International Journal of Applied Positive Psychology (2026) 11:18
https://doi.org/10.1007/s41042-026-00281-1

RESEARCH

Cross-Cultural Differences in the Experience of Flow: An Investigation between Turkish, Scottish, and Australian Athletes

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Received: 3 July 2025 / Accepted: 27 February 2026

Abstract
The purpose of this study is to examine the cross-cultural generalizability of flow experiences by testing the factor structure and measurement invariance of the Dispositional Flow Scale-2 (DFS-2) across individualistic and collectivistic cultures. This study examines the factor structure and cross-cultural invariance of the DFS-2 between the original English version (Jackson & Eklund, 2002) and the translated Turkish version (Aşçı et al., 2007). Using a cross-sectional design, three samples from Turkey, Scotland, and Australia completed the DFS-2. The results confirmed the first-order 9-factor structure for the overall sample, S-Bχ2 (108, N=1099)=1183.128, $p < .001$, CFI = 0.964, TLI = 0.960, SRMR = 0.031, RMSEA = 0.024 (90%-CI: 0.022, 0.027), and for each national sample, indicating good fit of the data. Multigroup invariance testing showed full measurement invariance between samples from Scotland and Australia, partial measurement invariance between Turkey and samples from Australia and Scotland. The core constructs of the DFS-2 dimensions were comparable across individualistic and collectivistic samples, suggesting a similar understanding across groups. Within the Turkish sample, elevated modification indices and standardized residual covariances were found for challenge-skills, clear goals, and concentration on the task at hand items. Based on the sound factor structure of the DFS-2 for each sample and evidence for factorial invariance, we concluded that the English and Turkish versions of the DFS-2 are psychometrically sound and practical in cross-cultural research.

Keywords Flow · Cross-cultural research · Multigroup CFA

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Published online: 14 April 2026

1 Introduction

Flow is a specific, subjective, self-rewarding state characterized by deep task engagement, intense focus, and changes in time perception (Csikszentmihalyi, 1975, 2000). Csikszentmihalyi (1990) reported that flow occurs when individuals perceive a match between skill and situational challenge levels that are balanced and above average. The experience reflects a highly intrinsically motivated state of flow, perceived as particularly meaningful. Despite the proposed universality of flow experiences, little research has examined cultural differences in flow experiences. Berry et al. (2002) proposed three goals that researchers should pursue within cross-cultural studies, including the examination of (i) the validity and generality of existing psychological theories and contentions in different cultural contexts; (ii) differences in behaviors that can be attributed to cultural contexts; and based on the findings of the first two goals (iii) the "attempt to assemble and integrate into a broadly based psychology […] and to generate a more nearly universal psychology that will be valid for a broader range of cultures" (p. 4). To evaluate these objectives, it is preferable to select participants from nations that exhibit considerable cultural differences in their upbringing, specifically by comparing groups from individualistic and collectivistic cultures. Consequently, the aim of this study is to investigate the generalizability of flow experiences among athletes hailing from both individualistic and collectivistic backgrounds.

Since the introduction of flow theory by Csikszentmihalyi in 1975, there have been comparatively few efforts to investigate the appropriateness and generalizability of the flow model across different cultural groups. According to Moneta (2004a), the flow model may be influenced by specific cultural factors beyond the individualism–collectivism continuum. The first comparative study examining the flow model across cultures with varying levels of individualism and collectivism involved Chinese college students and 12th graders from the United States (Moneta 2004b). The findings revealed significant cultural differences in the experience of flow. Specifically, the optimal challenge/skill ratio—a critical prerequisite for achieving flow—was skewed toward the skills dimension rather than the challenge dimension in both groups, with this bias being notably stronger among the Chinese participants (Moneta 2004b). These cultural disparities in flow experiences are attributed to variations in participants' perceptions of autonomy and self-construal (Moneta 2004b).

The seminal work of Markus and Kitayama (1991) indicated that people from individualistic cultures are more likely to have an independent self-construal and a tendency to construe one's own existence as an individual separate from the social context and relationships entertained with others. In comparison, people from collectivistic cultures possess an interdependent self-construal, with a tendency to construe one's own existence as integral to a social group characterized by reciprocal bonds and commitments. Therefore, perceptions of autonomy and self-construal may have developed in opposite directions among people who grew up in individualistic and collectivistic countries, which may also be reflected in different experiences of the flow state.

The traditional binary view of self-construal (independent vs. interdependent) has been extended by proposing a multidimensional model that distinguishes dis-

tinct dimensions of cultural self-views (Vignoles et al., 2016). The self-construal dimensions were conceptualised on continua anchored by differences and similarities, self-direction and connectedness, self-reliance and dependence, consistency and variability, self-expression and harmony, and self-interest and commitment to others. This approach moves beyond the simple East-West dichotomy and suggests that cultures can emphasize different facets of both independence and interdependence (Vignoles et al., 2016). A key finding of this renovated theorizing is that these dimensions are often uncorrelated (or even negatively correlated) at both the individual and cultural levels of analysis, meaning that a culture high on one aspect of independence might be low on another, highlighting the complexity of cultural characteristics. This model could be applied to understanding national differences in well-being and team identity dynamics, as both aspects are central to the experience of flow. Although potential connections between flow and self-construal conceptualisations would remain theoretical, both theories address the self. Examining the mechanisms that trigger flow state in individual and team sports would help integrate flow research into a cross-cultural context.

Flow in sport has been extensively researched from a qualitative and quantitative perspective. Based on early qualitative work by Jackson (1995, 1996), nine flow dimensions emerged, labelled challenge-skills 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. Building on qualitative results, several validation studies tested psychometric properties of the Flow State Scale (FSS; Jackson & Marsh, 1996), and dispositional flow (TFS; Marsh & Jackson, 1999). The state and dispositional measures have undergone rigorous validation and revalidation procedures, leading to the establishment of the Flow State Scale-2 (FSS-2) and Dispositional Flow Scale-2 (DFS-2; Jackson & Eklund, 2002), as well as short forms of the FSS-2 and DFS-2 (Jackson et al., 2008).

Evidence for the factor validity of the DFS-2 has been found for the English and translated versions. The measurement models of the English version provided evidence for the 9-factor first-order model of the DFS-2 (Jackson & Eklund, 2002; CFI = 0.950, NNFI = 0.943, RMSEA = 0.043), and for translated versions of the DFS-2 into Japanese (Kawabata et al., 2008; CFI = 0.955, NNFI = 0.949, RMSEA = 0.042), Portuguese (Gouveia et al., 2012; CFI = 0.95, NNFI = 0.95, RMSEA = 0.040), and Turkish (Aşçı et al., 2007; CFI = 0.920, NNFI = 0.909, RMSEA = 0.043). In sum, these studies provided evidence for the 9-Factor first-order model of flow in different cultures.

Despite the extensive, rigorous assessment of the DFS-2 measure, surprisingly little cross-cultural flow research has been conducted. These results would help support the notion that flow is a universal construct and that the experience differs little across cultural contexts (Csikszentmihalyi, 1990; Jackson & Csikszentmihalyi, 1999). One of the few flow studies that compared groups from individualistic and collectivistic cultures was conducted by Kawabata et al. (2008), comparing samples from Japan and Australia. Configural invariance testing showed an adequate-to-strong fit of the data for state and dispositional measures. Measurement invariance was achieved at the factor-loading and intercept levels. Latent mean difference testing was conducted for the FSS-2 but not for the DFS-2 because the conditions were not strictly met,

indicating that the English-speaking sample scored higher on seven flow dimensions than the Japanese sample. Methodologically, it might be preferable to evaluate flow data gathered from a dispositional rather than a state measure, as flow state might vary considerably due to situation-specific environmental factors rather than cultural ones. The examination of dispositional flow should be more consistent than flow state, which should provide more substantial evidence for the generalizability of flow across cultures. To our knowledge, no study has examined the adequacy of flow frequency across multiple cross-cultural samples.

2 Present Study

Research on flow has focused on behavioral, motivational, cognitive, and personality aspects, but rarely on the cultural level (Pfeifer et al., 2022). Despite the recognition that flow is a universal construct, research examining the flow experience across cultural groups remains limited (Pfeifer et al., 2022). The DFS-2 is one of the most frequently used flow measures for assessing flow propensity in physical activity (Jackman et al., 2021), exercise (Jackman et al., 2019), and sport performance settings (Harris et al., 2023). To date, there is no research testing the cross-cultural validity of the DFS-2 outside of validation studies (e.g., Kawabata et al., 2008).

The present study examines the cross-cultural generalizability of dispositional flow between samples from Scotland, Australia, and Turkey. Based on the bipolar individualistic-collectivistic dimension, the Scottish and Australian cultures have been defined as individualistic, whereas Turkey has been defined as collectivistic, representing cultural diversity (Hofstede, 1983; Markus & Kitayama, 1991). Building on theoretical arguments in cross-cultural psychology (Berry et al., 2002) and empirical evidence on differences in flow experiences across individualist and collectivist countries (Moneta 2004a, b; Kawabata et al. 2008), this study examined (1) cross-cultural factor validity of the 9-factor first-order model of flow, and (2) cross-cultural measurement invariance of the flow measurement model. We hypothesize that dispositional measures of flow will demonstrate factor validity within each cultural subsample (Aim 1), whereas differences in flow may be revealed across cultural groups (Aim 2). The findings will provide further evidence on whether flow reflects a universal construct or varies between individualistic and collectivistic cultures.

2.1 Method

2.1.1 Participants

A total of 1099 men ($n=702$) and women ($n=397$) athletes between 16 and 43 years ($M=20.97$; $SD=3.45$) of age from team (e.g., football $n=294$; basketball $n=103$; volleyball $n=98$) and individual sports (e.g., martial arts/wrestling $n=61$; swimming $n=36$) participated in this study. Participants had been involved in their sports on average for 10.32 years ($SD=4.52$) and trained in their sport for a mean of 8.19 h per week ($SD=6.44$). Demographic information for the subsamples is presented in Table 1.

Table 1 Demographic Statistics for the three Subsamples

		Total	Turkey	Scotland	Australia
		$N = 1099$	$n = 356$	$n = 369$	$n = 374$
Gender	Men	702	227	235	240
	Women	397	129	134	134
Sport Type	Team	821	264	271	286
	Individual	278	92	98	88
Age (in years)	*M*	20.97	22.39	19.87	20.71
	SD	3.45	3.97	2.68	3.13
Participation (in years)	*M*	10.32	10.28	10.09	10.58
	SD	4.52	4.42	4.57	4.55
Competitions per year	*M*	20.76	22.51	19.39	20.45
	SD	13.20	12.84	13.79	12.78
Training hours per week	*M*	8.19	13.13	5.30	6.33
	SD	6.44	7.16	4.05	4.69

3 Measures

Dispositional Flow Scale-2 (DFS-2; Jackson & Eklund, 2002). The DFS-2 assesses the frequency of flow and comprises 36 items across nine subscales, each comprising four items that assess one of the nine dimensions of flow. Thus, the nine subscales represent the nine flow dimensions. Item examples of the nine subscales are "My abilities match the high challenge of the situation" (challenge–skills balance), "Things seem to happen automatically" (action–awareness merging), "I know clearly what I wanted to do" (clear goals), "I am aware of how well I am performing" (unambiguous feedback), "My attention is focused entirely on what I am doing" (concentration on the task at hand), "I have a sense of control over what I am doing" (sense of control), "I am not concerned with how others may be evaluating me" (loss of self-consciousness), "It feels like time goes by quickly" (time transformation), and "I really enjoy the experience" (autotelic experience). The response format is a 5-point Likert scale anchored by 1 (never) and 5 (always), assessing respondents' frequency of flow experiences.

The Turkish version of the DFS-2 (Aşçı et al., 2007) was used to collect the data from Turkish participants. The DFS-2 was translated into Turkish using a standardized back-translation procedure (Brislin, 1986). Confirmatory factor analysis results confirmed the factor structure of the 36-item Turkish version of the DFS-2, CFI = 0.920, NNFI = 0.909, SRMR = 0.051, RMSEA = 0.043 (90%-*CI*: 0.037, 0.048). Aşçı and colleagues (2007) reported internal consistency coefficients for the Turkish DFS-2 version ranging from 0.55 (challenge-skill balance) to 0.87 (loss of self-consciousness).

4 Procedure

Following approval from the Liverpool Hope University Ethics Committee, we requested access to University students who had taken part in sport psychology and physical education classes, as well as to athletes with a sports background. The main

inclusion criterion was active experience in sport and physical activities; no incentives for participation were provided. We followed standard consent procedures, and participants were informed of the study aims, confidentiality, anonymity, and data security. The participants completed demographic information and the DFS-2 through an online system or in face-to-face group settings, taking about 10 min in total. The procedures were identical across samples. The researchers ensured consistent application of the research protocol (e.g., instructions).

4.1 Data Analysis

Power and sample size calculations for this study followed the guidelines by Jobst et al. (2023). G*power software 3.1.9.7 was used to estimate the required sample size (Faul et al., 2009). The analysis was based on $\chi 2$ and goodness-of-fit tests, incorporating a priori input parameters of alpha error probability (set at 0.05), an effect size of 0.50, with an expected 200 degrees of freedom, and 90% power. The result indicated a required minimum sample size of 267 participants. Confirmatory factor analysis (CFA) was undertaken using AMOS 21.0 software. The data are distributed on a 5-point Likert-type response scale. Using CFA in conjunction with maximum likelihood estimation tends to create biases in parameter estimation. To avoid estimation error and address potential issues through the ordinal structure at the item level, Brauer et al. (2023) provided evidence that, rather than applying maximum likelihood estimation, using means- and variance-adjusted weighted least squares (WLSMV; Muthén et al., 1997) is preferable. Given the limited Likert response range in this study, all CFA models will be estimated using WLSMV.

Regarding Aim 1, the measurement models were assessed through parsimonious fit, we employed a chi-square test ($\chi 2$), incremental fit was examined through the comparative fit index (CFI; Bentler, 1990) and the Tucker-Lewis index (TLI; Bollen, 1989), and absolute fit was analyzed through the standardized root-mean-square residual (SRMR; Hu & Bentler, 1998) and the root-mean-square error of approximation (RMSEA; Steiger, 1990). Based on the standards developed by Hu and Bentler (1999), excellent fit of the data is achieved when CFI and TLI scores exceed 0.95, SRMR remains below 0.08, and RMSEA below 0.06. Marsh et al. (2004) proposed more conventional cutoff points for CFI and TLI values of 0.90 and above, and SRMR and RMSEA of 0.08 and below. For this study, we considered the conventional cutoff points by Marsh et al. (2004) as reflecting acceptable fit, and the more stringent thresholds by Hu and Bentler (1999) as indicating excellent fit. Once the best-fitting model was established, we used measurement invariance techniques. Regarding Aim 2, we assessed the covariance structure of the main model across cultures, following the propositions by Gregorich (2006) and Cheung and Rensvold (2002). We examined multigroup invariance between cultural samples in a set sequence of models assessing (i) configural invariance, (ii) metric invariance, (iii) scalar invariance, (iv) error variance invariance, (v) factor variance invariance, (vi) factor covariance invariance, and (vii) factor mean invariance (Milfont & Fischer, 2010). Fit indices for the invariance test have been included, following recommendations by Chen (2007) and Milfont and Fischer (2010): c2, Δc2, CFI, ΔCFI, RMSEA, ΔRMSEA, SRMR, and ΔSRMR. Recommendations for determining measurement invariance with equal

sample sizes across groups and with larger samples of at least 300 participants have been proposed (Chen, 2007). Model noninvariance for factor loadings is evident if $\Delta CFI \geq -0.010$, $\Delta RMSEA \geq 0.015$, and $\Delta SRMR \geq 0.030$. Model comparisons at an intercept or residual invariance level indicate noninvariance when $\Delta CFI \geq -0.010$, $\Delta RMSEA \geq 0.015$, or $\Delta SRMR \geq 0.010$ (Chen, 2007).

5 Results

5.1 Descriptive Statistics and Data Screening

The data screening confirmed that no data were missing across samples. Testing for normality, the univariate assessment of skewness and kurtosis showed no indication of non-normality. All item scores for each of the three sub-samples were below the cut-off values of 2 for skewness and 7 for kurtosis as recommended by West et al. (1995). Multivariate normality was examined through Mardia's coefficient (Mardia, 1974). The multivariate values for the DFS-2 items were 201.536 (critical ratio = 36.349) for the Turkish sample, 209.521 (critical ratio = 47.143) for the Scottish sample, and 299.598 (critical ratio = 55.384) for the Australian sample. To correct for non-normality in the data, we used the Satorra-Bentler chi-square statistics. The multicollinearity diagnostics showed acceptable values for the DFS-2 subscales across all sub-samples, with variance inflation factors below the 10 cut-off (Hair et al., 2010). The subscale means and standard deviations for each group are presented in Table 2.

6 Reliability

McDonald's omega reliability scores ranged from 0.70 to 0.87 for most DFS-2 subscales. Lower omega scores were found in the Scottish sample for clear goals (0.67), and in the Turkish sample for challenge-skills balance (0.58), action-awareness merging (0.64), and time transformation (0.65). Low reliability might affect further analyses and the validity of these findings. Instead of primarily focusing on specific reliability thresholds, Zitzmann and Orona (2025) proposed including 95% confidence intervals around the reliability score. This approach provides a better indication than a single value, as reliability may be acceptably high. As the DFS-2 overall reliability was acceptable, the focus here is at the subscale level, particularly the results for the Turkish sample. The 95% confidence intervals for the time transformation and action awareness merging are 0.59 to 0.71 and 0.58 to 0.70, respectively. Both dimensions exceed the acceptable reliability threshold, whereas the challenge-skills balance ranges from 0.51 to 0.65.

To gain a better understanding, we also calculated construct reliability ($\rho\eta$), using the formulae provided by Fornell and Larcker (1981). Although there is no consensus about the lower acceptable limits, e.g., cut-offs of 0.50 (Fornell & Larcker, 1981), 0.60 (Bagozzi & Yi, 1988), or 0.70 (Yi & Davies, 2003) have been proposed, values for reliability in this study were generally above 0.70. All subscale constructs

Table 2 *Reliability, Means, Standard Deviations for Flow Dimensions*

DFS-2	Turkey				Scotland				Australia			
	M	SD	ω	ρ_η	M	SD	ω	ρ_η	M	SD	ω	ρ_η
1. Challenge-Skills Balance	4.02	0.58	0.58	0.62	3.78	0.61	0.71	0.78	3.81	0.61	0.78	0.77
2. Action-Awareness Merging	3.82	0.59	0.64	0.65	3.78	0.66	0.79	0.81	3.75	0.66	0.80	0.79
3. Clear Goals	4.27	0.54	0.70	0.69	4.08	0.59	0.67	0.74	4.02	0.66	0.81	0.81
4. Unambiguous Feedback	4.10	0.58	0.69	0.70	3.94	0.69	0.80	0.84	3.96	0.69	0.84	0.84
5. Concentration on the Task	4.12	0.60	0.72	0.73	3.8	0.71	0.75	0.81	3.85	0.67	0.80	0.81
6. Sense of Control	4.11	0.58	0.77	0.76	3.85	0.65	0.75	0.81	3.88	0.61	0.77	0.77
7. Loss of Self-Consciousness	3.49	0.93	0.87	0.87	3.32	0.97	0.80	0.84	3.29	0.89	0.81	0.81
8. Time Transformation	3.82	0.66	0.65	0.65	3.61	0.85	0.81	0.80	3.54	0.84	0.82	0.82
9. Autotelic Experience	4.38	0.53	0.72	0.71	4.15	0.63	0.73	0.76	4.17	0.64	0.80	0.80

ω = McDonald's omega coefficient; ρ_η = construct reliability

exceeded the 0.60 level (Table 2). Based on the reliability findings, we included all flow subscales across the three subsamples in the CFA and multigroup invariance testing.

6.1 Demographic Analysis

Testing demographic variables in conjunction with dispositional flow, the data showed no significant group differences in dispositional flow between gender, $t(1097) = 1.63$, $p = .104$, or between team and individual activity, $t(1097) = 0.12$, $p = .902$. For the whole sample, significant correlations were found between dispositional flow and age, $r = .11$, $p = .001$, years of participation, $r = .11$, $p = .001$, years of competition experience, $r = .15$, $p = .001$, number of competitions per year, $r = .11$, $p = .001$, and training hours per week, $r = .22$, $p = .001$.

6.2 Hierarchical Confirmatory Factor Analysis (Aim 1: Factor Validity)

The results showed poor data fit for both the single-factor and the uncorrelated first-order models (Table 3). An acceptable fit was found for the second-order model and the correlated nine first-order factor model: S-B$\chi 2$ (108, $N = 1099$) = 1183.128, $p < .001$; CFI = 0.964; TLI = 0.960; SRMR = 0.031; RMSEA = 0.024 (90%-CI: 0.022, 0.027). The results of the correlated 9-factor first-order factor were replicated across the three subsamples (Table 4). For this study, we employed the conventional cutoff points for CFI and TLI values of 0.90 and above, and SRMR and RMSEA of 0.08 and below (Marsh et al., 2004). The correlated 9-factor models were acceptable in the specific terms outlined by Marsh et al. (2004). Moreover, the data of the Australian sample revealed excellent model fit in conjunction with the more stringent thresholds by Hu and Bentler (1999), that is a CFI and TLI above 0.95. Based on these findings, the correlated nine first-order factor model was used to test cross-cultural measurement invariance.

6.3 Comparison of the 9-Factor First Order Model (Aim 2: Measurement Invariance)

In Table 5, the results between configural and metric models showed acceptable values for all group comparisons, $\Delta CFI \geq -.010$ (Chen, 2007). Comparing samples from Turkey and Scotland, as well as samples from Turkey and Australia, none of the ΔRMSEA and ΔSRMR were above the recommended limits by Chen (2007). Although ΔCFI, as the main criterion of these test indices, showed a marginal increase for the group comparison on a scalar level between Turkish and Scottish participants, which went beyond the acceptable threshold of ≥ -0.010. Group comparisons at the factorial level also indicated substantial differences among samples from Turkey, Scotland, and Australia. Therefore, partial measurement invariance was evident for models including data from the Turkish sample, whereas full measurement invariance was found for models between samples from Australia and Scotland. Although the ΔRMSEA and ΔSRMR indices supported measurement invariance between groups from Turkey and Scotland, the ΔCFI indicated partial invariance. Examining

Table 3 Examination of Fit Indices for 9-Factor First-Order and Alternative Models for the Overall Sample ($N = 1099$)

Model	S-Bχ^2	df	CFI	TLI	SRMR	RMSEA	RMSEA 90% CI
M1: Single-factor model	5479.274*	72	0.755	0.740	0.075	0.062	0.060–0.063
M2: Second-order model	1551.147*	81	0.950	0.947	0.038	0.028	0.025–0.031
M3: Uncorrelated 9-factor model	33293.672*	72	0.177	0.127	0.232	0.113	0.111–0.115
M4: Correlated 9-factor model	1183.128*	108	0.964	0.960	0.031	0.024	0.022–0.027

the results of the Turkish sample in more detail, the standarized residual covariance matrix showed local misspecification, in accordance with the guidelines by Saris et al. (2009) and Shi et al. (2018) for challenge skill-balance, clear goal, and concentration on the task at hand items.

7 Discussion

In this study, we examined the cross-cultural factor validity of the 9-factor first-order model of flow (Aim 1) and cross-cultural measurement invariance of the flow measurement model (Aim 2). Testing the equivalence of the DFS-2 is relevant to establishing the scale's cross-cultural validity and to whether the underlying construct has the same meaning across cultural groups (Gregorich, 2006). The characteristics of the samples from Turkey, Scotland, and Australia were reasonably broad, including athletes from a range of individual and team sports.

The results of the 9-factor first-order models demonstrated acceptable to strong correspondence with the hypothesized theoretical structure across all subsamples. The statistical fit underlines the general theoretical justification and interpretability of flow, as proposed by Csikszentmihalyi (1990, 2000). The robustness of these models, as indicated by the CFI and TLI indices, suggests that the findings are not sample-specific and are likely to be reproducible in applied research, such as intervention programs, and in quantitative, theory-driven research. In a cross-cultural context, the findings confirmed theoretical propositions of the flow concept as a universal construct (Csikszentmihalyi, 1990, 2000) as well as empirical studies testing the psychometric properties of the dispositional flow scale using sample participants from non-English speaking countries (Aşçı et al., 2007; Kawabata et al., 2008). Full measurement invariance was found between Scottish and Australian samples, whereas partial measurement invariance between the Turkish and the Western participants.

Examining invariance in the Turkish sample, configural invariance tests showed that the dispositional flow concepts were interpreted similarly, indicating a common reference point across cultures. Configural variance may occur when cultural background leads to different understandings of the constructs (Millsap & Everson, 1991). The results of this study provided evidence that different cultural samples have attached the same meaning to the flow dimensions. Similarly, support for metric invariance has been found across cultural groups, indicating invariance of the items' factor loadings. At the scalar level, variation was found between groups from Turkey and Scotland. Any difference in average scores between groups is due to an actual

Table 4 Correlated 9-Factor First-Order Models for each Subsample

Baseline Models	S-Bχ^2	df	CFI	TLI	SRMR	RMSEA	RMSEA 90% CI
Scotland (n = 369)	950.503*	108	0.940	0.932	0.049	0.027	0.021–0.033
Australia (n = 374)	724.541*	108	0.982	0.979	0.040	0.018	0.008–0.026
Turkey (n = 356)	939.163*	108	0.917	0.906	0.050	0.029	0.022–0.035

Table 5 Summary of Fit Statistics for Tests of Multigroup Invariance

Model	Model comparison	S-B χ^2	Df	$\Delta\chi^2$	Δdf	*p*	CFI	ΔCFI	RMSEA	ΔRMSEA	SRMR	ΔSRMR
Australia vs. Scotland												
M1: Configural invariance (n=743)	-	1696.654	1116	-	-	-	0.964	-	0.024	-	0.044	-
M2: Metric invariance	2 vs. 1	1727.633	1143	30.979	25	ns	0.967	0.003	0.023	0.001	0.049	0.005
M3: Scalar invariance	3 vs. 2	1765.458	1170	37.825	27	ns	0.966	−0.001	0.022	0.001	0.048	−0.001
M4: Error variance invariance	4 vs. 3	1841.064	1206	75.606	36	ns	0.964	−0.002	0.023	0.001	0.049	0.001
M5: Factor variance invariance	5 vs. 4	1828.524	1215	12.54	9	ns	0.966	0.002	0.022	0.001	0.051	0.002
M6: Factor covariance invariance	6 vs. 5	2319.743	1251	491.219	36	ns	0.960	−0.006	0.023	0.001	0.064	0.013
M7: Factor mean invariance	7 vs. 6	2338.858	1260	19.115	9	ns	0.960	0.000	0.024	0.001	0.065	0.001
Scotland vs. Turkey												
M1: Configural invariance	-	1889.903	1116	-	-	-	0.927	-	0.028	-	0.050	-
M2: Metric invariance	2 vs. 1	1838.275	1143	51.628	27	ns	0.939	0.012	0.025	0.003	0.053	0.003
M3: Scalar invariance	3 vs. 2	2011.657	1170	173.382	27	ns	0.926	−0.013	0.028	0.003	0.053	0.000
M4: Error variance invariance	4 vs. 3	2152.303	1206	140.646	36	ns	0.918	−0.008	0.029	0.001	0.057	0.004
M5: Factor variance invariance	5 vs. 4	2365.259	1215	212.956	9	ns	0.903	−0.015	0.031	0.002	0.062	0.005
M6: Factor covariance invariance	6 vs. 5	2144.912	1251	220.347	36	ns	0.954	0.051	0.021	0.010	0.065	0.003
M7: Factor mean invariance	7 vs. 6	2900.182	1260	755.270	9	<0.01	0.915	−0.036	0.028	0.007	0.074	0.011
Australia vs. Turkey												
M1: Configural invariance	-	1679.770	1116	-	-	-	0.957	-	0.024	-	0.045	-
M2: Metric invariance	2 vs. 1	1601.584	1143	78.186	27	ns	0.968	0.011	0.021	0.003	0.047	0.002
M3: Scalar invariance	3 vs. 2	1761.171	1170	159.587	27	ns	0.959	−0.009	0.023	0.002	0.048	0.001
M4: Error variance invariance	4 vs. 3	1960.352	1206	199.181	36	ns	0.948	−0.011	0.026	0.003	0.052	0.004
M5: Factor variance invariance	5 vs. 4	2321.649	1215	361.297	9	<0.05	0.926	−0.022	0.031	0.005	0.060	0.008

Table 5 (continued)

	Model comparison	Model	S-B χ^2	Df	$\Delta\chi^2$	Δdf	*p*	CFI	ΔCFI	RMSEA	ΔRMSEA	SRMR	ΔSRMR
Australia vs. Scotland													
M6: Factor covariance invariance	6 vs. 5		2647.249	1251	325.600	36	< 0.01	0.950	0.024	0.025	0.006	0.071	0.011
M7: Factor mean invariance	7 vs. 6		3172.523	1260	525.274	9	< 0.01	0.931	− 0.019	0.029	0.004	0.077	0.006

S−Bχ2 = Satorra-Bentler rescaled chi-square statistic, CFI = Comparative Fit Index, RMSEA = Root Mean Square Error of Approximation, SRMR = Standardized Root Mean Square Residual, ns = not significant

mean difference in the underlying flow dimensions, not to the groups interpreting the items differently.

The original English version of the DFS-2 satisfies the criteria for strong factorial invariance, as evidenced by results across Australian and Scottish samples. The translated Turkish version, on the other hand, did not demonstrate strong factorial invariance with either the Scottish or the Australian DFS-2 data. This might be due in part to cultural differences and in part to the translation of the DFS-2. Word choice, linguistic nuance, and idiomatic phrasing could have affected the psychometric properties that are reflected in the statistical qualities of reliability and validity. In particular, the reliability of the challenge-skills balance reflects lower-than-desirable scores, which was also highlighted in the initial validation research (Aşçı et al., 2007). Challenge-skills balance is a key construct within the conceptualisation of flow, as it is also considered a precondition for experiencing flow (Kawabata & Mallett, 2011). The low reliability of the Turkish version of the challenge-skills balance, as found in this study and by Aşçı et al. (2007), might indicate a different understanding and interpretation of the concept compared to Western samples. Future studies should be wary of potential issues with this flow dimension that could affect cross-cultural research findings.

In addition, the findings of Vignoles et al.'s (2016) study, based on the cultural model of selfhood, indicated that the Middle Eastern (Turkey, Oman, Lebanon…) selfhood model involved both independent and interdependent self-construal factors. Middle Eastern samples emphasized self-reliance and consistency, as well as receptiveness to influence and connection with others. Therefore, considering only independent or interdependent factors did not provide a detailed explanation for cultural differences. The ecological and sociopolitical circumstances, including physical climate, economy, education, mass media penetration, population demographics, and religious heritage, should be considered for explaining the cultural differences. For example, Vignoles et al. (2016) reported that Muslim religious heritage (e.g., Turkish) placed greater emphasis on self-reliance than on dependence on others. In this study, a large proportion of Turkish participants were involved in team sports, whereas the flow measurement reflected individual, but not team flow. This may have partly contributed to the variation in flow experiences between groups from Turkey and Scotland.

Full measurement invariance across Scottish and Australian samples provides evidence of a similar flow experience between these groups. Generally, people from Turkey are inclined to endorse conservative, collectivistic values, an interdependent self-view, and a sociocentric identity, perceiving themselves as less differentiated and more socially sensitive (Markus & Kitayama, 1991). However, nowadays, Turkish culture cannot be evaluated as merely collectivistic (Göregenli, 1995), since individualism is increasing among well-educated people, such as university students, who are developing more individualistic, competitive future orientations. Especially, Turkish youth tend to endorse both collectivist and individualistic values and combine independent and relational elements in their self-definitions (Kağıtçıbaşı, 1996). Results of the multigroup invariance test in this study, comparing Turkey and Western countries, generally supported this assessment. Partial measurement invariance in flow was found across cultural groups, with few significant differences observed,

and this pattern was also evident in model fit and error estimation. CFI, RMSEA, and SRMR indices are highly sensitive to measurement invariance testing and are relatively independent of sample size (Chen, 2007). Observed changes in these indices across groups are mainly due to sample structure, i.e., place of origin. One reason measurement variance did not show a more pronounced effect may be related to cultural changes. In previous decades, a trend has been observed of assimilating Turkish collectivist culture into an individualistic one (Kağıtçıbaşı, 2012). While upholding traditional cultural structures, a tendency toward individualization has been observed (Kağıtçıbaşı, 2012). In sum, the results of the multigroup invariance testing provided evidence that the flow experiences did not differ substantially across groups. The tendencies toward independent or interdependent self-construal of the experience of flow appear to be similar across groups. That is, participants were not affected by different cultural contexts, at least not at a statistically significant level.

Future cross-cultural research on flow should expand from measurement invariance to structural invariance. Theoretical contentions indicated that flow dimensions may be reflected in a sequential relationship and serve different functions (Csikszentmihalyi, 2000). Differentiating between flow conditions (i.e., challenge-skills balance, clear goals, unambiguous feedback), a requirement to get into flow, and flow characteristics, consisting of the remaining dimensions, has also been conceptualised in the sports domain (Kawabata & Mallett, 2011). Intervention research provided initial evidence that targeting flow conditions increased flow state in middle-distance runners from the Middle East (Koehn & Díaz-Ocejo, 2022). Testing the higher-order structural model would provide more evidence if different flow functions reflected a stable construct across cultural contexts, which, in turn, may facilitate more intervention research.

Questionnaire translation procedures are of key importance in cross-cultural research. To conserve the item's meaning may require refined translation methods. Anchoring vignettes are a methodology used in cross-cultural research to address the challenge of reporting homogeneity, where respondents from different cultures may interpret and use the same response scales (e.g., Likert-type scales) differently (He et al., 2017). The addition of item batteries provides hypothetical descriptions that standardize subjective responses, facilitate direct translation, and allow amendments in validation research.

This study revealed some limitations. Internal consistency of the DFS-2 subscales was generally satisfactory across samples. Although some flow dimensions in the Turkish sample showed lower-than-desirable reliability, although additional tests of construct reliability indicated acceptable fit. The sample characteristics and sample size across the three groups were homogeneous. Regarding training hours per week, however, the Turkish sample displayed a substantially larger group mean of 13.13 years, compared with the Scottish (5.30 years) and Australian (6.33 years) samples. The discrepancy in current sport involvement may partly account for the variance found within flow measurement. Based on the results of two Monte Carlo studies, it was found that changes in measurement invariance indices (CFI, RMSEA, and SRMR) were greater with equal than with unequal sample sizes (Chen, 2007). The results of this study show larger effects in the variance between cultural groups, rather than obscuring the detected pattern.

Conceptually, flow is characterized by a total immersion in the task at hand, signified by high motivation, focused attention, and enjoyment in the activity (Csikszentmihalyi, 2002). The intersection of human experience reflects the complexity of flow state in sport and exercise domains. Despite some measurement-level differences, the results indicate a similarity in flow experiences between participants from Turkish and Western countries. Assessing the flow concept in an applied context, imagery interventions aimed at increasing flow state have been shown to be effective for Australian (Koehn et al., 2014) and Middle Eastern athletes (Koehn & Díaz-Ocejo, 2022). Based on the combined evidence from this and previous studies, flow appears to be a stable cross-cultural construct.

In conclusion, there are several practical takeaways from this study's findings. The degree of measurement equivalence indicates that flow, as operationalised by the DFS-2, is measured and interpreted consistently across diverse cultural groups and performance situations. This consistency enables reliable research, the development of effective intervention programs, and theory-driven cross-cultural comparisons. The findings support the notion that the core components of flow constitute a stable construct (Csikszentmihalyi, 2000). Practitioners developing interventions on flow and performance should be able to observe real improvements rather than artifacts of flow. Future research should evaluate whether the DFS-2 is sensitive enough to capture contextual nuances in applied settings across cultures. Theory-driven research can identify the antecedents and consequences of flow experiences, leading to more accurate models of flow and its relationship to performance and well-being.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s41042-026-00281-1.

Author contributions All authors contributed to the study conception and design. The data collection has been evenly split across the research team. The analysis was performed by Dr SK. The first draft of the manuscript was written by Dr SK, DR HA, and Dr EC. All authors commented and provided feedback on previous versions of the manuscript. All authors read and approved of the final manuscript. Conceptualization: Dr SK, Dr HA, Dr EC Methodology: Dr SK, Dr HA, Dr EC Formal analysis and investigation: Dr SK Writing - original draft preparation: Dr SK, Dr EC Writing - review and editing: Dr SK, Dr HA, Dr EC.

Funding No funding was received to assist with the preparation of this manuscript.

Data Availability The author confirms that all data generated or analysed during this study are included in this published article.

Declarations

Ethical Approval We certify that the study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki Ethical guidelines and as provided by the American Psychological Association. Data collection commenced following approval by the departmental ethic committees from Liverpool Hope University.

Informed Consent None of the participants were underage or considered vulnerable in any way. They provided their own consent and volunteered in the data collection.

Competing interests The authors declare no competing interests.

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