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Confirmatory Factor Analysis and Psychometric Validation of the Cognitive Fusion Questionnaire Among Emerging Adults in Pakistan

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ABSTRACT

The present study examined the factor structure, reliability, and construct validity of a five-item CFQ form in a sample of Pakistani emerging adults reporting varying levels of daily internet use. Confirmatory factor analysis (CFA) using maximum likelihood estimation was conducted on data from 800 Pakistani emerging adults (60.0% aged 16–23; 51.7% male; 81.3% rural) to test the previously established one-factor model of the CFQ. Analyses were conducted in IBM SPSS Statistics version 28 and JASP (Version 0.19.3). Contrary to prior cross-cultural findings, the hypothesized single-factor model demonstrated poor and, in part, statistically inadmissible fit to the data, $\chi^2(5) = 2539.38$, $p < .001$, CFI = .528, TLI = .056, RMSEA = .796, SRMR = .223, with two standardized loadings exceeding 1.0 (Heywood cases). Internal consistency was acceptable ($\alpha = .809$), yet the markedly unequal item loadings and large modification indices pointed to two latent item clusters rather than a single coherent factor. These findings diverge sharply from the excellent fit reported for the CFQ in other populations and raise important questions about the measurement equivalence, translation fidelity, and cultural applicability of the scale among Pakistani emerging adults with heavy internet engagement. Implications for scale adaptation, cross-cultural assessment of cognitive fusion, and future validation work are discussed.



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Introduction

The rapid diffusion of smartphones and low-cost mobile internet across South Asia has transformed how emerging adults in Pakistan study, socialize, and regulate their emotions, and it has also created fertile conditions for problematic patterns of internet use to take root. Heavy and unsupervised internet use is associated with disrupted sleep, academic and occupational impairment, and elevated psychological distress (Young, 1998). Within Pakistan specifically, technology overuse has been linked to disturbed sleep and physical inactivity even among clinical populations (Shahbal et al., 2022), and broader evidence from South and East Asian youth samples consistently ties heavy internet, smartphone, and social media use to loneliness, self-concept instability, academic burnout, and affect dysregulation (Wang et al., 2022; Yang et al., 2024). Despite this accumulating evidence, the psychological mechanisms that shape patterns of internet use in Pakistani emerging adults, particularly those rooted in how individuals relate to their own thoughts and urges rather than merely how much time they spend online, remain poorly understood.

A growing trans diagnostic literature situates cognitive fusion, a central process within the Acceptance and Commitment Therapy (ACT) model of psychopathology, as one such mechanism. Cognitive fusion refers to the tendency for verbal and cognitive processes to dominate behavioral regulation, such that thoughts (e.g., "I need to check my phone or something bad will happen") are responded to as literal truths rather than as passing mental events, at the expense of contextually sensitive, values-consistent action. The Cognitive Fusion Questionnaire (CFQ) was developed to provide a brief, trans diagnostic, and psychometrically robust measure of this process, and its original validation demonstrated a stable one-factor structure, excellent internal consistency, and sensitivity to defusion-based intervention across diverse non-clinical and clinical samples (Gillanders et al., 2014). Subsequent adaptations

of the CFQ in Chinese community-dwelling adults, Somali immigrant young adults, Argentinian community samples, and clinical populations with chronic medical and mood-related conditions have repeatedly reproduced this unidimensional structure with strong fit and loadings, lending the instrument a reputation for exceptional cross-cultural robustness.

At the same time, a parallel body of work links cognitive fusion's closely related construct, dispositional mindfulness, to compulsive digital behaviors. Trait mindfulness and related self-regulatory capacities have been shown to buffer against excessive smartphone and social media use through pathways involving rumination, self-regulatory fatigue, emotion regulation, and meaning in life (Chang et al., 2023; Jeong & Bae, 2024; Kong et al., 2025; Li et al., 2023; Liu et al., 2024; Wang et al., 2025). Mindfulness-based interventions, which explicitly target the same fusion-defusion continuum that the CFQ was designed to assess, have shown promise for reducing excessive internet gaming, mobile phone, and broader technology-related engagement (Choi et al., 2021; Fallah et al., 2025; Garland et al., 2022; Li et al., 2025; Rosenthal et al., 2021; Tang et al., 2025). Cognitive reappraisal, perfectionism, self-control, and future anxiety have similarly been implicated as mechanisms connecting mindfulness-related processes to problematic technology use across adolescent, university, and young employee samples (Chen et al., 2022; Giancola et al., 2024; Li, Lu et al., 2025; Li, Man et al., 2025; Zheng et al., 2025). Taken together, this literature suggests that the capacity to relate flexibly to one's own thoughts and urges, rather than becoming fused with them, is theoretically central to understanding how emerging adults relate to and engage with the internet, and that reliable, culturally valid measurement of cognitive fusion is a necessary precondition for this line of research to advance in South Asian contexts.

This precondition, however, has not yet been established for Pakistan. No published study has examined whether the factor structure, reliability, and measurement properties of the CFQ

generalize to Pakistani emerging adults, a population characterized by distinct linguistic norms, predominantly rural residence, comparatively lower average educational attainment, and rapidly rising rates of unsupervised internet access relative to the Western and East Asian samples in which the CFQ has previously been validated. Using an instrument whose psychometric behavior has not been verified in a given population risks systematic measurement error, biased estimates of association with related outcomes, and, ultimately, misleading conclusions for both research and practice, including the design of ACT-informed or mindfulness-based interventions (Rosenthal et al., 2021; Zainal & Newman, 2023). This gap constitutes the central problem addressed by the present study, and it directly motivates the rationale for undertaking a formal psychometric validation rather than assuming measurement equivalence with prior CFQ validation samples.

Study Purpose

Accordingly, the purpose of the present study was to conduct a confirmatory factor analysis (CFA) of the CFQ among a large sample of Pakistani emerging adults reporting varying levels of daily internet use, and to evaluate its model fit, standardized factor loadings, internal consistency (Cronbach's α), and convergent validity (average variance extracted) within this population. Based on the consistent unidimensional structure reported in prior cross-cultural validations of the CFQ (Gillanders et al., 2014; see also cross-cultural

replications in Chinese, Somali, Argentinian, and clinical European samples), it was hypothesized that the previously established one-factor model would demonstrate adequate fit and acceptable reliability in the Pakistani sample. Testing this hypothesis provides an essential empirical foundation for the use of the CFQ in future research examining cognitive fusion as a mechanism relevant to internet use, and more broadly as a target for ACT- and mindfulness-based interventions, among Pakistani emerging adults.

Research Methodology

Participants

The sample consisted of 800 emerging adults recruited from community and educational settings across Pakistan. Participants ranged from 16 to 30 years of age, with 60.0% ($n = 480$) falling in the 16–23 age band and 40.0% ($n = 320$) in the 24–30 age band. The sample was approximately balanced by gender (51.7% male, $n = 414$; 48.3% female, $n = 386$). The majority of participants were single (72.0%, $n = 576$), with 23.9% ($n = 191$) married. In terms of educational attainment, 45.6% ($n = 365$) had completed intermediate-level education, 28.0% ($n = 224$) matriculation, 20.9% ($n = 167$) undergraduate education, and 4.4% ($n = 35$) graduate education. Consistent with national demographic patterns, the sample was predominantly rural (81.3%, $n = 650$), with 18.8% ($n = 150$) residing in urban areas. Full demographic characteristics are presented in Table 1.

Table 1

Characteristic	Category	n	%
Age	16–23 years	480	60.0
	24–30 years	320	40.0
Gender	Male	414	51.7
	Female	386	48.3
Marital Status	Single	576	72.0
	Married	191	23.9
	Other/Unspecified	33	4.1
Education	Matriculation	224	28.0
	Intermediate	365	45.6
	Undergraduate	167	20.9
	Graduate	35	4.4
	Other/Unspecified	9	1.1
Residence	Rural	650	81.3
	Urban	150	18.8

Note. $N = 800$. Percentages for some categories do not sum to exactly 100% due to a small number of unspecified or miscoded responses in the original dataset.

Measures

Cognitive Fusion Questionnaire (CFQ).

Cognitive fusion was assessed using a five-item form of the CFQ (Gillanders et al., 2014), a self-report measure originally developed to assess the extent to which individuals are psychologically entangled with, and dominated by, the form and content of their own thoughts. Items are rated on a Likert-type scale, with higher composite scores reflecting greater cognitive fusion. The present study evaluated the psychometric performance of this item set (CFQ1–CFQ5) within a Pakistani sample; a full account of translation and adaptation procedures should accompany future reports of this dataset.

Internet use. Internet engagement was assessed via a single self-report item asking participants to indicate their average daily hours of internet use, categorized into ordinal bands (0 hours, less than 2 hours, 2–4 hours, 5–7 hours, 8 or more hours), consistent with operationalization's used in earlier internet use literature to distinguish light from

heavy users (Young, 1998). This item was used descriptively to characterize the sample rather than as a clinical or diagnostic measure.

Demographic questionnaire. Participants also reported their age, gender, marital status, education level, and residential setting (rural/urban).

Procedure

Data were collected using a structured, self-administered survey from emerging adults meeting the inclusion criteria (age 16–30 years, regular internet access). Participation was voluntary, and standard ethical procedures for informed consent and data confidentiality were followed. All variables were entered and screened in IBM SPSS Statistics prior to analysis.

Data Analysis

Descriptive and frequency analyses were conducted in IBM SPSS Statistics version 28 to characterize the sample. Prior to CFA, the factorability of the CFQ item matrix was evaluated

using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. Confirmatory factor analysis of the previously established single-factor CFQ model was then conducted in JASP (Version 0.19.3) using maximum likelihood (ML) estimation. Model fit was evaluated using the chi-square test of exact fit, the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Normed Fit Index (NFI), Root Mean Square Error of Approximation (RMSEA) with 90% confidence intervals, the Standardized Root Mean Square Residual (SRMR), and the Goodness of Fit Index (GFI), alongside the Akaike (AIC) and Bayesian (BIC) information criteria. Conventional interpretive thresholds were applied (CFI/TLI $\geq$.90–.95, RMSEA and SRMR $\leq$.06–.08, indicating good fit). Standardized factor loadings, squared multiple correlations (R^2), and residual variances were examined for each item, and modification indices were inspected to identify potential local

sources of misfit. Convergent validity was evaluated using average variance extracted (AVE $\geq$.50 considered acceptable), and reliability was assessed using Cronbach's alpha.

Results

Preliminary Analyses

The overall KMO measure of sampling adequacy was .594, at the lower boundary of the range conventionally considered "mediocre" for factor analysis, and item-level sampling adequacy was highly uneven: CFQ3 showed a markedly higher measure of sampling adequacy (MSA = .973) than the remaining four items, which ranged from .560 to .582 (Table 2). Bartlett's test of sphericity was statistically significant, $\chi^2 (10) = 5357.44$, $p < .001$, indicating that the item correlation matrix was not an identity matrix and that factor analysis was in principle appropriate, notwithstanding the modest overall KMO value.

Table 2

Indicator	MSA
CFQ1	0.560
CFQ2	0.579
CFQ3	0.973
CFQ4	0.562
CFQ5	0.582
Overall KMO	0.594

Note. KMO = Kaiser-Meyer-Olkin measure of sampling adequacy; MSA = measure of sampling adequacy.

Confirmatory Factor Analysis: Model Fit

The hypothesized one-factor model of the CFQ was tested against the observed covariance structure of the five items. The model chi-square was statistically significant, $\chi^2 (5) = 2539.38$, $p < .001$, and, more critically, the incremental and absolute fit indices fell far outside conventionally accepted ranges (Table 3). The CFI (.528), TLI (.056), NFI (.528), and related incremental indices indicated that the hypothesized factor model explained only marginally more covariance than a null (baseline) model. The RMSEA (.796, 90% CI [.770, .822]) and SRMR (.223) likewise indicated

very poor absolute fit, well beyond the upper bounds typically considered acceptable (RMSEA $\leq$.08; SRMR $\leq$.08). Hoelter's critical N, an index of the sample size at which the model's fit would be judged adequate, was extremely low (N = 4.49 at $\alpha = .05$; N = 5.75 at $\alpha = .01$), reinforcing that the poor fit reflected substantive model misspecification rather than an artifact of the large sample size (N = 800) inflating the chi-square statistic. Only the GFI (.919) suggested acceptable fit; this index is known to be less sensitive to model misspecification than CFI, TLI, or RMSEA and should be interpreted with caution here.

Table 3

Fit Index	Value	Recommended Cutoff
χ^2 (df = 5)	2539.38, $p < .001$	n.s. ($p > .05$) preferred
CFI	0.528	$\geq .90-.95$
TLI / NNFI	0.056	$\geq .90-.95$
NFI	0.528	$\geq .90$
RMSEA [90% CI]	0.796 [0.770, 0.822]	$\leq .06-.08$
SRMR	0.223	$\leq .08$
GFI	0.919	$\geq .90$
AIC	10283.72	lower is better (comparative)
BIC	10353.99	lower is better (comparative)

Note. χ^2 = chi-square test statistic; df = degrees of freedom; CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; NFI = Normed Fit Index; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual; GFI = Goodness of Fit Index; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion.

Factor Loadings and Item-Level Parameters

Standardized factor loadings were markedly heterogeneous across items (Table 4). CFQ1 ($\lambda = 1.343$) and CFQ4 ($\lambda = 1.359$) loaded at implausible magnitudes exceeding 1.0, a statistically inadmissible result (a "Heywood case") that typically signals model misspecification, near-collinearity between two indicators, or an under identified/over-simplified factor structure. Correspondingly, these two items showed very

high R^2 values (.968 and .993, respectively) and near-zero residual variances, indicating that the latent factor, as specified, was estimated almost entirely from these two indicators. In sharp contrast, CFQ2 ($\lambda = .356$), CFQ3 ($\lambda = .341$), and CFQ5 ($\lambda = .371$) loaded weakly on the same factor, with low R^2 values (.089-.098) and large residual variances, indicating that the single-factor model captured only a small proportion of their variance.

Table 4

Item	Standardized Loading (λ)	R^2	Residual Variance
CFQ1	1.343*	0.968	0.059
CFQ2	0.356	0.091	1.268
CFQ3	0.341	0.089	1.191
CFQ4	1.359*	0.993	0.013
CFQ5	0.371	0.098	1.262

Note. * Standardized loading exceeds the theoretical maximum of 1.0 (Heywood case), indicating an improper/inadmissible solution for this parameter. R^2 = squared multiple correlation.

Reliability and Convergent Validity

Internal consistency for the five-item scale, as conventionally computed, was acceptable

(Cronbach's $\alpha = .809$; Table 5). However, this estimate should be interpreted with caution: alpha assumes essential tau-equivalence across

items, an assumption clearly violated here given the highly unequal factor loadings reported above, in which CFQ1 and CFQ4 dominated the factor while CFQ2, CFQ3, and CFQ5 contributed comparatively little. Under such conditions, alpha can overestimate the true internal consistency of the scale. Average variance extracted was .515,

nominally exceeding the conventional .50 thresholds for convergent validity; however, in light of the improper (Heywood) loading estimates from which it was computed, this value should be interpreted with substantial caution rather than as evidence of sound convergent validity.

Table 5

Factor	Cronbach's α
Factor 1 (Cognitive Fusion)	0.809
Parameter	Value
Average Variance Extracted (AVE)	0.515

Note. α = Cronbach's alpha; AVE = average variance extracted.

Modification Indices

Inspection of modification indices for residual covariance's revealed two very large, theoretically suggestive values: a residual covariance between CFQ1 and CFQ4 (MI = 779.49, EPC = 10.199) and between CFQ2 and CFQ5 (MI = 762.71, EPC = 1.236), with smaller but still substantial residual associations between CFQ2 and CFQ3 (MI = 104.11) and CFQ3 and CFQ5 (MI = 102.08) (Table

6). This pattern is consistent with the loading results above and suggests that the five CFQ items may not behave as reflective indicators of a single, homogeneous latent construct in this sample; instead, the data are more consistent with two distinguishable item clusters (CFQ1/CFQ4 versus CFQ2/CFQ3/CFQ5), a possibility discussed further below.

Table 6

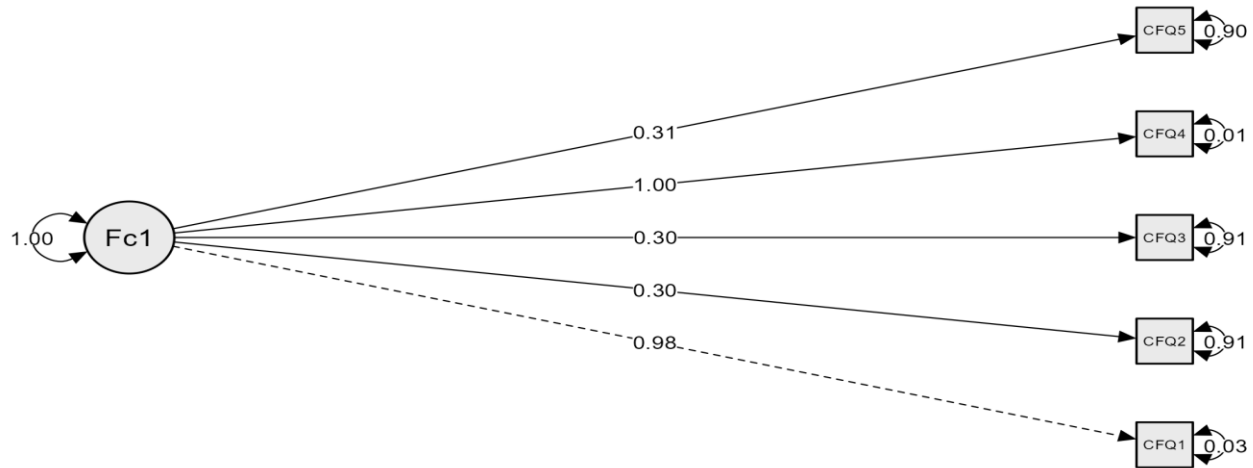
Residual Pair	Mod. Index	EPC
CFQ1 ↔ CFQ4	779.49	10.199
CFQ2 ↔ CFQ5	762.71	1.236
CFQ2 ↔ CFQ3	104.11	0.444
CFQ3 ↔ CFQ5	102.08	0.438

Note. MI = modification index; EPC = expected parameter change. Reported for descriptive purposes; no respecified model was estimated in the present study.

Path Diagram

Figure 1 presents the estimated one-factor CFA model, displaying the standardized factor loadings, residual variances, and factor variance for each of the five CFQ items. The diagram visually illustrates the disparity described above: CFQ4 ($\lambda = 1.00$) and CFQ1 ($\lambda = .98$, dashed path)

loaded at or near unity with correspondingly negligible residual variances (.01 and .03, respectively), while CFQ2, CFQ3, and CFQ5 loaded far more modestly ($\lambda = .30-.31$) with substantially larger residual variances (.90-.91), reinforcing that the factor was estimated almost entirely from two of the five indicators.

Figure 1

Note. Path diagram of the estimated one-factor CFQ model (Fc1) showing standardized factor loadings and residual variances for CFQ1–CFQ5. The dashed path (CFQ1) denotes a freely estimated loading approaching the same magnitude as CFQ4.

Discussion

The present study set out to establish whether the well-replicated one-factor structure of the Cognitive Fusion Questionnaire generalizes to Pakistani emerging adults reporting varying levels of internet use. Contrary to the study's hypothesis, and in marked contrast to prior validations of the CFQ in Chinese, Somali, Argentinian, Portuguese-speaking, and other clinical and non-clinical samples, the hypothesized single-factor model showed very poor fit and, for two items, produced statistically inadmissible standardized loadings. This pattern of results is not merely a matter of falling short of conventional fit cutoffs; it indicates a substantive breakdown of the assumed measurement model in this sample and warrants careful interpretation rather than acceptance of the scale in its current form for use with this population.

Several explanations are plausible. First, the marked asymmetry in loadings, with CFQ1 and CFQ4 behaving almost as duplicate indicators of a near-deterministic factor while CFQ2, CFQ3, and CFQ5 loaded weakly, together with the large modification indices linking CFQ1–CFQ4 and CFQ2–CFQ5, suggests that translation, back-translation, or cultural adaptation of specific items may have altered their meaning or redundancy

relative to the original English-language CFQ (Gillanders et al., 2014). Items that are worded similarly or reverse-scored can produce exactly this kind of method-effect signature when adaptation does not fully preserve semantic and psychometric equivalence across languages. Second, the markedly uneven item-level sampling adequacy observed in the preliminary KMO analysis, in which CFQ3 showed near-ceiling sampling adequacy while the remaining items were comparatively low, points toward heterogeneous response processes across items that a single unidimensional factor cannot adequately reconcile. Third, sample characteristics may have contributed: the present sample was predominantly rural (81.3%) and comprised largely of respondents with matriculation- or intermediate-level education, a very different composition from the university-educated and largely urban samples in which the CFQ has previously been validated (e.g., community and student samples in China, North America, and Argentina). Lower familiarity with abstract, metacognitive self-report items of the kind used in the CFQ (e.g., items describing one's relationship to one's own thoughts) may have introduced comprehension-related measurement noise that a simple one-factor model cannot

capture.

These findings should be considered against the broader literature linking fusion-adjacent constructs, such as trait mindfulness, rumination, and self-regulatory capacity, to problematic internet, smartphone, and social media use (Chang et al., 2023; Kong et al., 2025; Li et al., 2023; Wang et al., 2025; Yang et al., 2024). If cognitive fusion is to be used as a mechanism variable in future Pakistani research on internet use, whether as a mediator, moderator, or treatment target within ACT- or mindfulness-based interventions (Fallah et al., 2025; Garland et al., 2022; Rosenthal et al., 2021; Tang et al., 2025; Zheng et al., 2025), it is essential that the measurement instrument itself first be shown to behave coherently in this population. The present results indicate that, in its current five-item form and as administered here, the CFQ does not yet meet this threshold, underscoring the value of rigorous psychometric groundwork of the kind emphasized in validation studies of related constructs and measures (e.g., Judah et al., 2014, for the Attentional Control Scale; Baer et al., 2025, for the Five Facet Mindfulness Questionnaire) before substantive hypothesis testing proceeds.

The results also carry a broader methodological implication for cross-cultural psychometrics: strong fit in a scale's original validation, or even in several subsequent cross-cultural adaptations, does not guarantee measurement invariance in a new linguistic, educational, or socioeconomic context (Zainal & Newman, 2023). Formal validation, rather than direct translation and administration, remains a necessary first step whenever an instrument such as the CFQ, the Emotion Regulation Questionnaire (Gross & John, 2012), or the Five Facet Mindfulness Questionnaire (Baer et al., 2025) is introduced into a new population, particularly one as demographically distinct as the largely rural, lower-educational-attainment Pakistani emerging adult sample examined here.

Limitations

Several limitations qualify these findings. First, internet use was measured with a single self-

report item assessing average daily hours rather than a multi-item validated scale, limiting the ability to characterize participants' patterns of internet use in more nuanced or graded terms. Second, the cross-sectional design precludes any conclusion about temporal stability or the direction of association between cognitive fusion and internet use. Third, the sample, while large ($N = 800$), was a convenience sample and predominantly rural, which may limit generalizability to urban or more highly educated Pakistani emerging adults. Fourth, the study examined only five of the original CFQ items; the two omitted items may have provided additional information that would have altered the factor structure, and their absence should be considered when comparing these findings to prior seven-item validations. Finally, formal measurement invariance testing across gender, residence, and education level was not conducted and represents an important next step once a psychometrically sound baseline model has been established.

Implications and Future Directions

Before the CFQ is used substantively in Pakistani research or applied settings, we recommend (a) a formal translation and cognitive-interviewing study to evaluate item comprehension and semantic equivalence, particularly for CFQ1, CFQ4, and the item pair CFQ2/CFQ5 identified here as sources of local misfit; (b) re-estimation of the factor model using the full seven-item CFQ where available; (c) exploratory factor analysis to empirically examine whether a two-factor or bifactor structure better represents the data in this population before re-imposing a unidimensional model via CFA; and (d) measurement invariance testing across rural/urban residence and education level, given the demographic composition of the present sample. Only once a stable and theoretically coherent measurement model has been established should the CFQ be used to test substantive hypotheses linking cognitive fusion to internet use and to evaluate ACT- or mindfulness-based interventions among Pakistani emerging adults (Garland et al., 2022; Rosenthal et al., 2021; Schepers et al., 2025).

Conclusion

This study provides the first empirical examination of the Cognitive Fusion Questionnaire's factor structure among Pakistani emerging adults with varying levels of internet use. Rather than replicating the excellent unidimensional fit reported in prior cross-cultural validations, the hypothesized one-factor model showed very poor and, in part, statistically inadmissible fit, alongside evidence that the acceptable Cronbach's alpha estimate likely

masked substantial heterogeneity in item-level loadings. These findings caution against assuming the direct transportability of the CFQ to new cultural and linguistic contexts without prior validation, and they point to specific, actionable next steps, item-level cultural adaptation, exploratory restructuring, and measurement invariance testing, before the scale can be confidently used to advance research on cognitive fusion and internet use in Pakistan.

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