Beyond Screen Time: Smartphone Salience as a Cognitive Predictor of Problematic Smartphone Use

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Abstract

Research on problematic smartphone use has predominantly focused on screen time and usage frequency, implicitly treating digital engagement as a quantitative phenomenon. Adopting a cognitive perspective, the present study examines smartphone salience—the extent to which smartphones remain cognitively prominent and mentally accessible—as a proximal predictor of problematic smartphone use beyond usage frequency and individual differences. In a cross-sectional sample of 198 adult university students, we assessed smartphone salience, problematic smartphone use, perceived social relatedness, usage frequency, and demographic variables. Hierarchical regression analyses indicate that salience is positively associated with problematic smartphone use after controlling for age, gender, and usage frequency, and that it explains additional variance beyond usage frequency alone. Contrary to common assumptions, neither perceived social relatedness nor age moderated this association. These findings suggest that, alongside established predictors, smartphone salience represents an additional cognitive aspect that warrants consideration in research on problematic smartphone use, with implications for digital well-being in organizations and higher education.

Keywords: *smartphone salience, problematic smartphone use, attention, digital well-being, cognitive preoccupation, higher education*

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1. Introduction

Digital technologies have become deeply embedded in contemporary work and everyday life [1]. Smartphones, in particular, function as continuous access points to communication, information, and organizational systems. While such technologies enable flexibility and responsiveness, they also introduce new challenges for the sustainable allocation of attention [2]. Increasingly, concerns about digital well-being in organizations are framed not in terms of access or availability, but in terms of persistent cognitive engagement that interferes with task focus, recovery, and long-term performance [3], [4]. These dynamics are especially consequential in higher-education settings, where sustained attention is central to learning and academic performance and where students are among the most intensive smartphone users. Importantly, these concerns are not limited to younger individuals, as smartphone adoption and everyday use are now widespread across adult age groups [5].

Much of the existing discourse implicitly equates problematic technology use with the amount of time spent using digital devices [6]. However, this perspective risks oversimplifying the phenomenon by treating digital engagement as a purely quantitative issue. Psychological accounts increasingly conceptualize problematic technology use not as excessive engagement per se, but as a compensatory behavior aimed at regulating unmet psychological needs, such as social connectedness or belonging [7], [8]. From a self-determination theory perspective, such compensatory tendencies can be understood as reflecting frustration of the basic psychological need for relatedness—the need to feel socially connected, valued, and meaningfully engaged with others [9]. However, at the organizational level, sustainability concerns arise not merely when technologies are used frequently or serve compensatory functions, but when they become cognitively dominant or salient—persistently capturing attention in ways that undermine focused work and self-regulation [10]. In this context, smartphone salience refers to the extent to which smartphones remain cognitively prominent and mentally accessible, capturing attention even in the absence of active use [10], [11]. Crucially, salience is conceptually distinct both from the behavioral compulsion emphasized in addiction and dependence accounts and from problematic use itself: rather than an index of impairment, it represents a proximal cognitive antecedent—the mental prominence of the device—that may give rise to problematic engagement. This distinguishes salience from adjacent constructs such as habitual checking, cognitive preoccupation, or compulsive use, which either describe overt behavior or already presuppose dysfunction.

Emerging discussions within the attention economy suggest that digital technologies increasingly compete for cognitive resources not only through time demands, but through their mental availability [10]. In an economy in which human attention is the scarce and monetized resource, smartphones and their applications are deliberately engineered to maximize engagement, and their most durable effect may be to remain mentally present rather than merely to accumulate usage time. Smartphones may therefore remain salient even when not actively used, drawing attention through anticipation and habitual checking behaviors that operate largely automatically [12]. Such cognitive salience represents a qualitatively different form of engagement than frequency of use, with potentially stronger implications for attentional sustainability and self-regulation in work and study contexts [11]. From an organizational perspective, distinguishing

between frequency and salience is critical: two employees may use their smartphones equally often, yet differ substantially in how much the device occupies their attention during task execution. If problematic outcomes are driven primarily by salience rather than frequency, interventions focused solely on reducing screen time may fail to address the core mechanism underlying impaired focus and recovery.

Despite growing interest in digital well-being, little is known about whether cognitive preoccupation with smartphones—beyond sheer usage frequency or psychological overcompensation—functions as a proximal mechanism of problematic smartphone use. Two boundary conditions are theoretically salient. First, if salience partly reflects a compensatory response to unmet relatedness [7], [9], its association with problematic use should be stronger among individuals whose need for relatedness is frustrated and weaker among those who feel socially connected; perceived social relatedness might therefore attenuate the salience–problematic use link. Second, common assumptions about heightened vulnerability among younger, "digitally native" users imply that age should moderate this association, yet empirical evidence remains limited and inconsistent [13], [14]. Addressing these gaps, the present study examines smartphone salience as a central cognitive mechanism underlying problematic smartphone use, while considering perceived social relatedness and age as boundary conditions across adult age groups.

Accordingly, we tested four hypotheses. Smartphone salience is positively associated with problematic smartphone use after controlling for demographics and usage frequency (H1). Salience explains incremental variance in problematic smartphone use beyond usage frequency (H2). Perceived social relatedness moderates (attenuates) the salience–problematic use association (H3). Age moderates this association (H4).

2. Methods

2.1 Participants and Procedure

A total of 198 adult university students participated in the study. Participants were enrolled in undergraduate (BA) and graduate (MA) programs at universities in Zagreb (Croatia) and Luxembourg. The sample ranged in age from 18 to 51 years (M = 23.67, SD = 5.38) and was gender-balanced, with 97 participants identifying as male (49%) and 99 as female (50%); 2 participants (1%) did not report their gender. All participants owned a smartphone and completed an online questionnaire after providing informed consent. Participation was voluntary and anonymous, and the study protocol was approved by the ethics committee of Zagreb School of Economics and Management.

Of the 198 participants, 16 had incomplete data on one or more analysis variables (primarily age, n = 11) and were excluded via listwise deletion, yielding an analytic sample of N = 182 for all regression models.

2.2 Measures

Mobile Phone Salience (MPS-7). Smartphone salience was assessed using a 7-item Mobile Phone Salience Index (MPS-7), developed for the present study to capture the cognitive and behavioral prominence of the smartphone in everyday life (see Appendix). Items were rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree), with higher scores indicating greater salience. Example items include "I regularly check my phone even if it does not ring" and "My phone is within my reach even at night." Prior to scale construction, factorability diagnostics supported adequacy for exploratory factor analysis (KMO =.75; Bartlett's test $\chi^2(45) = 589.36$, $p < .001$). Exploratory factor analysis (principal axis factoring) was conducted on the initial 10 items. In the one-factor solution, two items (items 9–10) failed to load above.40 (h^2 =.15 and.13, respectively), and a third item (item 8) displayed a weak communality (h^2 =.24). In a two-factor solution, items 9 and 10 loaded strongly on a separate factor (.79 and.75), whereas item 8 did not load above.40 on either factor. Substantively, items 9 and 10 tapped a preference for mediated over face-to-face communication (e.g., "I prefer settling a dispute on the phone rather than face to face") rather than the cognitive prominence of the device, and item 8 captured interpersonal worry rather than device salience. All three were therefore excluded, and the remaining seven items formed a coherent single factor with acceptable internal consistency (Cronbach's α =.78). A composite salience score was computed as the mean of the retained items.

Problematic Smartphone Use (PSU). Problematic smartphone use was assessed using a 10-item self-report scale designed to capture functional impairment and maladaptive patterns of smartphone engagement in everyday contexts (see Appendix). Although several validated scales for problematic smartphone use exist (e.g., the Smartphone Addiction Scale [15]; the Mobile Phone Problem Use Scale [16]), the present study developed a context-specific 10-item measure to ensure conceptual alignment with its focus on everyday functioning and attentional outcomes rather than clinical addiction indicators. Items were rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Example items include "I have difficulty controlling the amount of time I spend on my smartphone" and "I feel a strong compulsion to check my smartphone even when I know there is nothing urgent or important." Factorability diagnostics indicated suitability for factor analysis (KMO =.88; Bartlett's test $\chi^2(45) = 898.14$, $p < .001$). Exploratory factor analysis using principal axis factoring supported a unidimensional structure, with all items loading strongly on a single factor (loadings ≥.53), explaining 45% of the variance. The scale demonstrated excellent internal consistency (Cronbach's α =.89). A composite PSU score was computed by averaging item responses.

Perceived Social Relatedness. Perceived social relatedness was assessed using the 8-item relatedness subscale of the Basic Psychological Need Satisfaction Scale [17], capturing the extent to which participants felt socially connected, accepted, and supported by others. Items were rated on a 5-point Likert scale, with higher scores indicating greater satisfaction of the need for relatedness [9]. The scale demonstrated acceptable internal consistency (Cronbach's α =.71). A composite score was computed by averaging item responses.

Smartphone Usage Frequency. Self-reported smartphone usage frequency was assessed using a single-item measure asking participants to indicate how frequently they use their smartphone in daily life, on a 5-point Likert scale, with higher scores reflecting more frequent

use. This measure captured overall usage intensity and served to distinguish frequency of use from cognitive salience in subsequent analyses.

2.3 Analytic Strategy

Analyses were conducted in R. Descriptive statistics and zero-order correlations were first examined for all study variables. To examine the association between smartphone salience and problematic smartphone use beyond usage frequency and individual differences, a series of regression analyses with sequential entry of predictors was conducted. In baseline models, age, gender, and smartphone usage frequency were included as covariates, and smartphone salience was then added as the focal predictor. To explore potential boundary conditions, interaction terms between salience and perceived social relatedness as well as age were examined in separate models. Continuous predictors were mean-centered prior to computing interaction terms, and interaction effects were further examined using simple slope analyses where applicable.

We acknowledge partial content overlap between the MPS-7 and PSU scales: both include items referencing phone checking and discomfort when the phone is unavailable. However, the two instruments differ in their target construct. MPS-7 items capture the cognitive prominence and accessibility of the device (e.g., keeping the phone within reach, checking without a prompt), whereas PSU items capture functional impairment and loss of control (e.g., neglecting responsibilities, difficulty controlling usage time). At the empirical level, the zero-order correlation between the two composites was moderate (r =.41), indicating approximately 17% shared variance—consistent with conceptually related but distinct constructs. Furthermore, variance inflation factors in all regression models remained low (VIF ≤ 1.32), suggesting that multicollinearity did not compromise the estimates.

3. Results

Variable	M	SD	α	1	2	3	4	5
1. PSU	2.70	0.83	.89	—				
2. MPS-7	3.59	0.79	.78	.41***	—			
3. Usage frequency	4.21	0.75	—	.52***	.48***	—		
4. Relatedness	5.06	0.90	.71	−.12	−.03	−.10	—	
5. Age	23.78	5.41	—	−.10	−.05	.04	−.03	—

Table 1. Descriptive statistics, reliability coefficients, and zero-order correlations (N = 182). *Note:* ***p <.001.

Table 1 presents descriptive statistics, internal consistency coefficients, and zero-order correlations for all study variables. To examine whether smartphone salience was associated with problematic smartphone use beyond demographic factors and usage frequency, a regression model including salience, usage frequency, age, and gender was estimated. Smartphone salience emerged as a significant positive predictor of problematic smartphone use (B = 0.20, p =.008), controlling for all covariates. Usage frequency was also positively associated with problematic use (B = 0.49, p <.001). Age showed a marginal negative association (p =.088), whereas gender was not significantly related to the outcome. The model explained approximately 32% of the variance (R^2 =.32), supporting H1.

A hierarchical regression tested whether salience explained additional variance beyond usage frequency and demographics (Table 2). In the baseline model, usage frequency was a strong positive predictor (B = 0.59, p <.001; R^2 =.29). When salience was added, it accounted for a significant increment in explained variance (ΔR^2 =.028), F(1, 177) = 7.19, p =.008. In the full model, both usage frequency (B = 0.49, p <.001) and salience (B = 0.20, p =.008) remained significant, indicating that salience contributes uniquely to problematic smartphone use beyond frequency of use, supporting H2. In practical terms, salience accounted for an additional 2.8 percentage points of explained variance after usage frequency and demographics were already in the model. Although modest in absolute magnitude, this increment was statistically significant and indicates that salience captures a dimension of problematic engagement not reducible to usage frequency. Figure 1 displays the standardized regression coefficients for the full model, illustrating the relative contribution of each predictor: usage frequency showed the largest standardized effect (β =.43), followed by smartphone salience (β =.19).

To test whether perceived social relatedness moderated the salience–problematic use association, a moderation model including salience, relatedness, their interaction, and covariates was estimated. Salience remained a significant positive predictor (B = 0.20, p =.007), whereas relatedness was not significantly associated with the outcome (p =.21). The salience × relatedness interaction was not significant (B = −0.02, p =.79), so H3 was not supported. To test age as a moderator, a further model was estimated; salience again predicted the outcome (B = 0.20, p =.008), and the salience × age interaction was not significant (B = −0.004, p =.75), so H4 was not supported. Across all models, salience consistently predicted problematic smartphone use independently of usage frequency and demographics (Table 3).

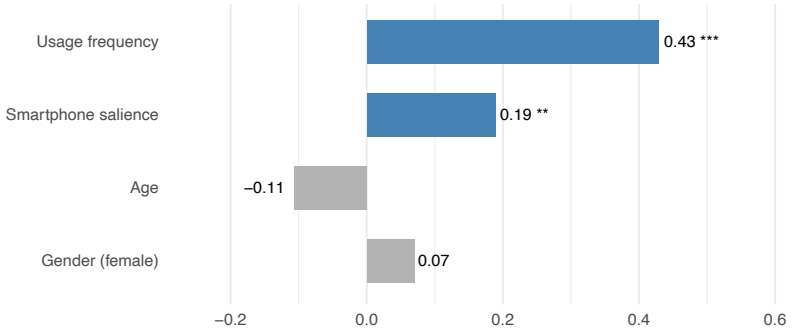


Figure 1. Standardized regression coefficients (β) for the full model predicting problematic smartphone use (N = 182). Blue bars indicate significant predictors. **p <.01, ***p <.001.

Predictor	Step 1: B	Step 1: p	Step 2: B	Step 2: p
Smartphone salience	—	—	0.20	.008
Smartphone usage frequency	0.59	<.001	0.49	<.001
Age	−0.02	.059	−0.02	.088
Gender (female vs. male)	0.07	.530	0.06	.574
R^2	.289		.317	
ΔR^2	—		.028	.008

Table 2. Hierarchical regression predicting problematic smartphone use (N = 182). *Note.* Step 1 R^2 =.289, F(3, 178) = 24.15, p <.001; Step 2 R^2 =.317, F(4, 177) = 20.54, p <.001; ΔF(1, 177) = 7.19, p =.008.

Hypothesis	Description	Result	Key statistics
H1	Salience predicts PSU	Supported	B =.20, p =.008
H2	Salience adds beyond frequency	Supported	ΔR^2 =.028, p =.008
H3	Relatedness moderates salience–PSU	Not supported	B = −.02, p =.79
H4	Age moderates salience–PSU	Not supported	B = −.004, p =.75

Table 3. Summary of hypothesis testing.

4. Discussion

The present study examined smartphone salience as a cognitive mechanism underlying problematic smartphone use, beyond usage frequency and individual differences. Across analyses, salience emerged as a consistent positive predictor of problematic smartphone use, even when controlling for age, gender, and usage frequency. When perceived social relatedness was additionally included as a covariate in the moderation model, salience remained a significant predictor (B = 0.20, p =.007). Problematic engagement with smartphones is thus not solely a function of how often devices are used, but also of the degree to which they remain cognitively salient and mentally accessible.

Importantly, salience explained additional variance beyond self-reported usage frequency, supporting a theoretical distinction between quantitative indicators of digital engagement and qualitative forms of cognitive involvement. Consistent with work emphasizing the cognitive costs of smartphone salience and mental availability [10], these findings position salience as

a proximal cognitive antecedent of problematic use rather than a mere symptom of it. We emphasize, however, that the cross-sectional design cannot establish this ordering: salience may precede problematic use, constitute one facet of it, or emerge as a consequence, and disentangling these possibilities is an important task for longitudinal research.

Contrary to the compensatory-use rationale, perceived social relatedness did not moderate the salience–problematic use association. Although we reasoned that salience would matter less for individuals whose relatedness needs are met, its effect appeared to operate largely independently of perceived social connectedness. Similarly, and against the "digital native" assumption, age did not moderate the association. Together, these null findings challenge the view that problematic smartphone engagement is primarily driven by social deficits or disproportionately affects younger users, echoing evidence that age-related differences in problematic use are often modest in adult samples [13].

4.1 Implications

These findings carry practical implications wherever sustained attention is at a premium. Because problematic use was associated with cognitive salience rather than usage frequency alone, interventions that target only screen time may miss the underlying mechanism. More promising are measures that reduce the mental prominence of the device—for example, norms that limit notifications, removing the phone from the visual field during focused work (in our data, keeping the phone "within reach" is a core salience marker), and training in attentional self-regulation. In organizations, this speaks to the design of recovery periods and interruption norms. In higher education specifically, from which our sample was drawn, the same logic suggests concrete steps for educators: designing learning environments and classroom policies that lower device salience, and helping students develop metacognitive strategies to manage the pull of the smartphone during study and lectures. Framing digital well-being around salience rather than screen time may thus be more actionable for both employers and educators.

4.2 Limitations and Future Directions

Several limitations qualify these conclusions. First, the cross-sectional design precludes causal inference and leaves the temporal ordering of salience and problematic use unresolved. Second, all measures were self-report, raising the possibility of common-method variance. Because both focal constructs were assessed with newly developed, context-specific indices, some content overlap between salience and problematic-use items is acknowledged (r =.41); future work should establish their discriminant validity against established problematic-use and preoccupation measures, ideally with confirmatory factor analysis in independent samples. In particular, a formal test of whether salience is redundant with the cognitive-preoccupation items of problematic-use scales—which the present data did not allow—would strengthen the construct claim. Third, usage frequency was captured with a single, coarse self-report item; objective usage logs and experience-sampling would provide finer-grained and less biased estimates. Fourth, the sample consisted of university students; although this aligns the study

with higher-education concerns and spans a meaningful adult age range, replication in broader occupational populations is needed. Finally, future research could incorporate additional contextual factors—work demands, personality, and technology-design features—that may shape the development and consequences of smartphone salience.

5. Conclusion

Moving beyond screen time, this study identifies smartphone salience—the cognitive prominence and mental accessibility of the device—as a predictor of problematic smartphone use that contributes uniquely beyond usage frequency. We found no evidence that this association varied as a function of perceived relatedness or age, suggesting that cognitive salience may represent a general vulnerability rather than one confined to socially disconnected or younger individuals.

For researchers, these findings underscore the need to complement frequency-based measures with indicators of cognitive involvement when studying digital well-being. For educators in higher education, the practical implication is that policies targeting screen time alone—such as phone bans—may be insufficient; more effective approaches may involve reducing the mental prominence of the device through environmental design (e.g., phone-free zones, notification management) and fostering students' metacognitive awareness of attentional capture. For organizations more broadly, the results suggest that digital well-being interventions should attend not only to how much employees use their devices, but to how persistently those devices occupy their attention during focused work and recovery.

Future research should examine these dynamics longitudinally and in more diverse populations, and establish the discriminant validity of smartphone salience against related constructs using confirmatory approaches.

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6. Appendix. Scale Items

Problematic Smartphone Use (PSU) items

1. I feel anxious or distressed when I am unable to use my smartphone.
2. I prioritize using my smartphone over other important activities in my life.
3. I have difficulty controlling the amount of time I spend on my smartphone.
4. I neglect responsibilities, such as work or school, due to my smartphone use.
5. I experience withdrawal symptoms, such as irritability or mood swings, when I am unable to use my smartphone.
6. I find myself using my smartphone excessively, even when it is not necessary or appropriate.

7. My smartphone use interferes with my ability to concentrate or focus on other tasks.
8. I have strained relationships with others due to my excessive attachment to my smartphone.
9. I feel a strong compulsion to check my smartphone even when I know there is nothing urgent or important.
10. I experience distress or negative emotions when I am not able to use my smartphone for an extended period.

Mobile Phone Salience Index (MPS-7) items — retained items in bold

1. **I regularly check my phone even if it does not ring.**
2. **I feel bad when I leave my phone at home / when it runs out of battery.**
3. **My phone is within my reach even at night.**
4. **If I left my phone at home, I would be willing to go home for it.**
5. **When I sit down somewhere, I put my phone at a visible place, within my reach.**
6. **I'm nervous if I cannot be reached on the phone.**
7. **I'm nervous if I cannot get through to somebody immediately.**
8. If a close friend / family member doesn't pick up the phone, I start to worry.
9. I prefer talking about awkward things on the phone rather than face to face.
10. I prefer settling a dispute on the phone rather than face to face.