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The abstinence from smartphone scale (ABSS-10): Psychometric properties and practical utility

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ABSTRACT

In order to frame excessive smartphone use as an addiction, it is important to understand whether this behavior determines abstinence symptoms and which damaging effect it has on emotions and cognition. However, an appropriate tool to assess the presence of smartphone abstinence symptoms is still lacking. In the present study, we propose a scale that is specifically developed to assess the psychological state deriving from smartphone abstinence: The Abstinence from Smartphone Scale (ABSS-10). The aim of this work is to validate ABSS-10 and to investigate its relevance in the context of smartphone addiction. Two studies were conducted to explore ABSS-10 psychometric properties, focusing on discriminant validity, and its relationship with smartphone dependence and emotional attachment. In Study 1, university students were administered the ABSS-10 two times during a two and a half-hour long smartphone restriction period. In Study 2, the scale was administered three times during a five-hour long smartphone restriction period. General state anxiety and smartphone dependence scales were also administered. The findings reveal that ABSS-10 effectively differentiates smartphone abstinence symptoms from general state anxiety and dependence. Moreover, results show that the scale detects changes in abstinence symptoms scores during a five-hour restriction period. The scale's utility in both research and practical settings is discussed, highlighting its potential contributions to understanding the psychological dynamics of smartphone use and abstinence. The present work suggests that ABSS-10 is a robust tool for research on the psychological effects of smartphone usage.

1. Introduction

Smartphones have become an integral part of our lives, replacing many other electronic devices that were widely used before their introduction. For instance, nowadays people can watch TV shows, check the weather, take pictures and chat with friends using just one device. This leads people to be connected most of the time and to have difficulties with being separated from their smartphones. This holds significant relevance, especially given recent reports indicating that the worldwide count of mobile Internet users hit 5.4 billion in 2023. Additionally, social media engagement stands out, with approximately 4.89 billion users globally in 2024, dedicating an average of 151 min daily to this activity (Statista Search Department, 2024). The growth of this tendency, aggravated by the introduction of social media, has led researchers from various field to study the potential negative consequences of excessive smartphone use.

Although there is no consensus over the definition of "excessive" or "problematic" smartphone use (Harris et al., 2020), it could be described as a difficulty with regulating one's use of smartphones that leads to negative consequences for the individual, impairing normal functioning and causing distress (Billieux, 2012). Documented negative consequences of this behaviour involve both physical and mental health (Wacks & Weinstein, 2021). On the physical level, excessive smartphone use is linked with reduced sleep time and quality (Ali et al., 2019),

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headache (Montagni et al., 2016), and other forms of chronical pain (Kim et al., 2016; Zhuang et al., 2021). On the mental level, this behaviour is associated with depression and anxiety (Demirci et al., 2015; Elhai et al., 2018) and negatively correlated with psychological well-being in general (Pera, 2020).

Numerous instruments have been designed to assess problematic smartphone use, considering the negative impact on individuals' daily lives, with the aim of identifying those who are severely affected by overuse. Harris et al. (2020) conducted a review of the instruments used to assess smartphone addiction and problematic smartphone use. Specifically, they identified 13 scales (see Table 1 in Harris et al., 2020) that shared Problematic Smartphone Use as an underlying construct. One of the main findings of this review was that, despite the proliferation of self-assessment scales, many are lacking in terms of consistent internal structure and long-term reliability, lacking a solid theoretical basis. Among the instruments for assessing problematic use of smartphones, the most prominent are the Mobile Phone Problem Use Scale - Short Version (MPPUS-10; Foerster et al., 2015) and the Problematic Use of Mobile Phones (PUMP; Merlo et al., 2013), which investigate various dimensions such as addiction, tolerance, social withdrawal and negative impact on users' daily lives.

The physical and emotional attachment that humans have towards smartphones may depend on the utility of this device, which provides access to information, social interaction, and enhances perceived safety (Aoki & Downes, 2003). One of the possible reasons why people are so attached to their smartphone might be the so-called "fear of missing out" (FoMO). This term refers to the worry of missing on events and experiences happening within our social circle when we cannot engage with it (Przybylski et al., 2013). More related to smartphones, the term "Nomophobia" (no-mobile-phone phobia) has been proposed to refer to the pathological fear of not being able to access communication devices in general (King et al., 2013).

The exaggerated attachment that people have towards smartphones also leads to negative consequences on their cognitive performance (for a review, see Wilmer et al., 2017). It is renowned that smartphones can cause distraction while performing ongoing tasks. For this reason, the use of smartphones is forbidden during high-demanding everyday activities such as driving, operating machines, and performing particular jobs. However, it has been observed that smartphones can impair performance even when they are not used actively. The phenomenon of "brain drain", described by Ward et al. (2017), indicates that the mere smartphone's presence in proximity of participants performing cognitive tasks can impair their performance. Similarly, simply receiving a notification, without actively interacting with the smartphone, has an attentional cost on task performance (Stothart et al., 2015).

The detrimental effects of excessive smartphone use call for a better understanding of smartphone addiction. This phenomenon presents similarities with Internet Gaming Disorder (IGD) and gambling (Kwon, Kim, et al., 2013; Young, 1998), which have been grouped together in the ICD-10 (World Health Organization [WHO], 2018) as behavioural addictions. Although smartphone addiction disorder is not recognised in psychiatry textbooks, screening studies estimate that the incidence of smartphone addiction ranges from just above 0%–35%, with one study reporting that 48% of university students are addicted to smartphones (Aljomaa et al., 2016). The most frequent range of incidence is between 10% and 20% (see Billieux et al., 2015; Carbonell et al., 2012 for a review). However, most of these studies use self-report measures, relying on the accuracy of users' perceptions of their use, and each study employs different methods and questionnaires to determine the presence of addiction.

While some similarities between excessive smartphone use and other forms of substance-related addictions have been identified, it must be clarified that the consequences of problematic smartphone use are generally not as harmful as those of addictions related to substances such as alcohol or drugs. Indeed, there is no sufficient documentation that problematic smartphone use causes significant functional impairment and severe physical consequences to the extent that substance-related addictions do (Panova & Carbonell, 2018). Moreover, there is limited evidence that problematic smartphone use can induce a crucial component of addiction, namely abstinence/withdrawal symptoms (Harris et al., 2020). If present, these symptoms should lead heavy smartphone users to experience anxiety, cravings, and mood fluctuations during periods of smartphone abstinence (i.e., the act of refraining from the use of smartphones; Wilcockson et al., 2019). The impact of abstaining from smartphone use remains an underexplored subject, and our understanding of it is limited (Turgeman et al., 2020). Further evidence on the occurrence of this phenomenon is necessary to clarify whether smartphone addiction could be conceptualized in a manner similar to substance-related addictions and thus be categorized as one.

The limited literature available on the effects of smartphone and social media abstinence reported inconsistent results. On one hand, some studies in which individuals were unable to access social media or were instructed to refrain from doing so showed an increase in their levels of craving (Stieger & Lewetz, 2018) and anxiety (Rosen et al., 2013). However, it has also been shown that abstinence can increase participants reported wellbeing (Vanman et al., 2018). As for smartphones, Clayton et al. (2015) reported that participants that were separated from them experienced negative emotions when they heard it ringing from another room. In another study, participants who abstained from using their smartphone for 24 hours showed increased levels of craving but no changes in mood and anxiety levels (Wilcockson et al., 2019). Differently, increased anxiety has been reported during abstinence in moderate to heavy smartphone users (Cheever et al., 2014).

Notably, not all the studies that explored this topic used a standard instrument to measure abstinence symptoms from smartphones. Most of them used self-report scales which were mere adaptations of

Table 1
Discriminant validity results.

Latent factors			Factor correlation and 95% CI			LRT test (df = 1) [a]		LRT test (df = 4) [b]	
			Estimate	Lower	Upper	Chisq. Diff.	p-value	Chisq. Diff.	p-value
1	–	2.	0.59	0.48	0.70	21.98	*0.000*	158.19	*0.000*
1	–	3.	−0.36	−0.48	−0.24	17.77	*0.000*	1137.82	*0.000*
1	–	4.	0.36	0.22	0.49	19.30	*0.000*	2291.88	*0.000*
1	–	5.	0.73	0.66	0.81	10.07	*0.002*	234.76	*0.000*
2	–	3.	−0.26	−0.39	−0.14	212.13 [c]	*0.000*	1574.08	*0.000*
2	–	4.	0.34	0.22	0.45	187.46	*0.000*	846.66	*0.000*
2	–	5.	0.48	0.37	0.59	21.00	*0.000*	212.40	*0.000*
3	–	4.	−0.77	−0.83	−0.72	6.84	*0.009*	272.05 [c]	*0.000*
3	–	5.	−0.31	−0.43	−0.19	11.30	*0.001*	392.22	*0.000*
4	–	5.	0.34	0.23	0.46	10.67	*0.001*	392.84	*0.000*

Notes. 1=Phone Dependence, 2=Phone Emotional Attachment, 3=S-Anxiety: Absent, 4=S-Anxiety: Present, 5=Phone Abstinence. Nested model LRT test alternatives: [a] df = 1, the constrained model is constructed by fixing each correlation at a time to a cutoff value (0.9). [b] df = 4, the constrained model is constructed by merging the two latent factors as one. [c] In two cases, the robust Satorra-Bentler difference test produced a negative result, so the ML test was used instead.

questionnaires that assess abstinence symptoms in other forms of addiction. For instance, Eide et al. (2018) used a modified version of the Cigarette Withdrawal Scale (CWS; Etter, 2005). They omitted subscales that were irrelevant to smartphones (e.g., The Appetite-Weight Gain and Insomnia subscales) and adapted other items from the Craving subscale to the smartphone content. Similarly, Wilcockson et al. (2019) used a modified version of the Desire for Alcohol Questionnaire (Love et al., 1998) with smartphone terminology replacing alcohol terminology. However, considering the aforementioned differences between substance-related addictions and smartphone addiction, these instruments may not be adequate to assess abstinence symptoms in this particular context. Given the importance of abstinence symptoms to frame excessive smartphone use as an addiction and given the potentially detrimental effect of smartphone abstinence on emotions and cognition, we propose a scale that is specifically developed to assess the psychological state deriving from smartphone abstinence: the Abstinence from Smartphone Scale (ABSS-10). In two studies we investigate and discuss the psychometric properties and the practical utility of the ABSS-10.

2. Study 1

The aim of Study 1 was to develop a scale to assess the psychological state deriving from smartphone abstinence specifically, i.e., the ABSS-10. The scale was developed and tested in Italian language; the English version together with the original Italian version is provided in the Appendix. The development of the ABSS-10 was guided by a careful analysis of the scientific literature concerning the problematic use of smartphones, ensuring the inclusion of the most relevant and crucial variables. In our literature review, we mainly observed the use of modified versions of existing scales to measure abstinence effects in substance related addiction (e.g., Eide et al., 2018; Wilcockson et al., 2019). We overcame state-of-the-art instruments by developing a new scale whose items are designed to reflect behavioural, emotional, and cognitive determinants of smartphone abstinence symptoms.

Moreover, Study 1 assessed the psychometric properties as well as the practical utility of ABSS-10. In particular, we examined its discriminant validity, namely its capability of assessing the state deriving from abstinence rather than just general state anxiety and smartphone dependence and explored the level of abstinence symptoms in participants with different levels of smartphone dependence (relatively low vs. high). To achieve these goals, we also explored the psychometric properties of the translation to Italian of the Phone Attachment and Dependence Inventory (PADI; Ward et al., 2017) and its factorial structure.

2.1. Materials & methods

2.1.1. Participants

The software G*Power (Faul et al., 2007) was employed to calculate the sample size, utilizing the following specifications: Repeated measures ANOVA, within-between interaction (2 groups, 3 measurements), a power of 0.95, significance level (α) of 0.05, effect size $f = 0.10$ (small), correlation among repeated measure = 0.50 and nonsphericity correction = 0.80. This analysis yielded a recommended sample size of 306 participants. A convenience sample of three hundred and thirty-four undergraduate students ($F = 272$; $M = 62$) were recruited for this study. Their age ranged from 18 to 49 years ($M = 20.6$; $SD = 2.8$). The study adhered to ethical standards outlined in the Declaration of Helsinki and gained approval from the University's Ethics Committee (minutes n. 129, dd. March 29, 2023). Prior to data collection, each participant provided written informed consent.

2.1.2. Materials

2.1.2.1. Phone attachment and Dependence Inventory (PADI). The Phone Attachment and Dependence Inventory, validated by Ward et al. (2017), evaluates individual differences in smartphone dependence and attachment. This questionnaire consists of 13 exploratory questions with Likert-type response options ranging from 1 (strongly disagree) to 5 (strongly agree).

2.1.2.2. State-Trait Anxiety Inventory (STAI). The anxiety levels of participants were evaluated using the state portion of the State-Trait Anxiety Inventory (STAI; Spielberger, 1983). This section comprises 20 statements assessing various feeling states with Likert-type response options ranging from 1 (not at all) to 4 (very much so).

2.1.2.3. Abstinence from smartphone scale (ABSS-10). The ABSS-10 measures the degree of smartphone abstinence symptoms and is composed of 10 items with Likert-type response options ranging from 1 (strongly disagree) to 5 (strongly agree).

2.1.2.4. Questions about electronic devices. Participants were asked three questions to verify that they had not actually used their electronic devices during the study, namely: "*Did you access your phone?*"; "*Did you access other electronic devices (laptop/tablet) to take notes?*"; "*If you accessed other electronic devices, did you use the internet or checked notifications?*". Possible responses were "*Yes*" or "*No*". The final question, aimed at assessing if a participant was a low, moderate, or high smartphone user, was "*How many hours do you spend on your smartphone daily?*". Possible responses were: "*less than 3 h per day*", "*three to 5 h per day*", and "*more than 6 h per day*".

2.1.3. Procedure

The data collection took place during four university lectures (80–120 students per group), in the classroom. At the beginning of the lecture, students were asked if they were willing to participate in a study with the aim of validating a scale. Participants were told that it was crucial to the success of the experiment that they put their electronic devices away and refrain from using them for the entire duration of the study. Those who agreed to participate were given informed consent, which they read, filled in, and signed.

There were three measurement occasions (T0, T1, T2; see Fig. 1 for a summary of the study's timeline). T0 corresponds to the very beginning of the study, when participants completed the Italian version of the Phone Attachment and Dependence Inventory and the STAI. T1 corresponds to the moment when, about 1 hour and 15 minutes after T0, participants completed the ABSS-10 and the STAI. Immediately after T1, participants took their usual 10-minute break, and they were reminded to avoid looking at their smartphones for the success of the experiment. T2 corresponds to the moment when, about 1 hour and 15 minutes after T1, the participants completed the ABSS-10, the STAI and the questions regarding access to electronic devices. At the end of the experiment, they had the chance to declare whether they actually abstained from using their devices, to detect and exclude from the analyses those participants who did not follow the instructions.

2.1.4. Data analysis

First, we performed a principal component analysis with oblique rotation on the study's measures at their first presentation. We next used confirmatory factor analysis (CFA) with maximum likelihood estimation with robust standard errors (MLM), to test the factor structure. At each step, to assess the adequacy of model fit to the data, conventional (rule of thumb) threshold for fit indices were used (e.g., Hooper et al., 2008): χ^2statistic (not statistically significant), χ^2/df ratio (<3), Comparative Fit Index (CFI, at least >0.90, good fit >0.95); Tucker-Lewis Index (TLI, at least >0.90, good fit >0.95), Root Mean Square of Approximation

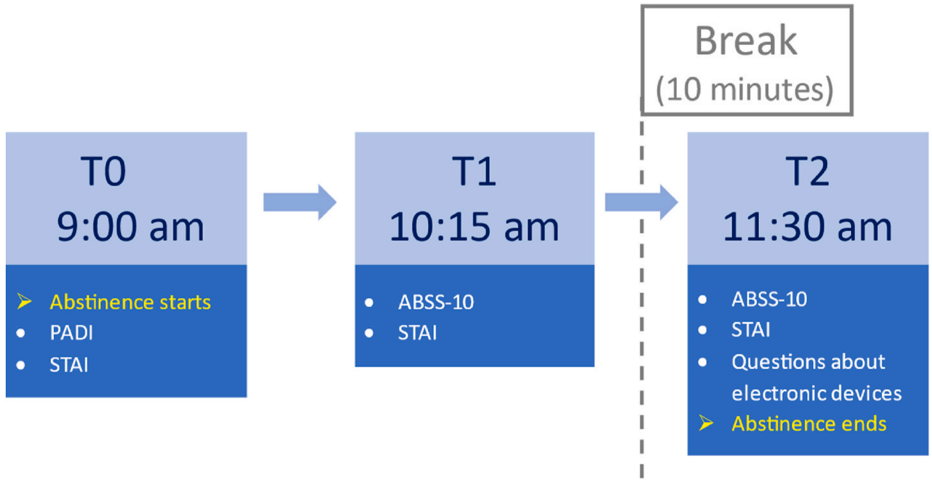

Fig. 1. Summary of Study 1 timeline.

(RMSEA, at least <0.08, good fit <0.07), and Standardized Root Mean Square Residual (SRMR, at least <0.08). While different indices reflect different aspects of model fit, formal assessment of threshold levels (Hu & Bentler, 1999) suggested brief two-index presentation strategies: a) RMSEA of 0.06 or lower and SRMR of 0.09 or lower, or b) CFI (or TLI) of 0.96 or higher and an SRMR of 0.09 or lower. Analysis was performed using the lavaan package (Rosseel, 2012) for R language (R Core Team, 2023).

To examine the discriminant validity of the study scales, we used (a) factor correlation estimates and confidence intervals to determine whether each pair of latent correlations was sufficiently below one (in absolute value). We then conducted a series of (b) likelihood ratio tests (LRT) to compare the original baseline model with constrained alternatives generated by fixing each factor correlation to one at a time, with a significant χ^2 statistic supporting discriminant validity. It is worth noting that if the correlation between two factors is equal to one, then their correlations with all other factors should also be equal (Rönkkö & Cho, 2022). In this context, we estimated a new constrained model by (c) adding the implied equality constraint, which was formally equivalent to testing a model that merged the two latent factors as one. These analyses were performed using the discriminant validity function (Rönkkö & Cho, 2022) from the semTools library for R (Jorgensen et al., 2022). As a final step, (d) the means of the scales used were compared between three independent groups of people reporting different hours of mobile phone use per day (less than 3 h, three to 5 h, and more than 6 h).

To quantify the practical utility of the Abstinence from Smartphone Scale proposed in the present study (ABSS-10), we compared the scores reported by participants on the two measurement occasions (T1 and T2). In addition, to test for the specificity of the phone abstinence scale with respect to general state anxiety, the analysis was also repeated for the subscales of the state anxiety, along the three measurement occasions (T0, T1 and T2). Data were analyzed with a two-way mixed-model ANOVA [within factor: Time (two or three levels)], controlling for the smartphone dependence [between factor: Phone dependence “High”, (*PADI* Total > Me) or “Low” (*PADI* Total ≤ Me)]. Post hoc comparisons were corrected according to Bonferroni. The effect size measures were reported as partial eta-squared and Cohen’s d. The ANOVA and post-hoc tests were performed with the jmv package (Selker, Love, & Dropmann, 2020), linear trend analyses for repeated measure were calculated using emmeans package (Lenth et al., 2023).

2.2. Results

2.2.1. Phone attachment and Dependence Inventory (PADI)

PCA with oblique Oblimin rotation was performed on the 13-item of the PADI (Ward et al., 2017). Scree plot and parallel analysis suggested a two-component solution (Fig. S1, Sakaluk & Short, 2017), which explained 43% of the variance. Rotated Component (RC) 1 (Phone Dependence; six items) explained 23.04% of the variance and was related to the degree of dependence on one’s smartphone (e.g., "I feel like I could not live without my cell phone"); RC 2 (Phone Emotional Attachment; seven items) explained 20.41% of the variance and was related to emotional smartphone use (e.g., "I feel excited when I have a new message or notification"; see Table S1). We then performed a CFA to test this 2-dimensional solution, markedly like that reported in the original study by Ward et al. (2017). Results showed that it did not fit the data well enough: $\chi^2(64) = 306.89$, $p = 0.000$, $\chi^2/df = 4.79$, $CFI = 0.77$, $TLI = 0.71$, $RMSEA = 0.11$ (90% CI 0.100, 0.125), and $SRMR = 0.09$. After modifying the initial model according to quantitative modification indices, we tested a model allowing the residuals of four pair of items to covary: (a) items 1–2, due to linguistic overlap with a day without a mobile phone, (b) 6–7, due to conceptual overlap with irritation by the presence of mobile connection problems, (c) 8–11, because of the conceptual intersection of loneliness and sadness, and (d) 12–13, because of a conceptual overlap between concentration and attention. The modified two-factor model obtained a good fit: $\chi^2(60) = 129.51$, $p = 0.000$, $\chi^2/df = 2.16$, $CFI = 0.93$, $TLI = 0.91$, $RMSEA = 0.06$ (90% CI 0.047, 0.077), and $SRMR = 0.07$.

All items loaded significantly ($p < .001$) on their hypothesized latent factors. To further investigation, the 6 items with salient loads on RC 1 (items 1–6) were averaged to form a Phone Dependence subscale, and the 7 items with salient loadings on RC2 (items 7–13) were averaged to form a Phone Emotional Attachment subscale. The internal consistency of the Phone Dependence subscale was acceptable (Cronbach’s alphas = 0.80; Duhachek’s 95% CI = 0.77, 0.84; average interitem correlation = 0.40), whereas it was low-to-moderate for the Phone Emotional Attachment (Cronbach’s alphas = 0.66; Duhachek’s 95% CI = 0.61, 0.72; average interitem correlation = 0.22) where, however, the value of average interitem correlation demonstrated a suitable level of item homogeneity and specificity (range 0.18–0.20; as suggested by Piedmont & Hyland, 1993).

2.2.2. State-Trait Anxiety Inventory (STAI)

Scree plot and parallel analysis on the 20-item State Anxiety (S-Anxiety) subscale indicated a two-component solution (Fig. S2). PCA with oblique Oblimin rotation extracted the well-established (e.g., Vigneau & Cormier, 2008) S-Anxiety present (RC1: 3, 4, 6, 7, 9, 12–14, 17–18) and S-Anxiety absent (RC2: 1, 2, 5, 8, 10–11, 15–16, 19–20) components, which explained 53% of the variance (31.09% and 21.82%, respectively; see Table S2). The initial CFA analysis on the two-factor structure indicated an inadequate fit: $\chi^2(169) = 431.71$, $p = 0.000$, χ^2/df= 2.55, CFI = 0.89, TLI = 0.88, RMSEA = 0.08 (90% CI 0.070, 0.088), and SRMR = 0.06. Subsequent CFA analysis showed that the two-factor structure fit the data adequately after correlating the errors of one pair of items (16–20, based on modification indices inspection and due to their conceptual overlap): $\chi^2(168) = 391.62$, $p = 0.000$, χ^2/df= 2.33, CFI = 0.91, TLI = 0.90, RMSEA = 0.07 (90% CI 0.064, 0.083), and SRMR = 0.06. All items loaded significantly ($p < .001$) on their hypothesized latent factors. We averaged the 10 items with salient loads on RC1 to form an S-Anxiety present subscale, and the 10 items with salient loadings on RC2 to form an S-Anxiety absent subscale. The internal consistency of the two subscales was good (State Anxiety present: Cronbach's alphas: = 0.88, Duhachek's 95% CI = 0.86 - 0.90, average interitem correlation = 0.44; State Anxiety absent: Cronbach's alphas: = 0.89, Duhachek's 95% CI = 0.87 - 0.91, average interitem correlation = 0.46).

2.2.3. *Abstinence from smartphone scale (ABSS-10)*

A PCA was applied to the 10-item inventory proposed in the present investigation to measure individual differences in phone abstinence symptoms. A one-component solution that explained 52% of the total variance was suggested by the parallel analysis (Fig. S3 and Table S3). We then performed a CFA to test this one-dimensional solution whose results showed a poor fit: $\chi^2(35) = 266.58$ $p = 0.000$, χ^2/df = 7.61, CFI = 0.82, TLI = 0.77, RMSEA = 0.16 (90% CI 0.143, 0.179), and SRMR = 0.08. An acceptable fit to the data was obtained by CFA on a modified one-dimensional model, which took into account three residual covariances (items 1–3, 1–6, 3–6) indicated by modification indices and whose justification is likely based on their linguistic overlap (i.e., because of the repeated use of the word "tempted"): $\chi^2(32) = 82.92$, $p = 0.000$, χ^2/df=2.59, CFI = 0.96, TLI = 0.95, RMSEA = 0.08 (90% CI 0.057, 0.097), and SRMR =0.04. All items loaded significantly ($p < .001$) on their hypothesized latent factors. The internal consistency of the phone abstinence scale was good: Cronbach's alpha = 0.90, Duhachek's 95% CI = 0.88 - 0.91, average interitem correlation = 0.46.

2.2.4. *Discriminant validity among study measures*

It was necessary to estimate a full factorial model, including all the subscales used in the study, before using the discriminant validity analysis routine. The full model provided a satisfactory fit to the data ($\chi^2(842) = 1362.57$, $p = 0.000$, χ^2/df=1.62, CFI = 0.90, TLI = 0.90, RMSEA = 0.05 (90% CI 0.043, 0.052), and SRMR =0.06), thus allowing the estimation of factor correlations, their confidence intervals, and the various LRT tests. Table 1 shows the complete set of results for the discriminant validity analysis between the scales of the study.

There were no issues with discriminant validity as all factor correlations and their 95% confidence intervals were well below the threshold of 0.85. Additionally, all LRT tests were statistically significant, indicating that each pair of latent variables represents distinct constructs.

2.2.5. *Relationships among scales and daily hours of mobile phone use*

Descriptive statistics for Phone Dependence, Phone Emotional Attachment, S-Anxiety present – absent, and Phone Abstinence study measures are presented in Table 2, whereas their intercorrelations are reported in Table 3. For all the study scales, data presented skewness and kurtosis values within the range of a symmetrical distribution.

As shown in Table 3, the subscales Phone Dependence and Emotional Attachment were both positively linked to Phone Abstinence and little correlated with S-Anxiety subscales. Correlations between S-Anxiety subscales and Phone Abstinence were similarly small.

We analyzed mean scale differences among individuals who reported less than 3 hours (8.33%), 3 to 5 hours (63.58%), and more than 6 hours (28.09%) of daily mobile phone use to further determine discriminant validity. Table 4 shows the results of the one-way between-subjects ANOVA (Factor: daily phone use, three levels) and the related post-hoc comparisons. In terms of individual differences on Phone Dependence measure, a full set of significant mean score differences were established among individuals reporting <3 hours (M =1.88, SD = 0.57), 3–5 h (M=2.72, SD = 0.78), and >6 hours (M=3.06, SD = 0.79) of daily use. Slope coefficient for a linear trend resulted statistically significant ($\widehat{\beta} = 1.01$, SE = 0.14, $t(321)=7.01$, $p < 0.001$). The Phone Emotional Attachment scale revealed a significant mean score difference between the <3 hours (M=2.51, SD = 0.69) and 3–5 hours (M=3.01, SD = 0.59) groups, as well as between the <3 hours and >6 hours (M=3.12, SD = 0.62) groups. Slope coefficient for a linear trend resulted statistically significant ($\widehat{\beta} = .69$, SE = 0.15, $t(321)=4.56$, $p < 0.001$), although of lesser magnitude. Similarly, the Phone Abstinence scale showed significant mean score differences between groups of <3 hours (M=1.38, SD = 0.48) and 3–5 hours (M=2.11, SD = 0.79), as well as between groups of <3 hours and >6 hours (M=2.30, SD = 0.89). Slope coefficient for a linear trend was statistically significant ($\widehat{\beta} = .78$, SE = 0.15, $t(321)=5.23$, $p < 0.001$), and again of lower magnitude, compared to the Phone Dependence scale. As for the state anxiety measure, there were no significant association between daily phone usage and S-Anxiety Present (<3: M=1.40, SD = 0.49; 3–5: M=1.49, SD = 0.53; >6: M=1.60, SD = 0.53) and Absent (<3: M=2.79, SD = 0.63; 3–5: M=2.70, SD = 0.58; >6: M=2.65, SD = 0.56) subscales, which clearly tap into separate constructs, as well as any significant linear trend in marginal means ($\widehat{\beta} = .26$, SE = 0.15, $t(318)=1.72$, $p = 0.086$, and $\widehat{\beta} = -.17$, SE = 0.16, $t(318)=-1.09$, $p = 0.277$, respectively).

2.2.6. *Practical utility of the ABSS-10*

Before conducting the ANOVA analysis on the change over time of the S-Anxiety and ABSS-10 scores, we calculated a total Phone Dependence score by averaging the two identified subscales. The sample was divided into two subgroups of equal size (N = 167) using the median split, with one group classified as having high dependence and the other as having low dependence. The ANOVA on S-Anxiety Present scores revealed a statistically significant main effect of Time and Phone Dependence (Table 4). The main effect of the Time showed higher state anxiety scores at the first measurement occasion, compared to the next two (T0: M=1.52, SD = 0.52; T1: M=1.44, SD = 0.50; T2: M=1.45, SD = 0.51). However, the effect size of these two significant differences was rather small (Cohen's d = 0.18-0.23; see Table 4 and Fig. 2), as was the magnitude of a statistically significant linear decreasing trend ($\widehat{\beta} = -.14$, SE = 0.037, $t(659)=-3.79$, $p < 0.001$; Phone Dependence: "High", $\widehat{\beta} = -.15$, SE = 0.058, $t(330)=-2.64$, $p = 0.009$; "Low", $\widehat{\beta} = -.14$, SE = 0.045, $t(329)=-3.03$, $p = 0.003$). The main effect of Phone

Table 2
Descriptive statistics for the study measures, at first measurement occasion.

Variables	n	M	SD	min	max	Skew.	Kurt.
Phone Dependence	334	2.74	0.82	1.00	5.00	0.29	−0.42
Phone Emotional Attachment	334	3.00	0.63	1.29	4.86	−0.06	0.04
S-Anxiety: Present	331	1.52	0.54	1.00	3.40	1.07	0.29
S-Anxiety: Absent	331	2.69	0.58	1.10	4.00	−0.20	−0.14
Phone Abstinence	334	2.10	0.83	0.90	4.60	0.56	−0.34

Table 3
Simple correlations among study measures, at first measurement occasion.

	1.	2.	3.	4.	5.
1. Phone Dependence	1.00				
2. Phone Emotional Attachment	0.52	1.00			
3. S-Anxiety: Present	0.29	0.22	1.00		
4. S-Anxiety: Absent	−0.26	−0.18	−0.66	1.00	
5. Phone Abstinence	0.60	0.43	0.29	−0.25	1.00

Note. N = 334, all correlations statistically significant at $p < 0.001$.

Table 4
Results of the statistical analyses on study scales by daily phone usage.

Variable	Effect	Factor	df	Statistics	p-value	E.S.
Phone	main	daily phone use (hr)	(2321)	**F=24.91**	***0.000***	0.13
Dependence	post hoc test	"<3" vs "3–5"	(321)	**t=-5.31**	***0.000***	***1.10***
		"<3" vs ">6"	(321)	**t=-7.01**	***0.000***	***1.57***
		"3–5" vs ">6"	(321)	**t=-3.57**	***0.001***	0.44
Phone Emotional	main	daily phone use	(2,321)	**F=10.43**	***0.000***	0.06
Attachment	post hoc test	"<3" vs "3–5"	(321)	**t=-3.94**	***0.000***	0.81
		"<3" vs ">6"	(321)	**t=-4.56**	***0.000***	0.95
		"3–5" vs ">6"	(321)	t=-1.53	*0.278*	0.20
Phone	main	daily phone use	(2,83.80)[a]	**F=29.38**	***0.000***	0.41
Abstinence	post hoc test:	"<3" vs "3–5"	(47.36)[a]	**t=-6.76**	***0.000***	0.95
		"<3" vs ">6"	(82.18)[a]	**t=-7.01**	***0.000***	***1.12***
		"3–5" vs ">6"	(155.44)[a]	t=-1.79	*0.176*	0.24
S-Anxiety:	main	daily phone use	(2,318)	F = 0.61	*0.544*	0.00
Absent	post hoc test:	"<3" vs "3–5"	(318)	t = 0.80	*0.703*	0.16
		"<3" vs ">6"	(318)	t=1.09	*0.521*	0.24
		"3–5" vs ">6"	(318)	t = 0.59	*0.824*	0.08
S-Anxiety:	main	daily phone use	(2,318)	F=2.19	*0.114*	0.01
Present	post hoc test:	"<3" vs "3–5"	(318)	t=−0.75	*0.735*	0.15
		"<3" vs ">6"	(318)	t=-1.72	*0.199*	0.38
		"3–5" vs ">6"	(318)	t=-1.78	*0.179*	0.22

Notes. [a] Welch corrected degree of freedom after statistically significant Levene's test for homogeneity of variances. E.S. = effect size, eta squared for the one-way ANOVAs and Cohen's d for the post hoc tests; statistics were reported in bold when p value < .05.

Dependence was that participants of high dependence group reported more state anxiety than low dependence group (High: M=1.61, SD = 0.66; Low: M=1.34, SD = 0.66; Cohen's d = 0.52, medium effect). As for the ANOVA on S-Anxiety Absent scores, the results were the same as before; however, the directions of the effects were obviously reversed. The analysis revealed a statistically significant main effect of Time and Phone Dependence (Table 4). The main effect of the Time showed lower score of absent state anxiety at the first measurement occasion, compared to the next two (T0: M=2.69, SD = 0.56; T1: M=2.77, SD = 0.58; T2: M=2.80, SD = 0.60). Again, the effect size of these two statistically significant differences was small (Cohen's d = 0.25-0.29; Table 4 and Fig. 2), as was the magnitude of a significant linear trend ($\widehat{\beta}$ = .19, SE = 0.032, t(659)=5.89, p < 0.001; Phone Dependence: "High", $\widehat{\beta}$ = .18, SE = 0.050, t(330)=3.49, p < 0.001; "Low", $\widehat{\beta}$ = .21, SE = 0.042, t(329)=5.05, p < 0.001). The main effect of Phone Dependence was that participants of high dependence group reported less absence of state anxiety than low dependence group (High: M=2.59, SD = 0.77; Low: M=2.91, SD = 0.77 Cohen's d = 0.54 medium effect).

Finally, the ANOVA on the ABSS-10 scores showed a statistically significant main effect of Phone Dependence (High: M=2.53, SD = 0.98; Low: M=1.66, SD = 0.98; Cohen's d= 1.20, large effect; Table 4). We did not find a statistically significant effect of Time (T1: M=2.10, SD = 0.72; T2: M=2.08, SD = 0.73; Cohen's d = 0.05, very small effect; Table 5).

2.3. Discussion

The objective of Study 1 was to create a novel tool designed to assess the psychological effects arising from smartphone abstinence and to assess its psychometric properties and practical utility. Results revealed that the ABSS-10 has a robust factorial structure, demonstrating high reliability and internal consistency. Additionally, the scale exhibited satisfactory discriminant validity, making it a reliable instrument for distinguishing smartphone abstinence symptoms from other concepts such as state anxiety and smartphone dependence. However, the scale failed to detect any notable rise in abstinence symptoms over time. This lack of evolution could be due to two possible reasons: 1) the ABSS-10 did not measure an evolving state, but rather a stable trait – this trait would then correspond to dependence; or 2) the time intervals that were used to measure abstinence symptoms evolution were too brief and the overall duration of abstinence was too short to detect any change in ABSS-10 scores. In Study 2 we further investigate this aspect by increasing the duration of both the overall abstinence period and that of the intervals between ABSS-10 measurements.

3. Study 2

In Study 1 we observed that the ABSS-10 adequately discriminates the construct of smartphone abstinence symptoms from that of state anxiety and smartphone dependence. However, the scale did not detect any evolution of abstinence symptoms through time. The aim of Study 2 was then to better determine whether the ABSS-10 can successfully detect evolutions of abstinence symptoms through time. To this purpose, we increased the overall duration of the abstinence and time intervals between ABSS-10 measurements. Moreover, to ensure that the scale specifically measures a psychological state (abstinence symptoms) and not a trait (dependence), we added a second measure of dependence to investigate whether the correlation between the two measures of dependence is greater than the correlations that they both have with ABSS-10. Altogether, these pieces of information would confirm the practical utility of the ABSS-10.

3.1. Materials & methods

3.1.1. Participants

The software G*Power (Faul et al., 2007) was employed to calculate the sample size, utilizing the following specifications: Repeated measure ANOVA, within-between interaction (2 groups, 3 measurements), a power of 0.95, significance level (α) of 0.05, effect size f = 0.10 (small), correlation among repeated measure = 0.87 (based on Study 1) and nonsphericity correction = 0.80. This analysis yielded a recommended sample size of 82 participants. Ninety-four undergraduate students (F = 71, M = 23; M_{age} = 21.9 years, SD_{age} = 2.4 years) took part in Study 2. They received academic credits for their participation. The study adhered to ethical standards outlined in the Declaration of Helsinki and gained approval from the University's Ethics Committee (minutes n. 129, dd. March 29, 2023). Prior to data collection, each participant provided written informed consent.

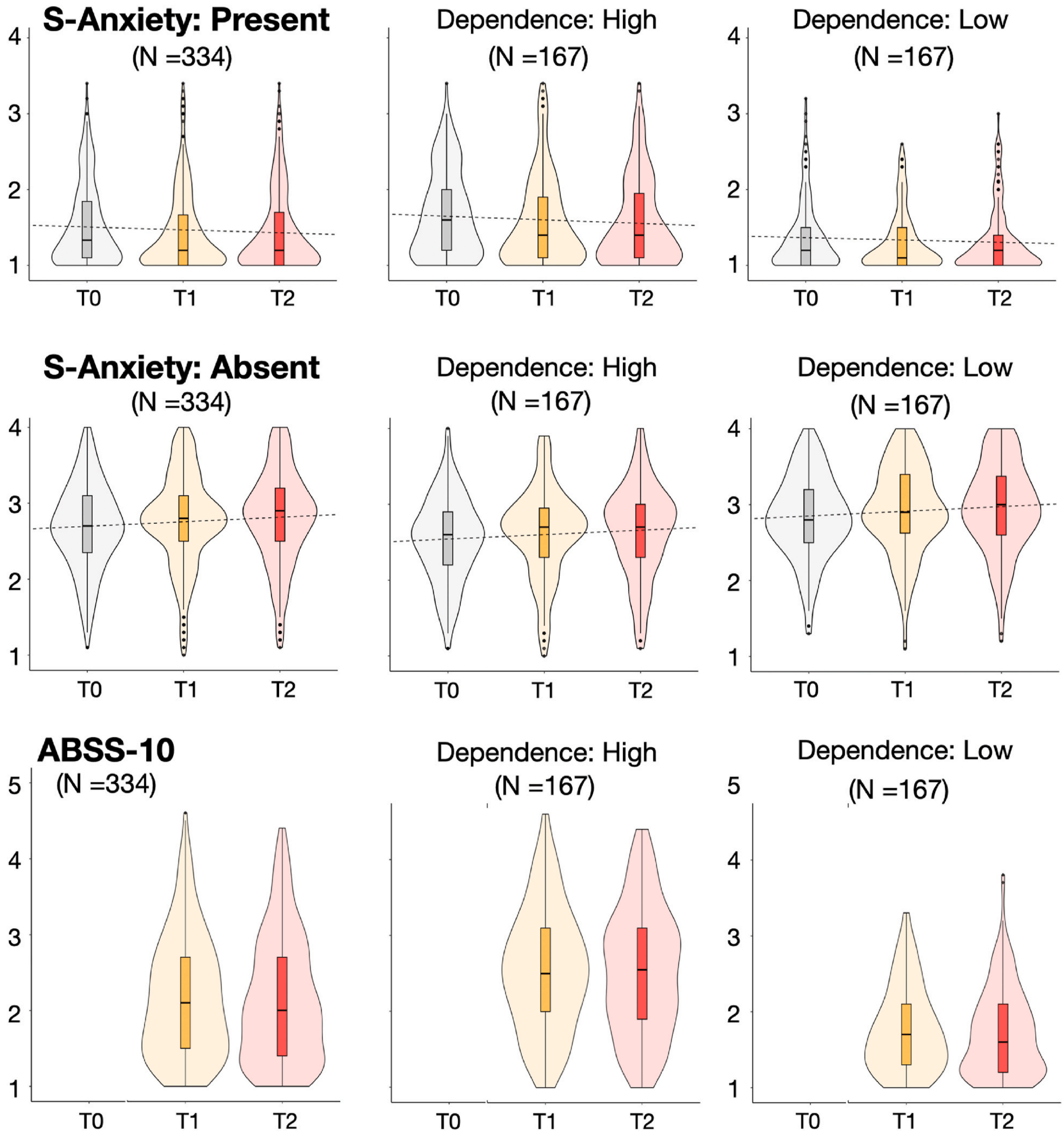

Fig. 2. The effect of mobile phone deprivation on the S-Anxiety Present/Absent and the ABSS-10 scales during the planned repeated measurement occasions. Participants with Phone Dependence total scores above the median (referred to as the "high" group) generally reported higher presence of state anxiety and phone abstinence. Consistently, they also reported a lower 'absence' of state anxiety. The presence (absence) of state anxiety tended to decrease (increase) with repeated measurement, although the observed effects are very small. ABSS-10 scores do not seem to change between the two planned measurement occasions (*see the text for details*).

3.1.2. *Materials*

3.1.2.1. Phone attachment and Dependence Inventory. The same scale as in the previous study was used to assess participants' dependence from smartphones, namely the Phone Attachment and Dependence Inventory (Ward et al., 2017).

3.1.2.2. Abstinence from smartphone scale (ABSS-10). The same scale as in the previous study was used to assess participants' smartphone abstinence symptoms, namely the Abstinence from Smartphone Scale (ABSS-10).

3.1.2.3. Short version of the Smartphone Addiction Scale (SAS-SV). We used the Italian version of The Smartphone Addiction Scale – Short Version (SAS-SV; De Pasquale et al., 2017; Kwon, Kim, et al., 2013). The scale comprises 10 items assessed using a 5-point Likert scale.

3.1.2.4. Questions on smartphone and PC habits. Participants answered six questions about their smartphone and PC usage habits: a) "*How many hours a day do you spend on your smartphone?*" (0 = up to 1 hour; 1 = between 1 and 2 hours; 2 = between 2 and 3 hours; 3 = between 3 and 4 hours; 4 = between 4 and 5 hours; 5 = between 5 and 6 hours; 6 = between 6 and 7 hours; 7 = more than 7 hours); b) "*Please give an*

Table 5
Results of the statistical analyses on S-Anxiety and Phone Abstinence by repeated measurement, controlling for phone dependence.

Variable	Effect	Factors	df	Statistics	p-value	E.S.
S-Anxiety: Present	main	Time	(1.76,576.89)[b]	***F*=10.65**	***0.000***	**0.03**
	main	Dependence[a]	(1328)	***F*=27.17**	***0.000***	**0.08**
	interaction	Time ✻ Dependence	(1.76,576.89)[b]	*F=0.39*	*0.648*	0.00
	post hoc	T0 vs T1	(328)	***t*=4.16**	***0.000***	**0.23**
	comparisons:	T0 vs T2	(328)	***t*=3.3**	***0.003***	**0.18**
		T1 vs T2	(328)	*t=-0.49*	*1.000*	0.03
S-Anxiety: Absent	main	Time	(1.83,601.1)[b]	***F*=18.73**	***0.000***	**0.05**
	main	Dependence[a]	(1328)	***F*=29.41**	***0.000***	**0.08**
	interaction	Time ✻ Dependence	(1.83,601.1)[b]	*F=0.12*	*0.872*	0.00
	post hoc	T0 vs T1	(328)	***t*=-4.46**	***0.000***	**0.25**
	comparisons:	T0 vs T2	(328)	***t*=-5.22**	***0.000***	**0.29**
		T1 vs T2	(328)	*t=-1.59*	*0.339*	0.09
Phone Abstinence	main	Time[c]	(1332)	*F=0.69*	*0.406*	0.00
	main	Dependence[a]	(1332)	***F*=131.15**	***0.000***	**0.28**
	interaction	Time ✻ Dependence	(1332)	*F=0.36*	*0.548*	0.00
	post hoc					
	comparison:	T1 vs T2	(332)	*t=0.83*	*0.406*	0.05

Notes. [a] Dependence: Phone dependence total score, dichotomized as “Low” (≤ Me) vs “High” (>Me).[b] Greenhouse-Geisser corrected degree of freedom. [c] Time factor is dichotomic. Abbreviation: E.S. = effect size, partial eta squared for the mixed ANOVAs and Cohen’s d for the post hoc tests; statistics were reported in bold when p value < .05.

estimate of how much you use your smartphone for study/work purposes, in percentage terms” (between 0 and 100); c) “*Please give an estimate of how much you use your smartphone using messaging apps (e.g. Whatsapp), in percentage terms*” (between 0 and 100); d) “*Please give an estimate of how much you use your smartphone using social networks (e.g. Instagram, Facebook, TikTok), in percentage terms*” (between 0 and 100); e) “*How many hours per day do you spend on the computer?*” (0 = up to 1 hour; 1 = between 1 and 2 hours; 2 = between 2 and 3 hours; 3 = between 3 and 4 hours; 4 = between 4 and 5 hours; 5 = between 5 and 6 hours; 6 = between 6 and 7 hours; 7 = more than 7 hours); f) “*Please give an estimate of how much you use your computer for study/work purposes, in percentage terms*” (between 0 and 100).

3.1.3. Procedure

Participants were recruited among university students. Throughout the recruitment process, participants were briefed on the total duration of the experiment (5 hours) and explicitly cautioned that one of the study’s requirements was that the use of smartphones or other electronic devices (such as PCs, smartwatches, kindles, etc.) was not allowed for the entire duration of the study, and that such devices would be collected by the researcher and kept in a guarded room. They were allowed to bring along paper-only material (e.g., books, printed articles, magazines). The experiment was conducted in groups of 6 participants. During the experiment, for about 75% of the time participants were free to do activities such as reading, writing, and studying. In the remaining time, they were involved in planned sessions of experimental activities lasting around 10/20 minutes each. Participants were asked not to interact with each other and to carry out their activities individually and quietly, so as to recreate the environment typical of a library.

The study followed a strict timeline (T0, T1, T2, T3; see Fig. 3 for a summary of the study’s timeline). At T0, participants arrived at the laboratory and read, completed, and signed the informed consent. Then the researcher collected their smartphones and electronic devices and placed them in a guarded room. At this point, participants filled in the short version of the Smartphone Addiction Scale (SAS-SV; De Pasquale et al., 2017; Kwon, Kim, et al., 2013) and the Phone Attachment and Dependence Inventory (Ward et al., 2017). Then they answered the 6 questions on smartphone and PC usage habits. T1 corresponds to the time when, exactly half an hour after T0, the participants first completed the ABSS-10. T2 represents the time when, 2 hours after T1, they completed for the second time the ABSS-10. T3 corresponds to the time when, 2 hours after T2, participants completed for the last time the

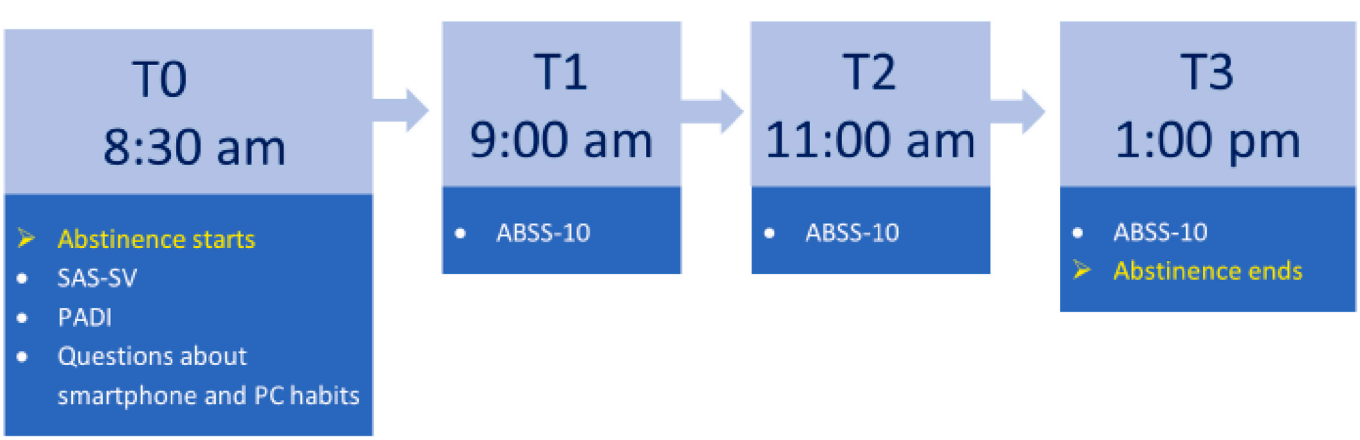

Fig. 3. Summary of Study 2 timeline.

ABSS-10.

3.1.4. Data analysis

Study 2 aimed to assess the practical utility of the ABSS-10 inventory. We examined changes in participants scores over three ABSS-10 measurement occasions (T1, T2, and T3), while controlling for smartphone dependence measured through the Phone Attachment and Dependence Inventory (Ward et al., 2017), as in Study 1. To assess its discriminant validity with abstinence measures in the present sample, an additional dependence measure based on the SAS-SV scale was included (De Pasquale et al., 2017; Kwon, Kim, et al., 2013). This was done to examine the magnitude of the correlation coefficients between dependence measures and between dependence and abstinence symptoms scores. The data were analyzed using a two-way mixed-model ANOVA, with Time (three levels) as the within factor and Phone Dependence (High vs Low) as the between factor. Post hoc comparisons were corrected using the Bonferroni correction. The effect size measures were reported as partial eta-squared and Cohen's d.

3.2. Results

3.2.1. Descriptive statistics

The two PADI subscales and ABSS-10 scores were calculated based on the item-to-factor structure obtained in Study 1. As in Study 1, a total Phone Dependence Score was calculated by averaging the two PADI subscales. This score, which will be dichotomized by a median split, will be used in further ANOVA analysis. The total score of the SAS-SV Dependency Inventory was calculated by averaging its 10 constituent items, based on a one-factor solution originally proposed for the instrument. Table 6 presents the descriptive statistics for the PADI (subscales and total), SAS-SV, and ABSS-10 scores, while their intercorrelations are reported in Table 7. The data presented skewness and kurtosis values within the range of a symmetrical distribution. The scales demonstrated good internal consistency, as indicated by Cronbach's alphas at the first measurement occasion: Phone Dependence = 0.82 (Duhachek's 95% CI 0.76, 0.88; average interitem correlation = 0.43); Phone Emotional Attachment = 0.66 (Duhachek's 95% CI 0.56, 0.77; average interitem correlation = 0.22); SAS-SV = 0.79 (Duhachek's 95% CI 0.73, 0.85; average interitem correlation = 0.28); ABSS-10 = 0.90 (Duhachek's 95% CI 0.87, 0.93; average interitem correlation = 0.46).

Table 7 shows that the two scales of phone dependence were strongly positively correlated, while they were moderately positively correlated with the ABSS-10 scores. There was an increase in the correlation between phone dependence and abstinence over time, which was particularly evident for the dependence scale validated in Study 1.

3.2.2. Change over time of the ABSS-10 scores

The ANOVA on the ABSS-10 scores revealed a statistically significant main effect of Time and Phone Dependence (Table 8). The main effect of the Time showed higher phone abstinence scores at the third measurement occasion, compared to the first two (T1: M = 1.74, SD = 0.67; T2: M = 1.82, SD = 0.65; T3: M = 2.03, SD = 0.76). The effect size of these two statistically significant differences was medium (Cohen's d = 0.44–0.43; see Table 8 and Fig. 4), as was the magnitude of a statistically significant linear trend ($\widehat{\beta}$ = .39, SE = 0.079, $t(184)=4.98$, $p < 0.001$; Phone Dependence: "High", $\widehat{\beta}$ = .52, SE = 0.118, $t(92) = 4.39$, $p <$ 0.001; "Low", $\widehat{\beta}$ = .30, SE = 0.117, $t(92) = 2.53$, $p = 0.013$). The main effect of Phone Dependence was that participants of high dependence group reported more phone abstinence than low dependence group (High: M = 2.11, SD = 0.87; Low: M = 1.63, SD = 0.87; Cohen's d = 0.68, medium effect).

Table 6
Descriptive statistics for the second study measures, at first measurement occasion.

Variables	n	M	SD	min	max	Skew.	Kurt.
Phone Dependence	94	2.78	0.87	1.17	4.83	0.28	−0.75
Phone Emotional Attachment	94	2.97	0.63	1.29	4.57	−0.33	−0.25
PADI (Tot.)	94	2.87	0.66	1.37	4.62	0.03	−0.35
SAS-SV (Tot.)	94	2.56	0.76	1.20	4.70	0.40	−0.47
ABSS-10 T1	94	1.74	0.70	1.00	3.40	0.88	−0.28
ABSS-10 T2	94	1.82	0.69	1.00	4.20	0.82	0.17
ABSS-10 T3	94	2.03	0.81	1.00	4.10	0.51	−0.78

Table 7
Simple correlations among second study measures, at first measurement occasion.

	1.	2.	3.	4.	5.
1. PADI (Tot.)	1.00				
2. SAS-SV (Tot.)	0.78	1.00			
3. ABSS-10 T1	0.36	0.50	1.00		
4. ABSS-10 T2	0.46	0.57	0.71	1.00	
5. ABSS-10 T3	0.54	0.53	0.62	0.80	1.00

Note. N = 94, all correlations statistically significant at p < .001.

3.3. Discussion

Since in Study 1 the ABSS-10 did not show any progression in abstinence symptoms over time, the objective of Study 2 was to more effectively assess whether the ABSS-10 can accurately detect temporal evolution in this variable. To achieve this, we extended the overall duration of abstinence and increased the time of the intervals between ABSS-10 measurements. Additionally, we introduced a second measure of dependence to examine whether the correlation between the two dependence measures is stronger than the correlations each measure has with ABSS-10. Results showed that highest abstinence symptoms scores were reported at the third measurement occasion compared to the first two and that there was a significant linear trend. Moreover, there was a greater correlation between the two dependence measures than between them and ABSS-10. These results confirm that ABSS-10 captures changes in abstinence symptoms over time and effectively discriminates abstinence symptoms from dependence.

4. General discussion

The aim of the present work was to develop a new instrument that allows to measure the psychological state deriving from smartphone abstinence specifically. The psychometric properties and practical utility of the inventory we developed, named "Abstinence from Smartphone Scale" (ABSS-10), were assessed in two studies. Results from Study 1 showed that the inventory has good psychometric properties. Nonetheless, in Study 1 the scale failed to detect any evolution of smartphone abstinence symptoms during the time period considered. In Study 2 we further investigated the practical utility of ABSS-10 by testing it in a longer overall period and with longer time intervals in between measurement occasions. Results showed that the scale successfully detected an increase in abstinence symptoms throughout the duration of smartphone deprivation.

Study 1 evaluated the psychometric properties of the ABSS-10. Results revealed that the inventory has a robust factorial structure based on a one-component solution, along with good internal consistency and reliability. Importantly, the specificity of ABSS-10 with respect to general state anxiety and smartphone dependence was tested by examining the overlap among various subscales considered in the study, such as the "Phone Dependence" and "Phone Emotional Attachment" components of the Phone Attachment and Dependence Inventory, the "S-Anxiety: Absent" and "S-Anxiety: Present" components of the STAI, and the "Phone Abstinence" component of the ABSS-10. This analysis confirmed that each pair of latent variables represented distinct constructs, ensuring

Table 8
Results of the statistical analyses on Phone Abstinence by repeated measurement, controlling for phone dependence.

Variable	Effect	Factors	df	Statistics	p-value	*E.S.*
Phone Abstinence	main	Time	(1.74,160.25)[b]	***F*=13.31**	***0.000***	**0.13**
	main	Phone Dependence[a]	(1,92)	***F*=14.24**	***0.000***	**0.13**
	interaction	Time ✻ Phone Dependence	(1.74,160.25)[b]	*F*=1.44	*0.240*	0.02
	post hoc	T1 vs T2	(92)	*t*=-1.43	*0.469*	0.15
	comparisons:	T1 vs T3	(92)	***t*=-4.24**	***0.000***	**0.44**
		T2 vs T3	(92)	***t*=-4.21**	***0.000***	**0.43**

Notes. [a] Phone dependence total score, dichotomized as "Low" (≤ Me) vs "High" (>Me). [b] Greenhouse-Geisser corrected degree of freedom. Abbreviation: E.S. = effect size, partial eta squared for the mixed ANOVAs and Cohen's d for the post hoc tests; statistics were reported in bold when p value < .05.

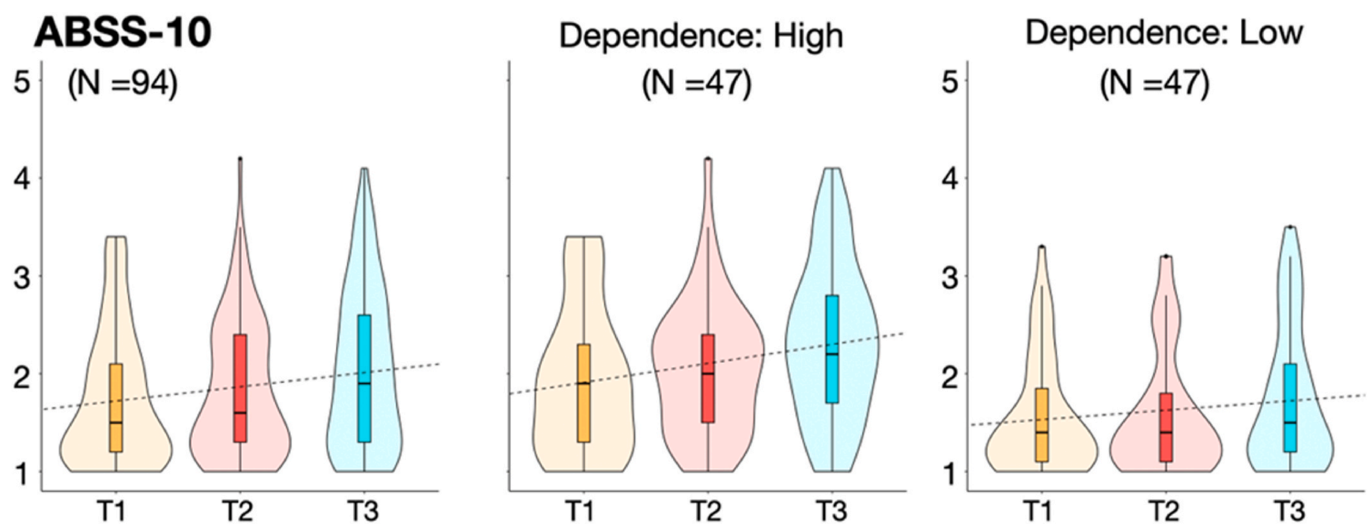

Fig. 4. The effect of mobile phone deprivation on the phone abstinence (ABSS-10) scores during the planned repeated measurement occasions. Participants with high phone dependence generally reported higher levels of phone abstinence symptoms, the levels of phone abstinence symptoms tended also to increase over time (*see the text for details*).

that ABSS-10 has a satisfactory discriminant validity and that it exclusively measures smartphone abstinence symptoms instead of generalized anxiety or smartphone dependence.

In Study 2 the overall duration of smartphone deprivation was extended to 5 hours to examine the changes in participants' ABSS-10 scores over three measurement occasions. Results indicated a significant main effect of time, with higher abstinence symptoms scores at the third measurement occasion, compared to the first two, as well as a significant linear trend. These observations ascertained that the inventory has the ability to detect temporal fluctuations in smartphone abstinence symptoms, which indicates that these symptoms reflect a psychological state determined by specific circumstances, namely smartphone deprivation. In this sense, abstinence symptoms cannot be confused with dependence itself, which reflects a relatively stable psychological construct. Abstinence symptoms are a distinctive physiological feature of addictions (Kaptsis et al., 2016) and are considered a diagnostic criterion for Internet Gaming Disorder (IGD; American Psychiatric Association, 2013). Therefore, their presence in problematic smartphone use would point towards a framing of this behaviour as an actual addiction. However, these symptoms may not be bound to addiction exclusively, but might also emerge in people with low levels of smartphone addiction. Indeed, in respect with dependence, we observed that participants with higher levels of dependence showed overall higher levels of abstinence symptoms; however, a similar linear trend of growing symptoms through times was observed in both groups.

It is important to highlight that, in the current studies, smartphone deprivation was intentionally scheduled: participants were informed in advance that they would not have access to their smartphones throughout the entire session. On one hand, this approach may have introduced a selection bias, as individuals highly attached to their phones or those requiring constant access due to obligations (such as family or work) might have opted not to participate. Nevertheless, it is noteworthy that, despite participants being aware of the 5-hours restriction on phone usage and potentially having notified friends or relatives about it, they still reported escalating levels of abstinence symptoms over time. For this reason, in instances of unscheduled smartphone restrictions, such as in situations with limited connectivity, ABSS-10 would reasonably be capable of detecting higher levels of abstinence symptoms that probably would arise more quickly.

The notable increase in reported levels of abstinence symptoms exhibited by participants, despite their prior preparation to smartphone separation, suggests that these symptoms may not solely stem from the impossibility of performing essential daily functions, challenging conventional explanations for smartphone dependence (Eide et al., 2018). This is further supported by participants' awareness that they would not be required to engage in these functions during the study. Conversely, it seems more likely that smartphone attachment and consequent abstinence symptoms is determined by the medium itself. This could be explained by the hypothesis that smartphones are perceived like an extension of the self (Belk, 2013), leading to potential separation anxiety in individuals that are separated from them (Cheever et al., 2014). Alternatively, the feeling of FoMO, which is the fear of missing on events happening in our social bubble (Przybylski et al., 2013), might be transferred entirely to the device, as posited by the theory of Nomophobia (King et al., 2013).

It is plausible to think that being separated from our smartphone can elicit high degrees of anxiety, given the multitude of tasks they facilitate (e.g., communicating, accessing the web) and the sensitivity of the information that are stored in it (e.g., bank account details, personal documents). The ten items forming the ABSS-10 scale have been accurately selected to reflect the importance that smartphones have nowadays and the gravity of the consequent distress caused by its absence (e.g., "I have thought that I missed something important because I couldn't check the cell phone"; "I felt discomfort due to not being able to check messages"; "I felt deprived of something for not being able to use the cell phone"). At the same time, the scale also covers an aspect of abstinence symptoms that is more related to a visceral bond that we have with this device, independently from its content (e.g., "I have often been tempted to unlock the cell phone"; "Despite not being able to use the cell phone, I felt serene"; "I can't wait to turn on the cell phone"), in line with the "Extended-self theory" presented above (Belk, 2013). Remarkably, ABSS-10 can detect smartphone abstinence symptoms regardless of the underlying cause behind this state.

It is important to acknowledge two constraints that may have impacted the methodology and interpretation of these results. Firstly, due to constraints within the experimental setting of Study 1, specifically a lecture session, a self-declaration-based screen time measurement was employed. This approach was chosen as it allowed for data collection within the limited timeframe, in contrast to methods relying on accessing smartphone apps, as recommended by Tomczyk and Selmanagic Lizde (2023). While a more objective measurement method would be preferable, it was not feasible in this instance. Secondly, both Study 1 and Study 2 were conducted using convenience samples comprised of university students. While this is a common approach, this choice presents potential limitations regarding the representativeness of the findings, as highlighted by Murgia et al. (2020). Consequently, future research should validate the efficacy of the ABSS-10 across diverse demographic groups, including older adults and adolescents, in order to ensure broader generalizability.

From a theorical standpoint, the role of abstinence in problematic smartphone use needs to be further investigated. The definition of smartphone abstinence characteristics such as its temporal determinants, individual differences, risk factors and its negative impact on emotions and cognition would move forward research in this field. Indeed, addressing these aspects would contribute to discerning whether problematic smartphone use is merely a maladaptive behaviour or a genuine addiction (Harris et al., 2020). Significantly, the current study proposes that the ABSS-10 inventory is a suitable tool for identifying the psychological state resulting from smartphone abstinence and, therefore, should be employed in studying this condition across various contexts.

With regard to applied research, ABSS-10 represents a valuable tool for examining abstinence symptoms across a range of experimental contexts. This instrument enables researchers to explore the adverse impact of this psychological state on diverse aspects of daily life. For instance, it is important to understand the negative effects of smartphone abstinence (and the consequent symptoms) on cognition. Participants undergoing such a negative state may indeed exhibit heightened distractibility, which could potentially lead to poorer performance in tasks related to attention, memory, and executive functions. Furthermore, the potential presence of abstinence-related anxiety could influence participants' decision-making abilities and their self-confidence in social interactions. Finally, ABSS-10 could be employed to detect the presence of abstinence symptoms, which could contribute to the diagnosis of smartphone addiction. Moreover, the scale could be adapted to other forms of behavioural addictions (e.g., gambling, internet and gaming addiction) and used for the same purposes.

5. Conclusions

Despite the growing interest in the research field of excessive smartphone use and its implications for mental health, there is still a limited understanding of smartphone abstinence symptoms. Indeed, a proper tool to measure smartphone abstinence symptoms was not available. Without a similar tool it is impossible to ascertain whether smartphones can actually induce abstinence symptoms in the first place. Consequently, it is difficult to establish whether excessive smartphone use reflects a genuine addiction or not. In this study, we introduced the Abstinence from Smartphone Scale (ABSS-10), specifically designed to measure the psychological state resulting from smartphone abstinence. The primary objective was to validate ABSS-10 and emphasize its significance in the field of smartphone addiction. Two studies were conducted to examine its psychometric properties, with a focus on discriminant validity and its association with smartphone dependence and emotional attachment. The results demonstrate that ABSS-10 effectively distinguishes smartphone abstinence symptoms from general state anxiety and smartphone dependence, highlighting the distinctive psychological consequences of smartphone restriction. The scale has potential applications in both research and practical settings, to deeper understand the psychological dynamics of smartphone use and abstinence. This work positions ABSS-10 as a valuable tool for conducting such investigations.

CRediT authorship contribution statement

Claudia Virginia Manara: Writing – review & editing, Writing – original draft, Project administration, Methodology, Conceptualization. **Serena Mingolo:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Conceptualization. **Michele Grassi:** Writing – review & editing, Writing – original draft, Visualization, Formal analysis, Data curation. **Fabrizio Sors:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Valter Prpic:** Writing – review & editing, Writing – original draft, Conceptualization. **Tiziano Agostini:** Writing – review & editing, Writing – original draft, Conceptualization. **Mauro Murgia:** Writing – review & editing, Writing – original draft, Conceptualization.

Declaration of competing interest

The authors declare no competing interests.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.chbr.2024.100428.

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