Motiv Emot (2008) 32:141–157
DOI 10.1007/s11031-008-9094-0

ORIGINAL PAPER

Brief approaches to assessing task absorption and enhanced subjective experience: Examining 'short' and 'core' flow in diverse performance domains

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Published online: 21 June 2008
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Abstract The overarching aim of the present study is to expand current approaches to assessing task absorption and subjective experience by assessing two brief measures of flow: (1) 'short' flow, reflecting an aggregate or global measure drawn from the 'long' multi-item multi-factor flow instrument and (2) 'core' flow reflecting the phenomenology of the subjective flow experience itself. We propose that short and core flow have complementary but non-overlapping merits, purposes, and applications. Study 1 examines 'short' flow in work ($N = 637$), sport ($N = 239$), and music ($N = 224$). Study 2 examines 'core' flow in general school ($N = 2{,}229$), extracurricular activity ($N = 2{,}229$), mathematics ($N = 378$), and sport ($N = 220$) contexts. With few exceptions, both flow measures demonstrated: (a) acceptable model fit, reliability, and distributions, (b) associations with motivation in hypothesized ways, and (c) invariance in factor loadings across diverse samples. Where common data are available, both short and core flow are positively correlated, but with approximately half the variance unexplained they are clearly not the same construct, and so we offer guidance regarding which measure/s to use under particular circumstances. We conclude that the brief flow measures are appropriate for research examining task absorption, subjective experience, and cognate constructs such as motivation.

Keywords Flow · Measurement · Construct validity · Positive psychology

Flow is characterized by absorption in one's tasks and activities, and as a result of this centeredness of mind, one's subjective experience is enhanced. To date, the bulk of empirical research assessing flow has employed multi-item multi-factor instruments (see below). In many respects such instruments are superior to brief unidimensional ones (e.g., see Marsh et al. 2006a, b). However, in this investigation, we propose that there are occasions when brief measures of flow are appropriate and may complement or augment research using 'long' multi-item multi-factor forms. Accordingly, the present study assesses two brief measures of flow and does so in the diverse performance domains of work, sport, music, and school; and with particular focus on the relationship between flow and motivation.

The two brief measures we assess are 'short' flow and 'core' flow. As discussed more fully below, short flow is akin to the global, higher order flow construct captured by the original multidimensional 'long' form (Jackson and Eklund 2002; Jackson and Marsh 1996). Core flow assesses the phenomenology of the flow experience itself. In this study we propose that short and core flow have complementary but non-overlapping merits, purposes, and applications. For example, for those seeking an aggregate profile of flow characteristics but are constrained by methodological or practical limitations (e.g., time, survey space), the short flow scale might be important to consider.

This article was in part prepared while the first author was Visiting Senior Research Fellow in the Department of Education at Oxford University and while the second author was a recipient of a University of Queensland Re-Entry Fellowship for Women.

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On the other hand, for those seeking to tap into the core phenomenological experience of what it is like to be in this optimal state of mind—and are also subject to methodological and practical constraints—the core flow scale might be a useful tool. The present study, then, seeks to provide psychometric guidance for decision-making by those interested in more appropriately targeted flow research and measurement. To date, no study has brought together these two approaches to flow. Indeed, this is the first time the core scale has been assessed and reported on, and thus we present new instrumentation. Further, the short flow scale is a relatively new instrument, and in this study it is assessed for the first time across the diverse domains of work, sport, and music. This study, then, offers new insights and directions for flow researchers and practitioners.

Previous 'long' multi-item multi-factor flow research

Flow research has been conducted across many domains including sport (e.g., Jackson 1995, 1996; Jackson and Csikszentmihalyi 1999), exercise (e.g., Grove and Lewis 1996), outdoor adventure (e.g., Delle et al. 2003), work (e.g., Csikszentmihalyi and Csikszentmihalyi 1988), artistic performance (e.g., Byrne et al. 2003), and educational settings (Gunderson 2003). Moreover, Csikszentmihalyi has demonstrated that the flow experience is a central component to the outstanding creative works of some of the world's most notable artists and scientists (1996), as well as to daily life experiences (1997).

Jackson and colleagues (Jackson and Eklund 2002, 2004; Jackson and Marsh 1996) developed the 'long' multi-item multi-factor flow scales comprising the Flow State Scale (FSS) and a corresponding dispositional version of the instrument, the Dispositional Flow Scale (DFS). These measures were developed and first validated in physical activity settings and have since been used in other performance-related domains as well (e.g., Martin and Cutler 2002; Wrigley 2005). The DFS is a dispositional assessment of the frequency with which people experience flow in a target activity and the FSS is designed to assess the state, or situation-specific component of flow. In both the DFS and FSS, nine key characteristics are assessed, following the nine-dimensional conceptual model of flow (Csikszentmihalyi 1990; Jackson and Csikszentmihalyi 1999). Each characteristic, or factor, comprises four items (hence the DFS and FSS are both 36-item instruments): challenge-skill balance, action-awareness merging, clear goals, unambiguous feedback, concentration on the task at hand, sense of control, loss of self-consciousness, time transformation, and autotelic experience. Both the DFS and FSS instruments yield an acceptable factor structure and reliability (Jackson and Marsh 1996; Marsh and Jackson 1999) with first order (involving the nine factors) models and higher-order (involving a global flow factor) models providing good fit to data.

Brief assessments of flow: Short and core flow

A good deal of psychometric research emphasizes the need for multidimensional measurement based on multiple items for a given scale (Marsh et al. 2006a, b) to enable more valid and reliable assessment of target constructs and to appropriately model error variance (Williams et al. 2002). Notwithstanding the psychometric benefits of multi-item multi-factor scales, there is also often a need for administering brief forms. For example, in multi-trait multi-method research (e.g., see Marsh et al. 2006b), 'other' ratings may be used (e.g., teacher rating a student) and, because these 'other' ratings require ratings of many individuals, a brief form is desirable. Or, in large-scale projects that include many measures, brief forms may be preferable. Indeed, in research where flow is not a construct of central interest, a brief form provides an opportunity to measure it without imposing restrictions on the more central constructs. Moreover, there are occasions where time constraints obviate the use of long instrumentation and so a brief form may be preferable. Taken together, it is evident that there are occasions when the administration of brief forms is appropriate. In view of this, the present study assesses the validity and reliability of two new brief flow scales. The first of the brief scales we are labeling 'short' flow and is assessed using a 9-item form based on the long multi-item multi-factor measure (Jackson and Eklund 2002, 2004; Jackson and Marsh 1996), broadly in line with the long higher order structure. The second of the two brief scales we are labeling 'core' flow and comprises a 10-item scale aimed at assessing the core experiential characteristics of the flow experience.

Short and core flow

The development of the *short* flow scale was driven by the need to develop a succinct measure of flow to use when there might exist research or practical constraints preventing the use of the long multi-item multi-factor scale. Since there is support for the higher order global flow model based on the long scale (Jackson and Eklund 2002; Jackson and Marsh 1996), it was considered worthwhile to examine whether a short version of the longer form could provide a valid and reliable measure of this global flow construct. Consistent with the broad higher order approach articulated above, Jackson selected a set of nine items from the long flow scales, one item representing each of the nine

flow dimensions. Items were selected that appeared to best measure the intended construct, based on the size of the standardized factor loadings in CFA from each of the nine flow factors in the long flow scales (see Marsh et al. 2005), and on conceptual grounds with items having good face validity. Hence, by selecting a target item from each of the nine flow factors of the long scale, the short flow scale can be considered a brief version of the global higher order flow construct.

The short flow scale has been examined in the physical activity domain (Jackson et al. in press; Martin et al. 2006), and acceptable preliminary psychometric support has been obtained through confirmatory factor analyses and examinations of associations with other psychological constructs. Because the short scale was developed with the purpose of being applicable across different settings, it is important to assess construct validity in diverse domains. The present research is the first such study of the short flow scale across domains.

The idea for the *core* flow scale reflects the potential utility of a brief measure of flow that taps into the phenomenology of the experience itself—consistent with original conceptualizations of subjective optimal experience underpinning flow. Therefore, while the short flow scale assesses the factors that comprise and/or lead to flow, the core flow scale captures the central subjective optimal experience—including, *inter alia*, being 'in the zone', being 'totally involved', feeling like 'everything clicks', and being 'totally focused'. In selecting items such as these for the core flow scale, the authors revisited the earlier qualitative research conducted on the experience of flow in elite athletes (Jackson 1992, 1995, 1996). Semi-structured interviews provided in-depth descriptions of what it was like to be in flow. The verbal expressions actually used by participants to describe their experience of flow were the basis of the resultant ten items in the core flow scale.

Together, the terms 'short' and 'core' are intended to capture two key dimensions of flow: a brief perspective traversing flow (short flow) and a targeted perspective capturing the experiential essence of flow (core flow). Hence, the short scale is akin to the global, higher order flow construct by way of a composite set of items drawn from each of the nine factors of the long form (Jackson and Eklund 2002; Jackson and Marsh 1996). It is, then, a brief measure capturing the scope of the long multidimensional form that a higher order factor would capture if the long form were administered. Although other terms (e.g., 'composite') might also capture the nature of the construct, we have opted for the term 'short' to maintain consistency with its long counterpart. The core scale is aimed at capturing the phenomenology of the flow experience and so is a targeted measure aimed at assessing the more 'real-time' experience of flow. Recent work (e.g., Shin 2006) has recognized different perspectives of flow along these lines and has suggested the need to more carefully consider the actual experience of flow alongside the more typical approaches to flow such as those conducted by Jackson and colleagues (e.g., Jackson and Eklund 2002; Jackson and Marsh 1996). The present study's assessment of short and core flow is one application of this more differentiated approach.

A construct validation approach to assessing brief flow

Psychometricians have increasingly emphasized the importance of developing and evaluating frameworks and instruments within a construct validation framework and across diverse performance domains (e.g., see Cronbach 1989; Marsh 2002). Construct validation approaches tend to be informed by internal and external aspects of validity. Internal validity concerns the internal structure of a construct and is typically assessed using empirical techniques such as confirmatory factor analysis (CFA) and reliability analysis. External validity seeks to establish a logical, theoretically consistent pattern of relations between constructs. This is achieved by employing statistical procedures such as correlation, regression, or structural equation modeling (SEM) analyses to examine relationships between measures and instruments (Cronbach 1989; Marsh 2002).

The present study uses internal and external approaches to validity and does so in the diverse performance domains of work, music, sport, and school. In terms of internal validity, the study uses confirmatory factor analysis to test the psychometric properties of short and core flow constructs. In terms of external validity, the study examines the empirical links between the brief flow constructs and a set of external constructs (e.g., motivation and engagement), and examines the invariance of factor structure across key samples and scales. Where common data are available, the present study also assesses the relationship between short and core flow with a view to better understanding their respective psychometric properties in the one sample and the variance shared between the two factors.

External validity correlates for flow: Motivation and engagement

From a construct validation perspective, then, it is not only important to address validity within an instrument (internal validity) but it is also necessary to explore the possible differential relationships between the target constructs and a set of theoretically relevant measures (external validity). In the present study, two broad sets of constructs—motivation and engagement—are proposed as external

constructs to provide a theoretically relevant basis for examining the validity of flow. Motivation has been linked to flow in the physical activity domain (Jackson et al. 1998; Martin et al. 2006) and is considered a feasible external correlate for consideration in this more thoroughgoing investigation of flow. Motivation in the present study encompasses four factors drawn from Martin's (2001, 2003, 2006b, 2007) Motivation and Engagement Scale (MES) that comprises four higher order factors: *adaptive cognitions* (comprising three-first order factors: self-efficacy, valuing, mastery orientation), *adaptive behaviors* (planning, task management, persistence), *impeding/maladaptive cognitions* (uncertain control, failure avoidance, anxiety), and *maladaptive behaviors* (self-handicapping, disengagement).

From the outset, flow has encompassed absorption in the present moment (Csikszentmihalyi 1990) and so engagement is a central concept in the flow framework. Engagement in the present study is broadly captured through enjoyment, aspirations, buoyancy, and participation. *Enjoyment* is a feasible external validity construct. Research in various settings finds that enjoyment is a key factor in individuals' engagement with tasks (e.g., see Luthans and Martinko 1987; Martin 2006c; Richardson and Watt 2006). In terms of *aspirations*, several researchers have shown that individuals higher in engagement are more likely to take advanced or optional courses and activities and also more likely to report positive future intentions (Meece et al. 1990). *Participation* is also deemed a feasible external validity construct. Environments that foster participation are found to enhance commitment (Richter and Tjosvold 1980); while a lack of participation is found to lead to unsuccessful outcomes such as emotional withdrawal and poor identification with the target setting (Fry and Martin 1994; Karasek and Theorell 1990). *Buoyancy* is the fourth engagement factor. Martin and Marsh (2006, 2008a, b) have defined domain-specific buoyancy as an ability to deal with setback, challenge, and adversity in a specific setting. In addition to a bulk of previous research that has assessed life/general resilience/buoyancy (e.g., Luthar and Cicchetti 2000; Masten 2001), Martin and Marsh proposed domain-specific buoyancy as a critical factor in individuals' ability to negotiate the challenges presented to them in a specific setting.

Aims of the present investigation

No study has brought together short and core approaches to flow. Indeed, this is the first time the core scale has been examined, and the first time the short scale has been examined psychometrically across diverse performance domains. We argue that because short and core flow have complementary but non-overlapping merits, purposes, and applications, the present study has the potential to offer new directions and insights for flow researchers and practitioners. Study 1 examines short flow in work, sport, and music. Study 2 examines core flow in school, extracurricular activity, and sport. Study 2 also assesses short and core flow in the one analytic model to more closely examine their psychometric properties and to directly investigate the correlation between the two brief measures. From an internal validity perspective, in each study we hypothesize that short and core flow factors will be reliable, approximately normally distributed, and evince acceptable model fit. From an external validity perspective, we hypothesize that short and core flow factors will relate to a set of key correlates and demonstrate invariance of factor structure across samples and scales. Taken together, we aim to show that short and core flow measures are psychometrically sound, offer complementary but unique perspectives on individuals' subjective experience and task absorption, and are appropriate for inclusion in studies seeking to better understand individuals' immersion and motivation in the tasks they perform in diverse settings. Findings, we hope, provide psychometric guidance for decision-making by those interested in more appropriately targeted flow measurement.

General method

Sample descriptions, procedures, and materials are described in detail under the two studies. Here the methods used to analyze the data are under focus.

Confirmatory factor analysis

Confirmatory factor analysis (CFA), performed with LISREL 8.80 (Jöreskog and Sörbom 2006), was used to test the hypothesized models. In CFA, the researcher posits an *a priori* structure and tests the ability of a solution based on this structure to fit the data by demonstrating that: (a) the solution is well defined, (b) parameter estimates are consistent with theory and *a priori* predictions, and (c) the χ^2 and subjective indices of fit are reasonable (Marsh et al. 1988; McDonald and Marsh 1990). Maximum likelihood was the method of estimation used for the models. In evaluating goodness of fit of alternative models, the comparative fit index (CFI), the non-normed fit index (NNFI), and root mean square error of approximation (RMSEA) are emphasized. Although the CFI, NNFI, and RMSEA are apparently the most widely endorsed criteria of fit, we also present the χ^2-test statistic, SRMR, and an evaluation of parameter estimates. Hu and Bentler (1998, 1999) recommended the use of SRMR as an absolute fit index, with

values close to .08 being regarded as reasonable. For RMSEAs, values at or less than .05 and .08 are taken to reflect a close and reasonable fit, respectively (see Jöreskog and Sörbom 1993; Marsh et al. 1996; Schumacker and Lomax 1996). However, where the CFI and NNFI are acceptable and the sample relatively small, the reader is urged to be mindful that larger RMSEA values can over-reject models that are true in the population (Hu and Bentler 1998). Further, RMSEA is overly sensitive when the number of indicators is small (Kenny and McCoach 2003), and thus caution is needed when interpreting these values for the short and core flow scales presented in this study. The CFI varies along a 0–1 continuum in which values at or greater than .90 and .95 are typically taken to reflect acceptable and excellent fits to the data, respectively (McDonald and Marsh 1990). The CFI contains no penalty for a lack of parsimony so that improved fit due to the introduction of additional parameters may reflect capitalization on chance, whereas the RMSEA contains penalties for a lack of parsimony.

Missing data

For most quantitative research, the inevitable missing data is a potentially important problem, particularly when the amount of missing data exceeds 5% (e.g., Graham and Hoffer 2000). A growing body of research has emphasized potential problems with traditional pairwise, listwise, and mean substitution approaches to missing data (e.g., Brown 1994; Graham and Hoffer 2000; Little and Rubin 1987), leading to the implementation of the Expectation Maximization Algorithm (EM Algorithm). This is currently the most widely recommended approach to imputation for missing data, as operationalized using missing value analysis in LISREL. In both studies, less than 5% of the data were missing and so the EM Algorithm was considered an appropriate procedure. Also explored were alternative approaches to this problem which showed that results based on the EM Algorithm used here were very similar to those based on the traditional pairwise deletion methods for missing data—as would be expected to be the case when there was so little missing data.

Multi-group CFA and tests of invariance

In assessing flow scales, inadequate attention is given to differences in factor structure and the question, for example, of whether a given instrument measures the same components of flow with equal validity for different groups. At a pragmatic level, the implications of this issue are substantial. For example, unless there is reasonable support for the invariance of flow across important subsamples, it may not be justifiable to compare flow responses across these samples. At a substantive level, the implications are also significant. Differences in factor loadings across samples, for example, would suggest that the samples are perceiving factors in different ways—and by implication, that different factors may exist for different samples. Such a finding would hold direct implications for theory building that for a large part relies on agreed upon factors. At an intervention level, invariance tests are also important. If it can be established that different samples are providing broad agreement as to the factors that would be addressed in intervention work, then efficient and targeted intervention is more effectively administered. Taken together, for pragmatic, substantive, and intervention reasons, invariance tests provide important information about the nature, parameters, and applied utility of flow.

Such concerns about factor structure invariance are most appropriately evaluated using CFA to determine whether—and how—the structure of flow varies according to key samples (see Byrne and Shavelson 1987; Hattie 1992; Marsh 1993). Moreover, because different dimensions of flow employ parallel instruments, invariance tests are also appropriate to determine whether—and how—the structure of different forms varies. Hence, in Studies 1 and 2 it was of interest to determine factor invariance across key samples and key instrumentation forms.

Testing for factor invariance essentially involves comparing a number of models in which aspects of the factor structure are systematically held invariant across groups/forms and assessing fit indices when elements of these structures are constrained. Relatively invariant fit indices are indicative of invariant factor structure. The present analyses examined the fit indices for a number of models that held successive elements of the factor structure invariant across samples and forms. We propose two levels at which to assess parameter invariance. The first—and most critical—is invariance in factor loadings, identified as the minimum criterion for establishing invariance (Marsh 1993). The second level is invariance in correlations, variances, and uniquenesses—with invariance in uniquenesses desirable but not indicative of poor instrumentation in the context of invariance in loadings, correlations, and variances.

Study 1: Assessing short flow

Study 1 assesses short flow in work, sport, and music.[1]

[1] The music and sport samples have also been the focus of three motivation and engagement studies of domain-specificity and the use of correlated uniquenesses in domain-specificity research (Martin 2008b, in press a, in press b).

Sample and procedure

Work sample

The work sample comprised 637 personnel from 18 Australian elementary and high schools. Two-thirds (68%) of the respondents were female and 32% were male. The mean age of respondents was 43.77 ($SD = 10.70$) years, and as a group, they had been working in schools for an average of 16.71 ($SD = 10.96$) years. Most participants (81%) were teachers, 13% were executive staff, and 6% were counseling or administrative staff. Just under half (47%) reported their highest educational qualification was an undergraduate degree, 44% reported a postgraduate qualification, 8% reported a certificate or diploma as their highest qualification, and a further 1% reported school as their highest educational attainment.

Sport sample

The sport sample comprised 239 young sportspeople from a sports high school in a major capital city in Australia. All participants were either representative sportspeople (e.g., for district, state, and/or country) or part of a formal sports program for young sportspeople. The participants were in junior high school (Years 7 and 8: 40%—approx. 12–14 years), middle high (Years 9 and 10: 43%—approx. 14–16 years), and senior high (Years 11 and 12: 17%—approx. 16–18 years). Just under half (43%) the respondents were female and 57% were male. The mean age of respondents was 14.20 ($SD = 1.61$) years. The major target sports played were football (21% of respondents), soccer (19%), netball (11%), swimming (8%), basketball (7%), surfing (7%), dancing (6%), athletics (5%), with a variety of other sports each being a target sport for less than 5% of the sample. On average, the participants had been playing their target sport for 6.66 ($SD = 3.21$) years.

Music sample

The music sample comprised 224 young classical musicians from a music high school ($N = 138$) and a university ($N = 86$) in a major capital city in Australia. The school musicians were in junior high school (Years 7 and 8: 33%—approx. 12–14 years), middle high (Years 9 and 10: 33%—approx. 14–16 years), and senior high (Years 11 and 12: 34%—approx. 16–18 years). Just under two-thirds (60%) of the respondents were female and 40% were male. The mean age of school musicians was 14.43 ($SD = 1.82$) years. On average, school musicians had been playing their target instrument for 6.83 ($SD = 2.95$) years. The university musicians were enrolled in music-related degrees and in first year (69%), second year (20%), and third and fourth years (8 and 3%, respectively). Just over half (59%) the university musicians were female and 41% were male. The mean age of university musicians was 19.60 ($SD = 2.63$) years. On average, university musicians had been playing their target instrument for 10.09 ($SD = 3.63$) years. The major target instruments played in the music sample were violin (20% of respondents), piano (19%), clarinet (9%), flute (8%), cello (6%), voice (6%), trumpet (5%), with a variety of other classical instruments each being a target instrument for less than 5% of the sample.

Materials

Short 9-item flow

The short flow scale (presented in the Appendix) contains nine items each reflecting one of the nine flow factors (Csikszentmihalyi 1990; Jackson and Csikszentmihalyi 1999) in the multi-item multi-factor long scale (Jackson and Eklund 2002) as follows: Challenge-skill balance (feeling competent enough to meet the high demands of the situation), Action-awareness merging (doing things spontaneously and automatically without having to think), Clear goals (having a strong sense of what one wants to do), Unambiguous feedback (knowing how well one is performing during the performance itself), Concentration on the task at hand (being completely focused on the task at hand), Sense of control (having a feeling of total control over what one is doing), Loss of self-consciousness (not worrying what others think of oneself), Transformation of time (having the sense that time passes in a way that is different from normal), and autotelic experience (feeling the experience to be extremely rewarding). Short flow in work, music, and sport items (e.g., "In my work/music/sport I am completely focused on the task at hand") were rated on a 1 (Strongly disagree) to 7 (Strongly agree) scale. By selecting a target item from each of the nine flow factors in the long form, the short flow scale can be considered a brief version of the global higher order flow construct.[2]

Martin et al. (2006) utilized the short flow scale in a sample of high school students where relationships with measures of motivation in physical activity as well as self-reported physical activity levels were assessed. The short scale yielded acceptable reliability, with a Cronbach's alpha of .82. Predicted relationships with physical activity motivation were found, with strong positive relationships demonstrated between the flow scale and adaptive cognitions and behaviors of physical activity. Their study

[2] Although the present study focuses on the generality of the short flow factor structure and comparative psychometrics across performance domains, for completeness it is appropriate to note that the sport sample reported significantly higher mean levels of short flow than both the music and work samples, $F(2, 1075) = 11.30$, $p < 0.001$.

provided good preliminary support for the short flow scale, but was restricted to one relatively smaller sample of high school students and was simply one of a number of dependent measures used to validate a physical activity motivation scale. Hence, further research was needed to examine the psychometric properties of the short flow scale. Jackson et al. (in press) examined the psychometrics of the short scale in a large physical activity sample, and in the context of relationships between the long and short scales. The present study extends this preliminary research by providing a comprehensive and singular examination of the short scale across more diverse performance settings.

External validity correlates

Respondents were also administered items that explored their *motivation, enjoyment* (of work, music, and sport), *participation, aspirations*, and *buoyancy*. Motivation was assessed using the four higher order factors of the Motivation and Engagement Scale, which has previously demonstrated strong factor structure, approximately normal factors that are also reliable, and is significantly related to target outcomes (Martin 2001, 2003, 2006b, 2007). Items are rated on a scale of 1 (Strongly disagree) to 7 (Strongly agree): *adaptive cognitions* (12 items each domain e.g., "If I try hard, I believe I can do my work well", Cronbach's $\alpha = .86$; "If I try hard, I believe I can perform music well", Cronbach's $\alpha = .78$; "If I try hard, I believe I can do well in my sport", Cronbach's $\alpha = .82$), *adaptive behaviors* (12 items each domain e.g., "If I can't understand something in my work at first, I keep going over it until I do", Cronbach's $\alpha = .88$; "If I can't understand something in my music at first, I keep going over it until I do", Cronbach's $\alpha = .78$; "If I can't do something in my sport at first, I keep going over it until I can do it", Cronbach's $\alpha = .78$), *impeding/maladaptive cognitions* (12 items each domain e.g., "When important or challenging work is coming up, I worry a lot", Cronbach's $\alpha = .85$; "When important or challenging music performances are coming up, I worry a lot", Cronbach's $\alpha = .71$; "When important or challenging sporting events are coming up, I worry a lot", Cronbach's $\alpha = .75$), and *maladaptive behaviors* (8 items each domain e.g., "I've pretty much given up being involved in things at work", Cronbach's $\alpha = .82$; "I've pretty much given up being involved in my music", Cronbach's $\alpha = .63$; "I've pretty much given up being involved in things in my sport", Cronbach's $\alpha = .68$).

Enjoyment, participation, aspirations, and buoyancy have been shown in previous research to be psychometrically sound and valid external validity correlates of flow (Martin 2006a, 2007, 2008a; Martin and Marsh 2006, 2008a, b). *Enjoyment* of work, music, and sport (e.g., "I enjoy my work", Cronbach's $\alpha = .93$; "I enjoy my music", Cronbach's $\alpha = .87$; "I enjoy my sport", Cronbach's $\alpha = .79$) each comprised 4 items which were rated on a scale of 1 (Strongly disagree) to 7 (Strongly agree). Work, music, and sport *participation* (e.g., "I get really involved when we do projects/tasks at work", Cronbach's $\alpha = .86$; "I get really involved when we do things in music", Cronbach's $\alpha = .91$; "I get really involved in the things we do in my sport", Cronbach's $\alpha = .80$) also each comprised 4 items which were rated on the same 1–7 scale. Work, music, and sport *aspirations* (e.g., "I look forward to continuing with this line of work", Cronbach's $\alpha = .87$; "I look forward to continuing with my music", Cronbach's $\alpha = .87$; "I look forward to continuing with my sport", Cronbach's $\alpha = .80$) each comprised 4 items which were rated on the 1–7 scale. Work, music, and sport *buoyancy* (e.g., "I'm good at dealing with setbacks at work (e.g., poor performance)", Cronbach's $\alpha = .80$; "I'm good at dealing with setbacks at music (e.g., poor performance)", Cronbach's $\alpha = .82$; "I'm good at dealing with setbacks at sport (e.g., poor performance)", Cronbach's $\alpha = .70$) each comprised 4 items rated on the 1–7 scale.

Results

Internal validity: Descriptive statistics and model fit

In the first set of internal validity analyses descriptive statistics and hypothesized model fit were examined. Table 1 presents results. Each of the short scales is reliable and approximately normally distributed. CFAs of the three instruments show that there is acceptable fit of the hypothesized models to the data for work flow ($\chi^2 = 136.78$; df = 27; CFI = .94; NNFI = .92; SRMR = .05; RMSEA = .08), sport flow ($\chi^2 = 112.38$; df = 27; CFI = .93; NNFI = .91; SRMR = .06; RMSEA = .12), and flow in music ($\chi^2 = 45.11$; df = 27; CFI = .99; NNFI = .98; SRMR = .04; RMSEA = .06). Clearly, however, the music scale fit the data best. Perhaps the nine specific dimensions of flow map more readily onto pursuits such as music amongst a relatively narrow and select sample of classical musicians and so pooling factors to form a short factor does not markedly reduce fit. On the other hand, for samples comprising a relatively diverse group of stakeholders such as those found in the workplace and in sport, not all flow factors may be relevant or salient and so a short measure drawing these factors together does reduce relative fit.

External validity: Relationships with key correlates

Having assessed the internal validity of the work, sport, and music scales, a series of external validity analyses was conducted comprising analyses of hypothesized key correlates. External correlates for all three short scales were participation, enjoyment, buoyancy, aspirations, adaptive

Table 1 Short (9-item) and core (10-item) flow: descriptive statistics and model fit

	Mean	SD	Skewness	Kurtosis	Reliability	CFA load range (mean)
Short flow						
Work 9-item						
Independent short	5.28	.71	−.17	−.01	.73	.23–.73 (.51)
CFA model fit: $\chi^2 = 136.78$; df = 27; CFI = .94; NNFI = .92; RMSEA = .08; SRMR = .05						
Sport 9-item						
Independent short	5.48	.98	−.46	−.45	.83	.47–.71 (.62)
CFA model fit: $\chi^2 = 112.38$; df = 27; CFI = .93; NNFI = .91; RMSEA = .12; SRMR = .06						
Music 9-item						
Independent short	5.12	.92	−.20	−.50	.84	.41–.71 (.61)
CFA model fit: $\chi^2 = 45.11$; df = 27; CFI = .99; NNFI = .98; RMSEA = .06; SRMR = .04						
Core flow						
General school 10-item						
Embedded core	4.32/7	1.18	−.26	−.10	.93	.61–.85 (.85)
CFA model fit: $\chi^2 = 585.80$; df = 35; CFI = .98; NNFI = .98; RMSEA = .08; SRMR = .04						
Mathematics 10-item						
Independent core	3.36/5	.75	.12	.01	.94	.56–.89 (.87)
CFA model fit: $\chi^2 = 172.73$; df = 35; CFI = .98; NNFI = .97; RMSEA = .10; SRMR = .04						
Extracurricular 10-item						
Independent core	4.41/5	.59	−1.19	1.61	.91	.53–.80 (.79)
CFA model fit: $\chi^2 = 590.18$; df = 35; CFI = .98; NNFI = .97; RMSEA = .08; SRMR = .03						
Sport (netball) 10-item						
Independent core	3.37/5	.75	−.26	−.22	.92	.59–.85 (.83)
CFA model fit: $\chi^2 = 124.79$; df = 35; CFI = .97; NNFI = .96; RMSEA = .11; SRMR = .05						

cognitions, adaptive behaviors, impeding/maladaptive cognitions, and maladaptive behaviors. Table 2 shows that all short flow measures were related to the external correlates in highly parallel and hypothesized directions. Hence, the short measures do operate in similar ways from an external validity perspective.

External validity: Invariance across scales

Multi-group CFA was conducted to assess invariance across the three work, sport, and music short scales. As described in General Method, invariance tests provide important pragmatic, substantive, and intervention information about the flow scales. Here, five models were assessed. The first allowed all factor loadings, uniquenesses, and correlations/variances to be freely estimated; the second held the factor loadings invariant; the third held factor loadings and uniquenesses invariant; the fourth held the factor loadings and correlations/variances invariant; and, the fifth held the factor loadings, the uniquenesses, and the correlations/variances invariant. As indicated earlier, two levels of invariance are of particular interest. The first examines factor loading invariance—and is the emphasis of invariance tests here (consistent with Marsh 1993). The second examines invariance across variances and uniquenesses.

Results in Table 3 indicate that at the first level of analyses when factor loadings are held invariant across the three scales it is evident that fit indices do not change markedly. Indeed, the application of recommended criteria for evidence of lack of invariance (i.e., a change of greater than 0.01 in fit indices—see Cheung and Rensvold 2002) indicates that there is relative invariance across factor loadings. In terms of the second level of invariance (i.e., relating to variances and uniquenesses), although there is invariance in terms of factor variances, there is a decline in fit at the uniqueness level—indicating that across the domains, the samples differ in terms of uniquenesses. Differences in uniquenesses can suggest there may be another method-based (e.g., as a function of item wording or structure) or substantive factor explaining variance in flow for one sample more than another. However, balancing this against the invariant factor loadings (that we emphasize as the necessary first level of invariance) suggests validity for the fundamental elements of the short flow factor structure across domains.

Table 2 Short (9-item) and core (10-item) flow: external validity (motivation and engagement) correlations

	Participation	Enjoyment	Buoyancy	Aspirations	Adaptive cognitions	Adaptive behaviors	Impede/maladapt behaviors	Maladaptive behaviors	Mean absolute *r*
Short flow									
Work 9-item									
Independent short	.74	.82	.81	.71	.72	.59	−.59	−.70	.71
CFA model fit: $\chi^2 = 6088.56$; df = 2231; CFI = .96; NNFI = .96; RMSEA = .05; SRMR = .08									
Sport 9-item									
Independent short	.90	.89	.74	.81	.73	.69	−.37	−.47	.70
CFA model fit: $\chi^2 = 4479.03$; df = 2231; CFI = .93; NNFI = .93; RMSEA = .07; SRMR = .08									
Music 9-item									
Independent short	.80	.73	.68	.73	.82	.70	−.49	−.60	.69
CFA model fit: $\chi^2 = 4054.76$; df = 2231; CFI = .95; NNFI = .95; RMSEA = .06; SRMR = .08									
Core flow									
General school 10-item									
Embedded core	.56	.71	.42	.68	.74	.83	−.11	−.79	.61
CFA model fit: $\chi^2 = 12921.95$; df = 2947; CFI = .98; NNFI = .98; RMSEA = .04; SRMR = .06									
Note that general academic correlates are multi-item constructs; also note that general academic core flow items rated on 7-point scale									
Mathematics 10-item									
Independent core	.49	.58	.15	.42	.67	.68	−.23	−.72	.49
CFA model fit: $\chi^2 = 1023.10$; df = 244; CFI = .96; NNFI = .95; RMSEA = .09; SRMR = .08									
Note that mathematics correlates are single-item constructs; also note that mathematics core flow items rated on 5-point scale									
Extracurricular 10-item									
Independent core	.25	.13	.20	.12	.23	.18	−.10	−.15	.17
CFA model fit: $\chi^2 = 12921.95$; df = 2947; CFI = .98; NNFI = .98; RMSEA = .04; SRMR = .06									
Note that extracurricular correlates are general academic multi-item constructs; also note that extracurricular core flow items rated on 5-point scale									

Study 2: Assessing core flow

Study 2 assesses core flow in general school, mathematics, extracurricular activity, and sport.[3] It also investigates the link between core flow and short flow.

Sample and procedure

General school sample

The general school sample comprised 2,229 students from four high schools in a major capital city in Australia. The students were in junior high school (Years 7 and 8: 39%—approx. 12–14 years), middle high (Years 9 and 10: 42%—approx. 14–16 years), and senior high (Years 11 and 12: 19%—approx. 16–18 years). Just over half (51%) the respondents were female and 49% were male. The mean age of respondents was 14.13 ($SD = 1.41$) years.

Extracurricular activity sample

The extracurricular activity sample comprised the same 2,229 students in the general school sample. A set of core flow items presented at the end of the general school survey asked students to identify their main extracurricular activity and then rate their core flow on that activity.

[3] The sport sample is the focus of construct validity research with the *short* flow scale in Jackson, Martin, and Eklund (in press).

Table 3 Short (9-item) and core (10-item) flow: invariance tests

	Chi-square	df	CFI	NNFI	RMSEA	SRMR
Model—invariance across work, music, and sport—9-item short flow						
All parameters are free (no invariance)	299.51	81	.95	.94	.08	.04
First order loadings are invariant (Model 1)	338.12	97	.94	.94	.08	.06
Model 1 and uniquenesses are invariant	613.91	115	.90	.90	.11	.08
Model 1 and variances are invariant	377.77	99	.93	.93	.09	.13
Model 1, variances, and uniquenesses are invariant	662.42	117	.89	.89	.11	.14
Model—invariance across mathematics, extracurricular activity, and sport—10-item core flow						
All parameters are free (no invariance)	881.21	105	.98	.98	.09	.05
First order loadings are invariant (Model 1)	918.29	123	.98	.98	.08	.06
Model 1 and uniquenesses are invariant	1211.22	143	.97	.97	.09	.09
Model 1 and variances are invariant	999.86	125	.98	.98	.09	.23
Model 1, variances, and uniquenesses are invariant	1304.26	145	.97	.97	.09	.29

Note: General school excluded from core flow invariance tests because items were rated on a 7-point scale whereas other scales were rated on a 5-point scale

Mathematics sample

The mathematics sample comprised 378 students from a high school in a major capital city in Australia. The students were in junior high school (Year 8: 33%—approx. 13–14 years) and middle high (Years 9 and 10: 67%—approx. 14–16 years). All the respondents were female. The mean age of respondents was 13.75 ($SD = .93$) years.

Sport sample

Core flow in sport was assessed amongst an Australian sample of 220 netball and volleyball players participating in a recreational league. The sample was 30% male and 70% female. The mean age of participants was 29 years (SD = 7.3), with 3% in late adolescence (less than 20 years of age), 56% in early adulthood (20–30 years), 38% in mid adulthood (30–40 years 32%; 40–50 years 6%), and 3% in later adulthood (50 years and over). Participants had been taking part in their sport for an average of 8.4 years ($SD = 9.8$). Importantly, for this sample, participants responded to items measuring both core and short flow. This enabled direct assessment of the link between core and short flow in the one domain.

Materials

Core 10-item flow

Core flow taps into the phenomenology of the flow experience itself—consistent with original conceptualizations of subjective optimal experience underpinning flow. As described earlier, the core flow items were developed from qualitative research (Jackson 1992, 1995, 1996) with individuals that included descriptions of what it feels like to be in flow during their target activity. These expressions were adapted into short statements using single quotation marks around the expression to emphasize that respondents were being asked to reflect on expressions rather than necessarily literal translations of the words used. A set of 10 items (presented in the Appendix) comprised core flow in general academic, mathematics, extracurricular activity, and sport.[4] Example items include: In this activity: "I am 'totally involved'"; "It feels like 'everything clicks'"; "I am 'tuned in' to what I am doing". Items were rated on a 1 (Never/Strongly Disagree) to 5 (Always/Strongly Agree) scale for mathematics, extracurricular activity, and sport (netball/volleyball). General school flow items were embedded within a larger instrument that used a 1 (Strongly Disagree) to 7 (Strongly Agree) rating scale.

The sport sample completed a state version of the core flow scale, while the other samples completed the dispositional version. For the state version, responses to the core flow scale were obtained in relation to a particular sports event just participated in; whereas for the other samples, which completed the dispositional version, participants were asked to think about how they felt in general when taking part in their activity. Thus, this study provided an examination of both dispositional and state versions of the core flow scale. The sport sample also completed short flow items (see Study 1 for a description of short flow items),

[4] Although the present study focuses on the generality of the core flow factor structure and comparative psychometrics across performance domains, for completeness it is appropriate to note there are significantly higher mean levels of core flow for general school than for math and netball, $F(2, 2824) = 664.71$, $p < 0.001$.

enabling direct assessment of the psychometric properties of short and core flow in the one domain and the relationship between these two brief measures.

External correlates

General school, extracurricular activity, and mathematics respondents were also administered items that explored their motivation, enjoyment, participation, aspirations, and buoyancy. Motivation was measured using the four higher order factors of the Motivation and Engagement Scale (Martin 2001, 2003, 2006b, 2007) rated on a scale of 1 (Strongly disagree) to 7 (Strongly agree). The same four factors as were used as external correlates in Study 2 were used here, and the Cronbach's alphas for the scales in this sample ranged from .83 to .90. The other external validity factors were: *enjoyment* of general school and mathematics (e.g., "I enjoy school", Cronbach's $\alpha = .91$, 4 items; "I enjoy maths", single-item), *participation* (e.g., "I get really involved when we do things in class", Cronbach's $\alpha = .88$, 4 items; "In maths I participate in activities and discussions", single-item), *aspirations* (e.g., "I look forward to continuing with school", Cronbach's $\alpha = .84$, 4 items; "I want to continue with maths in the future", single-item), and *buoyancy* (e.g., "I'm good at dealing with setbacks at school (e.g., poor performance)", Cronbach's $\alpha = .81$, 4 items; "I effectively deal with setbacks and pressure in maths", single-item). All these external validity measures have been validated in previous research (Martin 2006a, 2007; Martin and Marsh 2006, 2008a, b).

Results

Internal validity: Descriptive statistics and model fit

For the four core flow scales—general school, mathematics, extracurricular activity (self-nominated), and sport (netball/volleyball)—descriptive statistics and hypothesized model fit were examined. Table 1 presents results. Data show that each of the core scales is reliable—indeed, more reliable than the short flow scales of Study 1. Taken together, the core scales are approximately normally distributed with the minor exception of extracurricular activity which, being self-nominated, evinced concentrated numbers of higher core flow ratings. CFAs of the four instruments show that there is generally good fit of the hypothesized models to the data for core general school flow ($\chi^2 = 585.80$; df = 35; CFI = .98; NNFI = .98; SRMR = .04; RMSEA = .08), core mathematics flow ($\chi^2 = 172.73$; df = 35; CFI = .98; NNFI = .97; SRMR = .04; RMSEA = .10), core flow in extracurricular activity ($\chi^2 = 590.18$; df = 35; CFI = .98; NNFI = .97; SRMR = .03; RMSEA = .08), and core flow in sport ($\chi^2 = 124.79$; df = 35; CFI = .97; NNFI = .96; SRMR = .05; RMSEA = .11). We note the larger RMSEA in some models, but in the context of acceptable CFIs and NNFIs and the relatively lower sample sizes for mathematics and sport we cannot be certain that these figures are over-rejecting models that are substantially true in the population (see Hu and Bentler 1998). Moreover, as discussed earlier, RMSEAs for unidimensional scales are often lower than for multidimensional scales.

External validity: Relationships with key correlates

A series of external validity analyses was conducted comprising analyses of the following key correlates: participation, enjoyment, buoyancy, aspirations, adaptive cognitions, adaptive behaviors, impeding/maladaptive cognitions, and maladaptive behaviors. External correlates were available for general school, mathematics, and extracurricular activity scales. It is important to note at the outset: (a) the general school and extracurricular activity key correlates were multi-item factors, (b) general school items and key correlates were rated on a 7-point scale, (c) mathematics key correlates were single-item factors, (d) mathematics and extracurricular activity core flow items were rated on a 5-point scale, and (e) key correlates for extracurricular activity were academically oriented and so are 'off target' correlates.

Table 2 shows that core flow measures are related to external correlates in parallel and hypothesized ways. Correlations between general school core flow and multi-item key correlates (all rated on a 7-point scale) are higher than correlations between mathematics core flow and single-item key correlates (all rated on a 5-point scale)—notwithstanding this, both sets reflect generally high correlations. The consistently lower 'off target' correlations between extracurricular activity and general school key correlates indicate discriminant validity between different core flow constructs. Indeed, follow-up analyses to determine the relationship between general school core flow and extracurricular activity core flow yielded a correlation of .22, indicating good discrimination between the two core flow measures. Although the key correlate measures were not available for the sport sample, the short flow measure for sport was available and subsidiary analyses found a .72 correlation between core and short flow—indicating overlap, but 50% of the variance left unshared.

External validity: Invariance across scales

Multi-group CFA was conducted to assess invariance across the mathematics, extracurricular activity, and sport (netball) core flow scales (general school was excluded because component items were rated on a 7-point scale). As described in the General Method, invariance tests

provide important pragmatic, substantive, and intervention information about the flow scales. The same five models assessed in Study 1 were used here for invariance testing. Also consistent with Study 1, invariance is assessed on two levels—the first and most important is in terms of factor loadings (see Marsh 1993) and the second is in terms of variances and uniquenesses. Results in Table 3 indicate that when factor loadings are held invariant across the three core scales it is evident that fit indices do not change markedly. Indeed, the application of recommended criteria for evidence of lack of invariance (i.e., a change of greater than 0.01 in fit indices—see Cheung and Rensvold 2002) indicates that there is relative invariance across factor loadings. As with findings in Study 2, there is decline in fit at the uniquenesses level and also variances, indicating that across the domains, the samples differ in terms of uniquenesses and variances. Differences such as these can suggest there may be another method-based (e.g., as a function of item wording or structure) or substantive factor explaining variance in flow for one sample more than another. Again, however, balancing this against our emphasis on invariance in factor loadings suggests validity for the fundamental elements of core flow.

Relationship between short and core flow

For the sport sample, data were available for both core and short flow scales, enabling empirical assessment of the relationship between the two flow measures. To assess this relationship a two-factor CFA was conducted. This yielded an acceptable model fit ($\chi^2 = 544.92$; df = 151; CFI = .94; NNFI = .94; SRMR = .08; RMSEA = .11). The mean factor loading for short flow was .60 (median = .64; Cronbach's $\alpha = .82$) and the mean factor loading for core flow was .83 (median = .76; Cronbach's $\alpha = .92$). In terms of the correlation between the two factors, the CFA yielded an r of .72 ($p < 0.001$) indicating that there is a strong association between the two—but with approximately half the variance (48%) unexplained it is clear that they are not reflecting the same latent construct. Thus, when considered in the one sample under the same domain, both short and core flow evince sound psychometric properties. Importantly, however, although the two are positively correlated there is sufficient variance between them that is unexplained, leading to the conclusion that the two offer complementary but unique perspectives on individuals' subjective flow experience.

Discussion

The overarching aim of the present study has been to expand current approaches to assessing task absorption and subjective experience. Through further assessing *short* flow and introducing *core* flow, the present investigation tests brief approaches across the diverse performance domains of work, sport, music, and school in relation to motivation and engagement correlates. With few exceptions, both flow measures yielded acceptable model fit, reliability, and distribution properties in diverse performance settings. Both flow measures reflected associations with key motivation constructs in parallel and hypothesized ways. Both evinced invariance in factor loadings across diverse samples. When short and core flow were considered in the one sample, both measures demonstrated sound psychometric properties and were highly positively correlated, but with sufficient variance unexplained to conclude that they offer complementary but distinct perspectives on brief flow assessment. We conclude, therefore, that these two brief flow measures are appropriate for research seeking to use brief measures in assessing task absorption, subjective experience, and cognate constructs such as motivation. Notwithstanding this, the more detailed findings also offer guidance as to decision-making regarding which measure/s to use under particular circumstances. We present our recommendations from an operational perspective and a psychometric perspective—and then integrate both perspectives to provide advice for future research and practice.

Salience of findings from an operational perspective

The two brief measures presented in this study were designed to fulfill different purposes. The fact that they are highly correlated ($r = .72$) confirms that they are cognate constructs—consistent with our earlier contentions that they represent complementary perspectives on subjective experience and task absorption. However, the fact that nearly half the variance between them is unexplained demonstrates that they are sufficiently distinct to conclude that they might serve different operational purposes. The question, then, is this: How do we decide which brief measure is most appropriate to implement in a given research or applied setting? To answer this question, we propose that decisions on which measure to use should be dictated by the research purpose and questions.

Short and core flow

The short flow scale provides a brief assessment of the nine-dimensional conceptualization of flow. By selecting a target item from each of the nine flow factors in the long form, the short flow scale can be considered a brief version of the global higher order flow construct. The short measure, therefore, can be considered a more practical tool in situations where constraints prevent use of the more

complete long measure (see below) and where aggregate or global flow that encompasses the nine dimensions is of interest. The short flow scale items capture an aggregate profile of flow characteristics, making them potentially suitable to a range of settings. In this study, applicability to work, sport, and music have been demonstrated.

The core flow scale is a different way to think about assessing flow to the long and short flow scales. Core flow is designed to tap into the core phenomenological experience of what it is like to be in this optimal state of mind. Being an optimal and core experience, we hypothesized (and found) it to be unidimensional in nature. Having a brief assessment of the phenomenological experience of flow may help with advancing understanding of this optimal state, and its relationship to individual and environmental influences. The core flow scale is likely to be of interest when assessment of the central and subjective experience is the goal. The core flow measure is also likely to be relevant to studies where the more wide-ranging aggregate and multidimensional flow is not as central as the more targeted subjective optimal experience itself.

Understanding the brief measures in the context of the long measure

Importantly, the short and core measures must also be considered in the context of the long (multi-item multi-factor) flow measure that is known to be psychometrically very robust (Jackson and Eklund 2002, 2004; Jackson and Marsh 1996). The long flow scales provide a rich, multidimensional assessment of the nine dimensions of flow. The long scales are particularly suited to projects where a fine-grained description of flow characteristics according to the theoretical formulation of Csikszentmihalyi (1990) is desired. Since these scales measure the nine theorized flow dimensions, they are also useful for intervention-based studies, allowing the researcher to assess the impact of an intervention across the nine flow components. In addition, the nine-dimensional flow measure provides specific and targeted direction for intervention to increase the likelihood of flow occurring, or on what areas to focus to attain flow. Indeed, recent research highlights the fact that the more targeted and differentiated intervention work is, the more effective it is in bringing about important change (Martin 2005, 2008a; O'Mara et al. 2006). Hence, where these issues are of primary importance (as they often are), it is recommended that the long flow measures are the ones of choice.

Salience of findings from a psychometric perspective

The short measure fit well and correlated more highly with external factors than did the core flow measures with external factors. Thus, the short measure may be a more suitable tool for providing a brief assessment of flow from the nine-dimensional conceptualization. Notwithstanding this, initial psychometrics presented show that the core scale does provide a valid and reliable assessment of the central subjective experience. Moreover, when short and core flow were considered in the one analytic model under the one domain (sport), they both demonstrated sound psychometric properties and were significantly correlated. While the RMSEA values for core flow were on the high side, this may be attributed to the number of items in this measure (Kenny and McCoach 2003) and the corresponding SRMR values did demonstrate satisfactory fit. Taken together, however, although the preliminary data presented here on both short and core flow are encouraging, being new measures, more research is needed to further examine the psychometrics of both scales.

Operational and psychometric guidance for research and practice

Short and core flow scales performed in similar ways but with half the variance between them unexplained they are clearly not the same construct. Given their generally strong psychometric properties and their internal and external validity, decision-making regarding their use will devolve to the purpose of a given study. Studies aiming to capture the very specific 'in the zone' experience may opt for core flow. Studies aiming to capture aggregate or global flow that reflects broader parameters (e.g., challenge-skill balance, clear goals, sense of control, etc.) may opt for short flow. The present investigation has been important in that it shows both core and short measures are valid and appropriate for use across diverse performance settings.

We believe a balance between applied and psychometric considerations to be important when making decisions on which measures to use. The two brief scales offer different, but complementary ways of assessing flow, and should open up more possibilities for including flow as a focal construct in research across a range of settings. The present research included several samples, spanning a range of contexts. There was participant diversity in age, gender, experience in target activity, and type of target activity. Originally conceived and developed in sport and physical activity, the present research demonstrates that while the scales are useful in this setting, they also have potential in other settings including work, school, and a range of extracurricular activities.

Conclusion

In our concluding remarks we point to some limitations of the study, outline directions for future research and

practice, and provide final comment relevant to the measurement and administration of the short and core flow scales.

As with most psychological constructs, there is no *one* way to measure flow. Flow is an optimal experience, a state of consciousness. Like all experiential phenomena, flow cannot easily be quantified by psychometrics or illuminated through investigative interviewing. No single measurement approach will be able to provide trouble-free assessments of the flow experience. Another point to note is that the data presented in this study are all self-reported. Although this is a logical and defensible methodology in its own right given the substantive focus, it is important to conduct research that examines flow using data derived from additional sources such as, for example, that from coaches, teachers, and parents. Other important 'objective' data would include achievement and outcome data relevant to the performance domain. Indeed, extending the data base in these ways brings into consideration the need for other construct validity extensions that were not conducted in the present study. Extensions such as these include assessments of incremental validity with respect to existing measures, discriminant validity from measures it should not strongly predict, and temporal reliability and stability. These are important directions for future construct validity work into short and core flow.

On this issue of validity it is also appropriate to comment on the high correlations in some of the between-network analyses. Specifically, short flow (in particular) is very highly correlated with constructs such as buoyancy and enjoyment (in some cases sharing more than three-quarters of the variance). On the one hand, high correlations are to be expected—because these analyses involve related adaptive constructs they will yield high correlations. On the other hand, these constructs are sufficiently conceptually and operationally distinct that they ought not correlate so substantially—particularly as they are zero-order correlations. In explaining these findings, it is important to note that these flow and between-network scales were located in the same section of the survey instrument. Hence, over and above what variance they would share in the ordinary course of individuals' lives, there appears to be additional variance that is something of a response bias or halo effect. This is important to consider when interpreting findings.

A further suggestion on data collection is the need for more research assessing short and core flow in the one domain. The present investigation collected common short and core flow data in the sport sample of Study 2, providing support for complementary psychometric strength and the nature of their empirical links. However, these findings are preliminary and so there is a need for further research across diverse samples and contexts to better understand short and core flow under the one conceptual and empirical framework.

Another limitation is that like all self-report instruments, the flow scales presented in this research are subject to problems of retrospective recall, and of group average representations of experience. Any attempt to quantify an experiential state is going to be a difficult task, and it is acknowledged that the information provided by the scales present a partial picture of what the experience of being in flow is like. The flow measures also provide opportunities for exploring climates such as that in teams, classrooms, and workplaces. Although the present study adopted an individual-differences approach, it is recognized that group-level factors are also potentially relevant. Indeed, advances in statistical software enable researchers to more accurately assess the relative influence of individual- and group-level factors using multi-level modeling (see Bryk and Raudenbush 1992; Goldstein 2003) and so future research can readily explore the influence of group-level flow climates relative to individual-level variation in flow.

A final limitation to consider is that although the present study focused on the two short and core measures, it is important to note that the multi-item multi-factor long flow scales (Jackson and Eklund 2002, 2004; Jackson and Marsh 1996) provide a richer, multidimensional assessment of the nine dimensions of flow and are particularly suited to projects where fine-grained descriptions of flow characteristics according to the theoretical formulation of Csikszentmihalyi (1990) are desired. Similarly, in work revolving around targeted intervention and assessment it may be that the multi-item multi-factor long flow scales are of greater utility than the unidimensional short and core scales assessed here. Further research is needed to assess this possibility.

To conclude, the present study validates two complementary but non-overlapping brief flow measures. This expansion on the existing flow framework provides direction for support aimed at addressing individuals' flow experiences and also for the design of interventions aimed at more structured approaches to developing flow. Findings also provide psychometric guidance for decision-making by those interested in more appropriately targeted flow research in which short and core flow have distinct merits, purposes, and applications. Taken together, the findings of the present investigation hold substantive and methodological implications for researchers studying issues relevant to task absorption, subjective experience, and motivation. The findings are also relevant to practitioners seeking to enhance diverse outcomes that rely in large part on the extent to which individuals are in flow.

Appendix: Short and core flow items and factor loadings

When I participate in this activity…

Short flow items	Music	Sport	Work
I feel I am competent enough to meet the high demands of the situation	.58	.67	.63
I do things spontaneously and automatically without having to think	.41	.61	.25
I have a strong sense of what I want to do	.69	.69	.73
I have a good idea while I am performing about how well I am doing	.71	.69	.63
I am completely focused on the task at hand	.44	.55	.23
I have a feeling of total control	.68	.67	.53
I am not worried about what others may be thinking of me	.56	.47	.37
The way time passes seems to be different from normal	.70	.71	.65
The experience is extremely rewarding	.69	.56	.57

Core flow items	Extra-curricular	Math	Sport	General school
I am 'totally involved'	.71	.79	.65	.72
It feels like 'everything clicks'	.72	.76	.73	.66
I am 'tuned in' to what I am doing	.75	.82	.78	.72
I am 'in the zone'	.80	.89	.85	.81
I feel 'in control'	.72	.79	.70	.82
I am 'switched on'	.77	.81	.82	.61
It feels like I am 'in the flow' of things	.79	.86	.84	.85
It feels like 'nothing else matters'	.53	.56	.59	.80
I am 'in the groove'	.74	.80	.80	.84
I am 'totally focused' on what I am doing	.62	.71	.68	.79

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