of flow and anxiety states, while apathy and boredom were more frequently experienced when engaging the least difficult challenges. These results are consistent with Csikszentmihalyi's (1975) discussions of rock climbing in that in order to experience flow during the most difficult climbs, one must have the necessary level of skill or, if one lacked skill, the fear of failure would produce experiences of anxiety.

Furthermore, the finding that the anxiety channel was equal or greater in frequency than the flow channel at two of the three Class V rapids demonstrated that, generally, kayakers perceived these rapids to be more difficult in relation to their paddling skills. Some kayaking experiences in difficult whitewater may have been more frequently characterized as states of anxiety because of a lessor propensity for thrill seeking, not accounted for in this study. Also as expected, less difficult river stages were more often experienced as either boredom or apathy, suggesting that, as consistent with flow theory, lower levels of challenge were perceived by kayakers based on opportunities for action in the setting. However, it should be noted that take-out and put-in sections were likely contaminated by expectations and reflections, respectively. For example, it is possible that many people experienced flow (33% at the take-out) because they were reflecting on their experience of the trip rather than purely evaluating the take-out section. While expectancy and reflection contamination effects are possible at all stages, they would be expected to be greatest at the put-in and take-out.

An additional interpretation of the residual effect of channels is that anxiety experiences increased markedly and remain high in frequency when individuals were nearing each of the Class V rapids, however, flow experiences did not overtake anxiety until the final Class V rapid. This finding suggests the possibility that if an additional number of Class V rapids had been encountered, flow may have also been highest immediately after the last Class V rapid and reduced anxiety similarly to the above pattern. If this pattern in channel frequency holds true across future studies in the adventure setting, it may be suggest that repeated extreme challenges rather than

one singular extreme challenge are most conducive to facilitating the flow experience. This sequential pattern may also reveal a critical threshold point in which flow is most distinguished from other states of consciousness.

A third finding important to future ESM designs concerns ecological validity. Ecological validity was supported by the fact that the four channel model performed according to theoretical expectation in a variety of different river settings. This finding may suggest concerns as to the ecological validity of post-hoc methods used to evaluate similar psychological states such as satisfaction, generally assessed only before or after the river experience. Thus, there are implications for benefits-based approaches to managing the whitewater river setting. River managers have typically relied on post hoc assessments to determine the benefit of visitor satisfaction. However, recent critics of post hoc approaches discuss the limited ability of individuals to recall experiences which may have occurred hours earlier (Bernard et al., 1984). The present study supports this argument in that the positivity of subjective experiences changed dramatically over the course of the river trip with residual effects influencing post-trip responses. Furthermore, the notion of a continuum of optimal benefits is consistent with Driver's (1979) Recreational Experience Continuum which states that kayakers would "peak" while anticipating the goal object, while achieving the goal object, and while recalling the experience of kayaking. Thus, prospective investigations should attempt to improve benefits-based assessment of whitewater river experiences through the inclusion of post-trip sampling in everyday life (Jones, Hollenhorst, & Schuett, 1998).

Limitations

A final note should be made concerning statistical constraints of ESM data. Flow studies often are constrained by the number of subjects required (within cells) to perform significance tests. In the present on-site study, to conduct individual level analyses of ESM data would have required greater control of environmental factors (e.g., water level, availability of subjects, and voluntary return to the same sets of rapids). However, the necessity of assessing experience level ESM data is limited by the lack control for serial control, an inherent assumption when using ordinary least squares regression approaches (Ellis, et al., 1994). Techniques used to overcome this assumption are generally constrained when assessing ESM data because intercorrelation may occur between adjacent observations of the dependent variables, independent variables, and regression residuals. Future studies should attempt to overcome the constraints of experience level analysis by addressing environmental constraints and serial correlation through complex study designs in on-site river settings.

References

Bernard, H., Killworth, P., Kronenfeld, D., & Sailer, L. (1984). On the validity of retrospective data: The problem of informant accuracy. *Annual Review of Anthropology, 13,* 495-517.

Borrie, W. (1995). *Measuring the multiple, deep, and unfolding aspects of the wilderness experience using the experience sampling method.* Unpublished doctoral dissertation, Virginia Polytechnic Institute and State University.

Chalip, L., Csikszentmihalyi, M., Kleiber, D., & Larson, R. (1984). Variations of experience in formal and informal sport. *Exercise and Sport, 55* (2), 109-116.

Csikszentmihalyi, M. (1975). *Beyond boredom and anxiety.* San Francisco: Jossey-Bass.

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience.* NY: Harper & Row.

Csikszentmihalyi, M. & Csikszentmihalyi, I. (1988). *Optimal experience: Psychological studies of flow in consciousness.* NY: Cambridge Press.

Csikszentmihalyi, M. & Larson, R. (1987). Validity and reliability of the experience sampling method. *Journal of Nervous and Mental Disease, 175* (9), 526-536.

Driver, B. (1979). Toward a behavioral interpretation of recreational engagements with implications for planning. In Van Doren, Priddle, and Lewis (2nd Ed.), *Land and Leisure: Concepts and methods in outdoor recreation* (pp. 86-104). Chicago, IL: Maaroufa Press, Inc.

Ellis, G., Voelkl, J., & Morris, C. (1994). Measurement and analysis issues with explanation of variance in daily experience using the flow model. *Journal of Leisure Research, 26* (4), 337-356.

Ewert, A. & Hollenhorst, S. (1989). Testing the adventure model: Empirical support for a model of risk recreation participation. *Journal of Leisure Research, 21,* 124-139.

Freeman, P. (1993). *The experience of "flow" during challenge education activities for adults.* Unpublished doctoral dissertation, Indiana University.

Hood, R. (1977). Eliciting mystical states of consciousness with semistructured nature experiences. *Journal for the Scientific Study of Religion, 20,* 261-273.

Jackson, S. & Marsh, H. (1996). Development and validation of a scale to measure optimal experience: The flow state scale. *Journal of Sport and Exercise Psychology, 18,* 17-35.

Jones, C., Hollenhorst, S., & Schuett, M. (1998). Experience quality considerations in managing for risk recreation access. *Trends, 35* (1), 2-8.

Keiss, H. & Bloomquist, D. (1985). *Psychological research methods: A conceptual approach.* Newton, MA: Allyn and Bacon, Inc.

Kimiciek, J. & Stein, G. (1992). Examining flow experiences in sport contexts: conceptual issues and methodological concerns. *Journal of Applied Sports Psychology, 4,* 144-160.

Kirshnit, C., Ham, M., & Richards, M. (1989). The sporting life: Athletic activities during early adolescence. *Journal of Youth and Adolescence, 18* (6), 511-530.

Kubey, R. & Csikszentmihalyi, M. (1990). *Television and the quality of life: How viewing shapes everyday experience.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Larson, R. & Delespaul, P. (1990). Analyzing experience sampling data: A guidebook for the perplexed. In M. deVries (Ed.), *The experience of psychopathology.* Cambridge University Press.

Mannell, R. Zuzanek, J. & Larson, R. (1988). Leisure states and "flow" experiences: Testing perceived freedom and intrinsic motivation hypotheses. *Journal of Leisure Research, 20* (4), 289-304.

Martin, P. & Priest, S. (1986). Understanding the adventure experience. *Journal of Adventure Education, 3* (1), 18-21.

Massimini, F., & Carli, M. (1986). La selezione psicologica humana tra biologia e cultura. In F. Massimini & P. Inghilleri (Eds.), *L'esperienza quotidiana* (pp. 65-84). Milan: Franco Angeli.

Massimini, F. & Carli, C. (1990). The systematic assessment of flow in daily experience. In Csikszentmihalyi and Csikszentmihalyi (Ed.). *Optimal experience: psychological studies of flow in consciousness* (pp. 266-287). New York: Cambridge University Press.

Moneta, G. & Csikszentmihalyi, M. (1996). The effect of perceived challenges and skills on the quality of subjective experience. *Journal of Personality, 64* (2), 276-310.

Priest, S. & Bunting, C. (1993). Changes in perceived risk and competence during whitewater canoeing. *Journal of Applied Recreation Research, 18* (4): 265-280.

Silva, J. & Weinberg, R. (1984). *Psychological foundations of sport.* Champaign, Ill. : Human Kinetics Publishers.

Stein, G., Kimiciek, J., Daniels, J. & Jackson, S. (1995). Psychological antecedents of flow in recreational sport. *Personality and Social Psychology Bulletin, 21* (2), 125-135.

Voelkl, J. (1990). The challenge-skill ratio of daily experiences among older adults residing in nursing homes. *Therapeutic Recreation Journal, 24* (2), 7-17.