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MEASURING COMPULSIVE TEXTING: PSYCHOMETRIC PROPERTIES OF THE CTS IN A PORTUGUESE SAMPLE

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Abstract
Introduction: Compulsive texting refers to persistent and excessive texting behaviors that interfere with daily functioning and are often conceptualized within problematic mobile phone use. Valid instruments are needed to assess this construct in different cultural contexts. Aim: This study examined the psychometric properties of the Compulsive Texting Scale (CTS) in a Portuguese adult sample. Method: Factorial validity was tested through confirmatory factor analysis using the DWLS estimator. Reliability was assessed with Cronbach's alpha and McDonald's omega. Convergent and discriminant validity were evaluated using average variance extracted and inter-factor correlations. Measurement invariance across sex and schooling was examined through multi-group CFA with robust maximum likelihood estimation. Results: The CTS demonstrated a three-factor structure with good model fit and strong item loadings. Reliability indices were acceptable to strong across factors. Convergent validity was supported, although discriminant validity between Interference Tasks and Cognitive Preoccupation was limited. Measurement invariance was confirmed across sex and partially supported across schooling levels. Conclusion: The findings indicate that the CTS is a generally reliable and valid measure for assessing compulsive texting in Portuguese adults. Some subscales, particularly Concealment, may benefit from refinement. Future research should further strengthen discriminant validity and explore cultural considerations in compulsive texting assessment.

Keywords: compulsive texting; compulsive texting scale; psychological assessment; validation

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Introduction

Compulsive texting refers to a pattern of excessive, uncontrollable, and habitual texting behavior that can interfere with an individual's daily life, social relationships, and overall psychological well-being (Billieux et al., 2015; Lister-Landman et al., 2017). Unlike frequent or enthusiastic texting, compulsive texting is marked by a persistent sense of urgency, anxiety when not engaging in the behavior, and difficulty in reducing or stopping it - even when the individual is aware of its negative consequences (Throuvala et al., 2019).

Compulsive texting: psychological mechanisms, and consequences

Psychologically, compulsive texting is often viewed as a form of problematic mobile phone use or even as a behavioral addiction (Lu et al., 2011), particularly common in teens and young adults, though it can affect anyone (Panova & Carbonell, 2018). When individuals are unable to text, they may experience withdrawal-like symptoms, such as irritability, anxiety, or restlessness (Kardefelt-Winther, 2014; Lister-Landman et al., 2017). It may also be linked to traits such as impulsivity (Hussain et al., 2017), social anxiety, or an emotional reliance on digital communication for validation and connection (Harrison & Gilmore, 2012; Jiang & Zhao, 2016). In some cases, it reflects a deeper avoidance of direct interpersonal contact, as texting allows individuals to maintain a sense of connection while controlling the pace, tone, and content of interactions - something not possible in face-to-face communication (Panova & Lleras, 2016).

Over time, compulsive texting can lead to negative consequences. It often disrupts sleep due to late-night messaging and can increase overall anxiety or stress levels (Christensen et al., 2016; Thomee et al., 2011). Individuals may constantly check their phones for messages, even without notifications, and may feel anxious or irritable when unable to text. They may also neglect face-to-face interactions or daily tasks to stay engaged in messaging (Billieux et al., 2008). Texting during inappropriate times - such as while driving, in class, or late at night - is common, as is the need to text more frequently to feel satisfied (Rosen et al., 2013). This behavior may lead to loss of control, where attempts to cut back fail and texting interferes with responsibilities such as schoolwork, professional tasks, or in-person social interactions (Kardefelt-Winther, 2014). Compulsive texting can also serve as a form of mood regulation, used to cope with boredom, loneliness, or emotional distress because it provides immediate social stimulation and distraction from uncomfortable internal states (Montag, 2019).

This behavior is increasingly relevant, as it has been associated with poor academic performance, disrupted sleep, emotional dysregulation, and increased stress (Christensen et al., 2016; Murdock, 2013). It can also strain real-life relationships by prioritizing virtual interaction over face-to-face communication (Lu et al., 2014). Understanding and measuring compulsive texting - particularly through validated tools like the Compulsive Texting Scale (Lister-Landman et

al., 2017) - is therefore essential for identifying at-risk individuals and supporting healthier patterns of technology use. Underlying causes of compulsive texting include dopamine-driven reinforcement loops, where each message triggers a small dopamine release (Montag et al., 2019), fear of missing out (FOMO) (Przybylski et al., 2013), and its use as a coping mechanism for loneliness, anxiety, or low self-esteem (Panova & Lleras, 2016).

Cultural adaptation and validation of the Compulsive Texting Scale

The cross-cultural adaptation and validation of psychological instruments, such as the Compulsive Texting Scale (Lister-Landman et al., 2017), are essential to ensure conceptual and psychometric appropriateness within the Portuguese context (Beaton et al., 2000; Hedrih, 2020). Although these tools are often developed in different cultural environments, research consistently shows that patterns of mobile phone use - and the meanings attached to behaviors like compulsive texting - vary according to local language, social norms, and technology practices (Kuss et al., 2018; Lopez-Fernandez et al., 2017a).

Cultural adaptation and validation processes test whether a scale retains its intended structure, reliability, and construct validity, while ensuring that it accurately captures the lived experiences and specific challenges of the target population (Beaton et al., 2000; Hedrih, 2020; Gjersing et al., 2010). This is particularly relevant in Portugal, where smartphone penetration among adolescents and young adults is high, and where problematic digital behaviors are increasingly linked to declines in mental health and well-being (Elhai et al., 2020). Validated instruments like the Compulsive Texting Scale allow researchers to assess compulsive texting in a way that reflects the cultural context, enabling more precise identification of at-risk individuals and more effective intervention strategies (Elhai et al., 2020; Lister-Landman et al., 2017; Roberts et al., 2014).

The availability of culturally sensitive and psychometrically robust tools supports both clinical and educational initiatives aimed at early detection and prevention of problematic technology use (Elhai et al., 2020; Hedrih, 2020). It also facilitates participation in international research, allowing for meaningful cross-cultural comparisons that can uncover both universal and culture-specific aspects of digital behavior (Lopez-Fernandez, 2017a; Lopez-Fernandez et al., 2017b). Recent Portuguese adaptations of scales for social media addiction and phubbing further illustrate the importance and feasibility of these processes (Leite et al., 2023; Mendes et al., 2022).

Objective

The present study aims to validate the Compulsive Texting Scale (CTS; Lister-Landman et al., 2017) for the Portuguese population, examining its psychometric properties, including factor structure, reliability, and construct validity. By doing so, this study seeks to enhance the scientific rigor of

psychological assessment in Portugal and contribute to a broader understanding of compulsive texting within this cultural context (Twenge & Campbell, 2019).

Method

Participants

The sample consisted of 648 participants, predominantly women (75.8%), with a mean age of 25.07 years (SD=5.55). Most participants had completed secondary (37.0%) or higher education (45.7%) and lived with both parents (82.7%). A majority did not engage in regular physical exercise (61.0%), and among those who did, the average frequency was 3.60 times per week. Most participants were non-smokers (79.8%), and smokers reported consuming an average of 8.34 cigarettes per day. Regarding digital behavior, nearly all participants had internet access at home (99.5%), and 95 owned more than one mobile phone (14.7%). Participants reported varying levels of daily text messaging, with a mean of 2.55 messages (SD=1.81).

Measures

Participants responded to a sociodemographic questionnaire that gathered information on their age, gender, educational background, and health-related behaviors, including physical activity and smoking habits.

The Compulsive Texting Scale (Lister-Landman et al., 2017) is unifactorial and includes 14-item self-report measures that assess problematic texting behaviors. Items are rated on a 5-point Likert scale ranging from 1 (not at all true) to 5 (completely true), with higher scores indicating greater levels of compulsive texting behavior. The original scale demonstrated good internal consistency with Cronbach's alpha of .86 (Lister-Landman et al., 2017).

For this study, the CTS was translated into Portuguese following a rigorous translation-back translation procedure. Two bilingual researchers independently translated the scale from English to Portuguese, and discrepancies were resolved through discussion. A third bilingual researcher back-translated the Portuguese version into English. The back-translated version was compared with the original English version to ensure conceptual equivalence. Adjustments were made until the final Portuguese version was deemed equivalent to the original.

Procedure

This study received ethical approval from the Scientific Board of the Ethics Committee of the Universidade Católica Portuguesa (Conselho Científico; reference UCP2024/RS046). All procedures complied with the principles outlined in the latest revision of the Declaration of Helsinki (World Medical Association, 2013).

Before participation, individuals were informed about the study's objectives, procedures, potential risks and benefits, and the voluntary nature of their involvement. They were assured that refusal or withdrawal would carry no negative consequences and that they could discontinue participation at any time.

Written informed consent was obtained from all participants, with information presented in clear and accessible language to ensure genuine understanding and autonomous decision-making.

To protect privacy and confidentiality, all data were anonymized and stored securely in accordance with the General Data Protection Regulation (GDPR; European Parliament & Council of the European Union, 2016). The protocol included detailed procedures for data handling, storage, and participants' rights regarding the use and withdrawal of their data. Ethical oversight was maintained throughout the study, with the ethics committee retaining authority to monitor the research process and review any protocol amendments, in line with international ethical standards.

Participants were recruited through convenience sampling using university networks and social media platforms. Eligibility criteria required participants to be at least 18 years old, reside in Portugal, have owned a smartphone for at least six months, and possess sufficient Portuguese proficiency to complete the survey.

Data were collected between December 2024 and February 2025 using an online Qualtrics survey. Completion time averaged 20-25 minutes. The survey included sociodemographic questions and the Portuguese-translated version of the Compulsive Texting Scale (CTS). To ensure data quality, attention-check items were embedded throughout the questionnaire.

Data analysis

All statistical analyses were carried out using R (version 4.3.2; R Core Team, 2023). Descriptive metrics - including means, standard deviations, skewness, and kurtosis - were obtained using the skimr package (Waring et al., 2023). To examine the factorial validity of the measurement model, a confirmatory factor analysis (CFA) was conducted with the lava an package (Rosseel, 2012), employing Diagonally Weighted Least Squares (DWLS), which is suitable for analyzing non-severe non-normally distributed ordinal data (Marôco, 2024). Model fit was evaluated using multiple indices: the Comparative Fit Index (CFI; Bentler, 1990), Tucker-Lewis Index (TLI; Tucker & Lewis, 1973), Root Mean Square Error of Approximation (RMSEA; Steiger, 1990), and Standardized Root Mean Square Residual (SRMR). According to established benchmarks (Bentler, 1990; Marôco, 2021), acceptable model fit was indicated by CFI and TLI values $\geq .90$, RMSEA $< .06$, and SRMR $< .08$.

Internal consistency reliability was estimated using both Cronbach's alpha and McDonald's omega, computed via the semTools package (Jorgensen et al., 2021). Reliability coefficients were deemed acceptable when α and ω were equal to or exceeded .70 (Marôco, 2021). Convergent validity was assessed through the Average Variance Extracted (AVE), with values above 0.50 considered adequate (Fornell & Larcker, 1981). Discriminant validity was evaluated by verifying that the square root of the AVE for each construct surpassed the correlations between latent factors (Fornell & Larcker, 1981).

To test measurement invariance across groups, multi-group CFA was conducted using the robust maximum likelihood estimator implemented in lavaan. That estimator is suitable for ordinal bell-shaped data (Marôco, 2024) and, contrary to DWLS, does not require data in each item category per group. The assessment followed a hierarchical procedure, testing configural, metric, and scalar invariance as outlined by Cheung and Rensvold (2002) and further detailed in Marôco (2021). Invariance was supported when changes in chi-square ($\Delta\chi^2$) were not statistically significant and when changes in fit indices were within acceptable thresholds (ΔCFI $\leq$ .010 and ΔRMSEA $\leq$ .015).

Results

Item descriptives

Table 1 presents descriptive statistics for the observed variables included in the measurement model. The means ranged from 1.16 (A14) to 2.57 (A4), with standard deviations indicating moderate variability. Visual inspection of the histograms suggests distributions are generally right-skewed, with some items showing floor effects (*e.g.*, A14, A13). Most skewness values were below 3, and kurtosis values below 7, suggesting no severe violations of univariate normality (Kline, 2015). Although A13 (Sk=2.77, Ku=7.99) slightly exceed these thresholds, the use of robust estimators in CFA (*e.g.*, MLR) mitigates concerns. That was not the case of A14 (Sk=4.11, Ku=20.48) which strong violation of the normality assumption and poor psychometric sensitivity recommend against keeping the item in further analysis. However, since the Conceal has only three indicators, we kept item A14 signaling it for further psychometric studies with different samples (see further on discussion). These results support the appropriateness of the overall dataset for confirmatory factor analysis and tests of measurement invariance.

Table 1. Descriptive statistics for observed indicators (n=648)

Item	M	SD	Min	P25	Med	P75	Max	Skewness	Kurtosis	Histogram
A1	1.56	0.78	1	1.00	1.00	2.00	5	1.28	1.03	
A2	2.19	1.16	1	1.00	2.00	3.00	5	0.67	-0.51	
A3	1.62	0.90	1	1.00	1.00	2.00	5	1.51	1.98	
A4	2.57	1.15	1	2.00	2.00	3.00	5	0.35	-0.71	
A5	2.12	1.14	1	1.00	2.00	3.00	5	0.83	-0.12	
A6	1.83	1.00	1	1.00	2.00	2.00	5	1.10	0.54	
A7	1.66	0.96	1	1.00	1.00	2.00	5	1.51	1.73	
A8	1.41	0.72	1	1.00	1.00	2.00	5	1.99	4.49	
A9	1.62	0.90	1	1.00	1.00	2.00	5	1.49	1.65	
A10	1.29	0.67	1	1.00	1.00	1.00	5	2.58	6.81	
A11	1.62	0.96	1	1.00	1.00	2.00	5	1.62	2.03	

Table 1. Descriptive statistics for observed indicators (n=648)

Item	M	SD	Min	P25	Med	P75	Max	Skewness	Kurtosis	Histogram
A12	1.79	1.09	1	1.00	1.00	2.00	5	1.34	0.98	
A13	1.28	0.68	1	1.00	1.00	1.00	5	2.77	7.99	
A14	1.16	0.49	1	1.00	1.00	1.00	5	4.11	20.48	

Evidence of validity related to internal structure

A confirmatory factor analysis (CFA) was conducted to assess the measurement model. All standardized factor loadings were statistically significant at p <.001, indicating good convergent validity (Table 2). Items A1 through A9 loaded significantly onto the latent factor InterfTasks, with loadings ranging from .627 to .808. Similarly, items A6 to A11 loaded onto CognPreoc, with loadings between .623 and .808. Finally, items A12 to A14 loaded on Conceal, showing strong loadings (.660 to .931). The overall fit of the measurement model was assessed using several standard indices of model fit. The chi-square test was statistically significant, $\chi^2(74)=345.94$, $p<.001$, which is common in models with larger samples and does not alone indicate poor fit (Marôco, 2021). The Comparative Fit Index (CFI=0.964), Tucker-Lewis Index (TLI=0.956), and Normed Fit Index (NFI=0.955) all exceeded the commonly accepted cutoff of .95, indicating excellent fit (Hu & Bentler, 1999; Marôco, 2021). The Standardized Root Mean Square Residual (SRMR=0.055) was below the recommended threshold of .08, further supporting good fit. The Root Mean Square Error of Approximation (RMSEA=0.075; 90% CI]0.067, 0.083) was slightly above the ideal threshold of .06, but within an acceptable range (Browne & Cudeck, 1992). Taken together, these indices support the conclusion that the model demonstrates an acceptable to good overall fit to the data.

Table 2. Standardized factor loadings for the measurement model

Latent Factor	Indicator	β	SE	Z	p
InterfTasks	A1	.663	.071	12.43	<.001
InterfTasks	A2	.746	.071	15.76	<.001
InterfTasks	A3	.761	.081	14.43	<.001
InterfTasks	A4	.627	.058	13.92	<.001
InterfTasks	A5	.654	.065	13.28	<.001
InterfTasks	A9	.808	.106	12.97	<.001
CognPreoc	A6	.749	.081	13.96	<.001
CognPreoc	A7	.623	.069	11.58	<.001
CognPreoc	A8	.700	.083	11.76	<.001
CognPreoc	A10	.780	.124	10.06	<.001
CognPreoc	A11	.808	.109	12.59	<.001
Conceal	A12	.660	.083	10.56	<.001
Conceal	A13	.889	.220	8.85	<.001

Table 2. Standardized factor loadings for the measurement model - *continued*

Latent Factor	Indicator	β	SE	Z	p
Conceal	A14	.931	.497	5.13	<.001

Note: Standardized factor loadings (β), standard errors (SE), Z-values, and significance levels are reported for each indicator. InterfTasks (Interfering Tasks), CognPreoc (Cognitive Preoccupation), and Conceal (Concealment).

Evidence of convergent and discriminant validity

To evaluate construct validity, both convergent and discriminant validity were assessed using the Fornell-Larcker criterion (Fornell & Larcker, 1981). The square roots of the Average Variance Extracted (AVE), presented on the main diagonal of the matrix (Table 3), were squared to obtain the AVE values. Results indicated that Interference Tasks had an AVE of 0.527, Cognitive Preoccupation had an AVE of 0.558, and Concealment had an AVE of 0.787. As all three values exceed the conventional threshold of 0.50, these findings support adequate convergent validity for each construct.

In contrast, discriminant validity was not fully supported. According to the Fornell-Larcker criterion, each construct's √AVE should be greater than its correlations with other constructs. However, the correlation between Interference Tasks and Cognitive Preoccupation was 0.934, which exceeds both of their √AVE values (0.726 and 0.747, respectively), indicating substantial conceptual overlap. Similarly, Concealment was highly correlated with both Interference Tasks (r=0.830) and Cognitive Preoccupation (r=0.842), and although these correlations were slightly below Concealment's √AVE of 0.887, the margins were narrow. These results suggest that discriminant validity is particularly problematic between Interference Tasks and Cognitive Preoccupation, and may also be questionable with respect to Concealment, warranting empirically support for an overall compulsive texting second order factor.

A second-order CFA with Compulsive Texting reflected on the first order Interference Task, Cognitive preoccupation and Concealment was fitted to the data. Figure 1 shows the standardized factor loadings for the second order and first order constructs.

Table 3. Fornell-Larcker matrix for latent constructs

	Interf. Tasks	Cognitive Preoc.	Concealment
Interf. Tasks	0.726		
Cognitive Preoc.	0.934	0.747	
Concealment	0.830	0.842	0.887

Note: Main diagonal: √AVE; Off-diagonal: latent factor correlations.

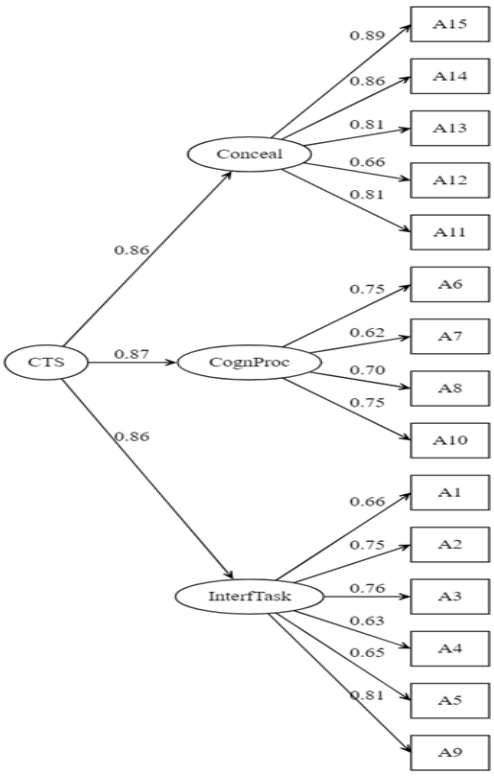

Figure 1. Standardized loadings for the second order factor model of CTS (reflected on Conceal, CognProc, and InterfTask) and observed variables (A1-A15) (CFI=0.964, TLI=0.956, NFI=0.955, SRMR=0.055, RMSEA=0.075, IC 90% RMSEA=[0.067; 0.083])

Internal consistency

Table 4 presents the reliability estimates for the first-order latent factors in the measurement model. Internal consistency was assessed using Cronbach's α, McDonald's ω, and Average Variance Extracted (AVE). The CTS factor demonstrated excellent reliability with a Cronbach's α of .91. Interf. Tasks showed good reliability (Cronbach's α=.80, McDonald's ω=.82, AVE=.53), as did Cognitive Pre. (Cronbach's α=.76, McDonald's ω=.79, AVE=.56). Concealment exhibited acceptable reliability with a Cronbach's α of .60 and McDonald's ω of .71, though its AVE was notably higher (.79), indicating strong convergent validity despite the lower internal consistency estimates. The second order CTS also displayed excellent reliability (ωL1=.91).

Table 4. Reliability estimates for first-order latent factors (Interf Tasks, CognitivePre, Concealmente) and second order CTS

Factor	Cronbach's α	McDonald's ω	Average Variance Extracted (AVE)
Interf. Tasks	0.795	0.815	0.527
Cognitive Pre.	0.758	0.785	0.558
Concealment	0.600	0.706	0.787
CTS		0.910	

Measurement invariance for sex and education

The analysis of measurement invariance across sex groups and schooling groups is presented in Table 5. The analysis of measurement invariance across sex groups indicated strong support for configural invariance ($\chi^2(148)=575.031$, CFI=0.876, RMSEA=0.094), demonstrating that the underlying factor structure remains consistent across groups. Metric invariance was also upheld, with non-significant differences in factor loadings ($\Delta\chi^2(11)=11.537$, p=0.399, ΔCFI=-0.002, ΔRMSEA=-0.002), suggesting comparable relationships between latent constructs and observed variables. The scalar invariance test yielded a non-significant chi-square change ($\Delta\chi^2(11)=17.471$, p=.095, ΔCFI=-0.002, ΔRMSEA=-0.002), indicating that item intercepts remain stable across sex groups. However, the test for means invariance showed significant differences ($\Delta\chi^2(3)=11.431$, p=.010) that were not confirmed by ΔCFI=0.003, ΔRMSEA=0.000. These results suggest potential variation in latent mean scores between sexes that warrants further investigation.

For schooling, configural invariance was supported ($\chi^2(148)=549.127$, CFI=0.883, RMSEA=0.091), confirming that the measurement structure is consistent across groups. However, metric invariance showed a significant chi-square difference ($\Delta\chi^2(11)=22.285$, p=.022) but only trivial ΔCFI=-0.008, ΔRMSEA =0.000) in factor loadings. Likewise, scalar invariance was not fully supported, as item intercepts significantly differed ($\Delta\chi^2(11)=26.351$, p=.006) but changes were trivial (ΔCF =-0.004, ΔRMSEA=-0.002), suggesting that response patterns are similar on educational background. Means invariance testing showed non-significant differences ($\Delta\chi^2(3)=6.228$, p=0.101, ΔCFI=0.001, ΔRMSEA=0.000), implying that latent mean scores remain relatively stable across education levels despite assuming invariance of factor loadings and intercepts. These findings suggest that measurement invariance across educational levels may be partially constrained, highlighting the need for further exploration of group-specific variations in item responses.

Table 5. Analysis of invariance for sex and schooling

Model	Df	χ^2	$\Delta\chi^2$	Δdf	P[$\Delta\chi^2(\Delta df)\geq\Delta\chi^2$]	CFI	RMSEA	ΔCFI	ΔRMSEA
Sex (1-M, 2- F)									
Config	148	575.031	-	-	-	0.876	0.094	-	-
Metric	159	594.428	11.537	11	0.399	0.874	0.092	-0.002	-0.002
Scalar	170	611.397	17.471	11	0.095	0.872	0.090	-0.002	-0.002
Means	173	623.368	11.431	3	0.010	0.872	0.090	0.003	0.000
Schooling (1-Secondary, 2-Higher)									
Config	148	549.127	-	-	-	0.883	0.091	-	-
Metric	159	587.601	22.285	11	0.022	0.875	0.091	-0.008	0.000
Scalar	170	612.748	26.351	11	0.006	0.871	0.090	-0.004	-0.002
Means	173	620.778	6.228	3	0.101	0.871	0.090	0.001	0.000

Note: $\Delta\chi^2$ are corrected with Santorra-Bentler correction for skewness and kurtosis

Discussion

The descriptive statistics indicated generally low item means, suggesting that problematic texting behaviors were not widely endorsed in this Portuguese sample. This pattern is consistent with prior research showing that compulsive or socially undesirable digital behaviors often display floor effects in community samples (DeVellis & Thorpe, 2021; Tourangeau & Yan, 2007). Items A13 and A14, which assess secretive or inappropriate texting, were particularly right-skewed, reflecting the rarity of these behaviors. Similar distributional issues have been reported in other adaptations of compulsive or addictive technology-use scales, where concealment-related items tend to be endorsed only by a small subset of users (*e.g*., Lopez-Fernandez et al., 2017a).

Although most items met Kline's (2015) criteria for univariate normality, item A14 clearly violated these assumptions. This mirrors findings from other behavioral-addiction instruments, where items capturing socially sensitive behaviors often show non-normality but remain theoretically essential (Brown, 2015). Retaining A14 was therefore justified to preserve the structural integrity of the Concealment factor, especially given the use of robust estimation (MLR), which tolerates non-normality (Muthén & Muthén, 2017). Future studies should nonetheless examine whether this item performs similarly across different Portuguese subpopulations.

The Confirmatory Factor Analysis (CFA) demonstrated excellent fit, supporting the original three-factor structure - Interference Tasks, Cognitive Preoccupation, and Concealment - proposed by Lister-Landman et al. (2017). This aligns with previous validations in other cultural contexts, which also found strong loadings and clear differentiation of these dimensions (*e.g*., Roberts et al., 2014; Lopez-Fernandez et al., 2017a). Notably, Concealment items (A12-A14) showed particularly high loadings (up to β=.931), suggesting that concealment represents a distinct and potent component of compulsive texting in Portugal. However, the strong loading of A14 must be interpreted cautiously due to its distributional limitations (Byrne, 2016). This pattern - high loading but low variance - is common in items capturing secretive or socially sensitive digital behaviors (DeVellis & Thorpe, 2021).

Convergent validity was robust, with AVE values exceeding .50 for all factors (Fornell & Larcker, 1981; Sarstedt et al., 2022). However, discriminant validity was less satisfactory. Interference Tasks and Cognitive Preoccupation showed substantial overlap, replicating findings from earlier studies where cognitive and behavioral manifestations of compulsive texting were also highly correlated (Lister-Landman et al., 2017). This overlap suggests that, in practice, difficulties managing texting behavior and persistent preoccupation with messaging may be intertwined experiences rather than fully distinct constructs. Concealment also correlated strongly with the other factors, though slightly below its √AVE, indicating marginal discriminant validity.

These results support conceptualizing compulsive texting as a second-order construct, consistent with theoretical models of problematic technology use that emphasize a unified underlying mechanism (Marsh et al., 2014; Brown, 2015). The second-order CFA replicated the excellent fit of the first-order model, reinforcing the hierarchical structure and offering a more parsimonious representation of the phenomenon.

Reliability estimates were strong for the overall scale (ω=.91) and for the Interference Tasks and Cognitive Preoccupation subscales, aligning with reliability levels reported in previous CTS validations (Lister-Landman et al., 2017). The Concealment subscale showed high AVE but lower α (.60), likely due to its small number of items and the problematic distribution of A14 (Raykov, 2001). This pattern is not uncommon in short subscales assessing sensitive behaviors and suggests that Concealment may benefit from item refinement or expansion in future Portuguese studies.

Measurement invariance analyses provided further insight into the scale's robustness. Configural, metric, and scalar invariance across sex indicate that the CTS measures the same constructs equivalently for men and women, enabling meaningful comparisons (Milfont & Fischer, 2010). The observed differences in latent means - women scoring higher - mirror international findings linking compulsive texting to social anxiety, FOMO, and relational needs, which tend to be more pronounced among women (Lister-Landman et al., 2017; Morrill et al., 2013; Zhu et al., 2024). This convergence strengthens the argument that compulsive texting is influenced by gendered patterns of digital communication.

For education, partial invariance was supported. Although $\Delta\chi^2$ suggested minor deviations in metric and scalar invariance, ΔCFI and ΔRMSEA remained within acceptable limits (Cheung & Rensvold, 2002). This indicates that the CTS is largely comparable across educational levels, though subtle differences in item interpretation may exist. These findings echo previous cross-cultural adaptation studies showing that educational background can influence how individuals interpret technology-related items (Beaton et al., 2000; Lopez-Fernandez et al., 2017b).

Conclusions

Overall, the Portuguese CTS demonstrates strong structural validity, reliability, and theoretical coherence. While convergent validity and model fit are excellent, future research should refine the Concealment subscale and further explore discriminant validity. The present study expands the international literature by offering a culturally adapted, psychometrically sound tool for assessing compulsive texting in Portugal, enabling more accurate research, prevention, and intervention efforts in a population with high digital engagement.

Theoretical and practical implications

This study contributes several important insights. First, it provides the first validated Portuguese version of the CTS, filling a critical gap in the assessment of compulsive texting within a cultural context characterized by high smartphone penetration and intensive digital communication among youth. Second, the confirmation of a second-order structure advances theoretical understanding by framing compulsive texting as a unified construct with interrelated cognitive, behavioral, and concealment components. This supports contemporary models of problematic technology use that emphasize multidimensional yet integrated mechanisms (Marsh et al., 2014).

Third, the partial issues with discriminant validity highlight the blurring boundaries between preoccupation, interference, and secrecy in real-world texting behavior. This suggests that compulsive texting may manifest as a holistic experience rather than discrete domains, an interpretation consistent with qualitative accounts of digital overuse.

Finally, the invariance findings underscore the CTS's utility for comparing groups, while also pointing to meaningful sex differences and subtle educational influences. These patterns align with broader literature on gendered digital behavior and the role of sociocultural factors in shaping technology use.

Limitations and future research directions

Despite the strengths of this study, several limitations should be acknowledged to guide interpretation and inform future research. First, although the Portuguese version of the CTS demonstrated strong structural validity and reliability, some items - particularly A14 - showed problematic distributional properties, including pronounced skewness and floor effects. These issues are common in measures assessing socially sensitive or infrequent behaviors, yet they may limit the item's sensitivity and reduce the precision of the Concealment subscale. Future studies should examine alternative formulations of this item or consider expanding the Concealment dimension to improve reliability and capture a broader range of concealment-related behaviors.

Second, although convergent validity was robust, discriminant validity between Interference Tasks and Cognitive Preoccupation was limited. This overlap suggests that, in practice, cognitive and behavioral manifestations of compulsive texting may be difficult to disentangle. While this supports the second-order conceptualization of compulsive texting, it also indicates that the current item pool may not fully differentiate these constructs. Future research should explore whether additional or revised items can better distinguish these dimensions or whether a more integrated conceptual model is theoretically preferable.

Third, measurement invariance was largely supported across sex but only partially supported across educational levels. Although ΔCFI and ΔRMSEA indicated acceptable invariance, minor deviations in factor loadings and intercepts suggest that individuals with different educational backgrounds may interpret certain items differently. Future research should replicate invariance

testing in more socioeconomically diverse samples and explore whether cultural or linguistic nuances influence item interpretation.

Fourth, the study relied on convenience sampling and self-report measures, which may introduce selection bias and social desirability effects. Participants were predominantly young adults with high digital engagement, which aligns with the population most likely to exhibit compulsive texting behaviors but limits generalizability to older adults or individuals with lower technology use. Future studies should employ probability sampling or targeted recruitment strategies to capture a broader demographic range.

Fifth, the cross-sectional design prevents conclusions about causality or temporal dynamics. Compulsive texting is likely influenced by fluctuating psychological states, interpersonal contexts, and situational stressors. Longitudinal or experience-sampling designs would allow researchers to examine how compulsive texting unfolds over time and how its cognitive, behavioral, and concealment components interact in daily life.

Finally, although this study focused on psychometric validation, future research should explore the CTS's predictive validity. For example, examining whether CTS scores predict academic impairment, sleep disruption, interpersonal conflict, or mental health outcomes would strengthen the scale's applied relevance. Cross-cultural comparisons would also be valuable, particularly given the rapid evolution of digital communication norms and the cultural specificity of texting behaviors.

Ethics statement

This study received ethical approval from the Scientific Board of the Ethics Committee of the Universidade Católica Portuguesa (Conselho Científico; reference UCP2024/RS046). All procedures complied with the principles outlined in the latest revision of the Declaration of Helsinki (World Medical Association, 2013).

Conflicts of interest

The authors declare no conflict of interest.

Author contributions

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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