REVIEW ARTICLE

Addiction, donut, or extended self: An interpretive analysis of nomophobia

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ABSTRACT

Nomophobia refers to the anxiety individuals experience when unable to effectively connect to the internet. Traditional explanatory frameworks often interpret this phenomenon as withdrawal symptoms, leading to an over-pathologization of daily behaviors. Theories from neutral perspective on the other hand, view nomophobia as a psychological manifestation of unmet connectivity needs but often fail to acknowledge the psychological benefits of digital technology. The attachment theory interprets nomophobia as separation anxiety, yet logical inconsistencies remain. Self-extension theories consider digital networks as part of the individual self but insufficiently explore the systemic and unique characteristics of the internet. A systematic literature review was conducted to identify key concepts following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, involving structured search queries, screening, eligibility assessment, and data extraction. *Via* evaluating and comparing these perspectives, this study introduces the concept of "Internet extension of virtual capacity" as a complementary enhancement to existing theories. Overall, the conceptual landscape surrounding this topic is characterized by significant overlap and ambiguity. Future research should aim to delineate the boundaries and applicability of these concepts to better understand the ambivalent "love-hate" relationship between human and Internet.

Key words: nomophobia, fear of missing out, phone attachment, self-extension, mobile psychology

INTRODUCTION

Nomophobia, short for "no-mobile-phone phobia", is defined as the fear, anxiety, or discomfort arising when individuals are without electronic devices or unable to access them (Rodríguez-García *et al*., 2020). In this study, it is specifically conceptualized as the anxiety experienced due to the inability to effectively connect to the internet. Traditional explanations of nomophobia often adopt a problem-focused lens, framing it within constructs such as internet addiction, smartphone addiction, or problematic smartphone use. These concepts vary in their characterization of individuals' dependence on technology and remain debated regarding their clinical validity and neurophysiological distinctions. Despite these differences, at the behavioral level, these frameworks address similar phenomena by highlighting the negative impacts of digital technology, explaining nomophobia through the lens of problematic use.

In this context, the human-technology relationship is predominantly characterized as one between a user and a tool, with an emphasis on over-reliance on technology. While the utility of electronic devices in facilitating instant communication, entertainment, social interaction,

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and knowledge acquisition is widely acknowledged, most psychological research within the problematic use framework focuses on the physiological, psychological, and social harms of these technologies. This dichotomy reduces the conversation to "technological benefits versus psychological harms", framing electronic devices merely as tools without considering their deeper roles in modern life.

However, in the post-pandemic era, we are more reliant than ever on the internet and electronic devices, which have become an essential part of everyday life. Even the "abuse" of internet technology and electronic devices can be regarded as normal behaviour that is in line with a certain lifestyle and a way to cope with stress (Toda *et al*., 2006). We now seem to have entered an era of 'media saturation' in which we are 'always online and always connected' (Reinecke *et al*., 2018). Maintaining one's online presence and availability has also become a basic assumption and essential element of social life by default. The online and offline worlds are integrated to form positive patterns of internet use, and the boundaries between them are becoming increasingly blurred (Lin *et al*., 2018b).

Given the transformative role of technology in reshaping lifestyles, researchers must reexamine the functions of electronic devices and reassess the human-technology relationship. The shifts in perspective are necessary to understand the psychological dynamics between individuals and digital networks. Beyond traditional frameworks of problematic use, newer concepts such as fear of missing out (FoMO), habitual internet use, and online vigilance have emerged to capture the nuanced psychological structures underlying the human-technology bond. Attachment theory and self-extension theory have also provided foundational frameworks for explaining these connections. In light of these evolving perspectives, how should nomophobia be redefined, and how can the psychological ties between individuals and technology be better understood? The current body of research is fragmented, with overlapping and inconsistently applied concepts, raising challenges for quantitative reviews (Akbari *et al*., 2021). To address this, this study seeks to examine and clarify the key concepts used to explain nomophobia, identify their unique contributions and limitations, and explore the complex psychological relationship between humans and digital networks.

METHODS

Our review process was executed in two distinct stages.

Concept identification

Firstly, the articles relevant to theoretical frameworks to explain nomophobia were reviewed. This exploratory review allowed us to identify nine key concepts commonly associated with the phenomenon to provide a comprehensive explanatory framework, based on their representativeness, existing empirical research, and ability to capture different dimensions and perspectives of nomophobia. The identified concepts were categorized as follows: (1) Negative perspective. Internet addiction, smartphone addiction, problematic smartphone use; (2) Neutral perspective. FoMO, habitual internet use, online vigilance, digital stress; (3) Positive perspective. Phone attachment, smartphone self-extension.

Literature search and data extraction

We conducted a systematic search using Google Scholar and Web of Science to retrieve studies related to each of the nine identified concepts. The search and selection process was inspired by PRISMA guidelines (Moher *et al*., 2010) and involved the following steps: (1) Identification. We developed structured search queries using each concept term itself to retrieve relevant literature, ensuring comprehensive coverage of theoretical and empirical discussions. (2) Screening. Duplicate records were removed, and the remaining studies underwent an initial screening based on title and abstract to determine their relevance. (3) Eligibility. Full texts of potentially relevant studies were reviewed based on predefined inclusion criteria: Empirical studies, systematic reviews, and theoretical papers with validated frameworks were included. Exclusion criteria involved studies focusing solely on general smartphone use without theoretical explanation of Internet use. (4) Inclusion: Studies that met all criteria were included for detailed data extraction and synthesis.

After summarizing the extracted literature, we conducted an in-depth analysis and synthesis of the concept of nomophobia and its associated explanatory frameworks.

CONCEPTUALIZATION OF NOMOPHOBIA

Defining nomophobia

Nomophobia, a portmanteau of "no mobile phone" and "phobia", has been described as a pathological fear of disconnection from technology (King *et al*., 2010). Definitions range from "fear, anxiety, and discomfort caused by being without electronic devices or unable to access them"(Rodríguez-García *et al*., 2020) to "anxiety triggered by disconnection from mobile networks or smartphones"(Anshari *et al*., 2019).

However, the characterization of nomophobia as a "phobia" may be inaccurate. Rather than a specific phobic disorder, it is more appropriately understood as a form of anxiety. The definitions of nomophobia lack

consensus on the specific type of emotional experience involved. Although the term includes "phobia", the predominant emotional component across definitions appears to be anxiety rather than fear. A review of the most widely used measurement tool for nomophobia, the Nomophobia Questionnaire (NMP-Q), supports this interpretation. Among the 20 items in the NMP-Q, 10 directly reflect anxiety-related terms such as "nervous" and "anxious", compared to only 2 items explicitly related to fear, such as "afraid" and "scared"(Yildirim & Correia, 2015). This distribution further suggests that nomophobia is more accurately classified as anxiety.

Additionally, the "nomo"(no mobile phone) aspect of the term is also imprecise. Nomophobia extends beyond the mere absence of mobile phones to encompass anxiety triggered by disconnection from broader virtual environments. Devices like laptops and tablets can similarly alleviate or exacerbate the condition. In fact, many definitions of nomophobia include electronic devices other than mobile phones, reflecting the entire virtual communication environment (Yildirim & Correia, 2015). Some researchers also believe that the method and device used to access the internet may not be important compared to motivation and cognitive and emotional factors (Griffiths, 2020; Montag *et al.*, 2021), because once the main technological channel changes, scales measuring similar constructs will have to be reinvented again and again (Janicke-Bowles *et al.*, 2023), but the essence of technology use has not changed. Naming different pathological concepts for different devices and ways of accessing the internet may lead to diagnostic inflation (Starcevic *et al.*, 2021), and as technology continues to evolve, old terms, old measurements and old studies will be eliminated after the primary access device changes, so it is necessary to grasp the core essence of internet connection. Given that the mobile phone is still the main communication tool to date and epitomises nomophobia (Nie *et al.*, 2020), and that the vast majority of current research focuses on mobile devices, the theories presented and the references used in this study will also incorporate research related to mobile phone use in addition to the main focus on the internet.

Therefore, while the term "nomophobia" has gained wide traction, it does not fully align with its actual implications. An alternative, such as "network disconnection anxiety", may better reflect the underlying psychological phenomenon. However, introducing a new term risks further conceptual confusion. For this reason, this study adopts the term "nomophobia" and redefines it as "the anxiety experienced due to the inability to effectively connect to the internet"—while acknowledging its limitations.

Nomophobia as a non-pathological phenomenon

Meta-analyses of nomophobia reveal significant heterogeneity in prevalence, symptom severity, and demographic differences, likely stemming from conceptual ambiguities (León-Mejía *et al.*, 2021). One key debate is whether nomophobia constitutes a pathological condition. Perspectives range from viewing it as a subclinical behavioral issue (Liu *et al.*, 2022) to classifying it as a harmful behavioral addiction (Anshari *et al.*, 2019), a disorder (Adawi *et al.*, 2019), or even a proposed phobia for inclusion in Diagnostic And Statistical Manual Of Mental Disorders Fifth Edition (DSM-V) (Bragazzi & Del Puente, 2014; Lin *et al.*, 2018a). Some scholars further position nomophobia as an epidemic or public health concern (Naser *et al.*, 2023).

Although certain studies link nomophobia to negative psychological outcomes (Gentina *et al.*, 2018), others argue that mild anxiety when separated from one's phone is a normal response that rarely leads to severe consequences (King *et al.*, 2010). More extreme forms of nomophobia—those that significantly disrupt daily functioning—are far less common. We suggest a continuum-based framework, which could classify nomophobia as a mild, common phenomenon, problematic use as moderate, and pathological use (*e.g.*, internet addiction) as severe. This perspective acknowledges that while individuals may shift between these categories, mild cases are often benign and reflective of unmet social needs in modern contexts (Sui & Sui, 2021).

Predominantly, research samples investigating nomophobia comprise functionally intact individuals—who are not deemed candidates for clinical intervention—with study populations primarily consisting of university students and youth/adolescents (León-Mejía *et al.*, 2021), rather than representing a comprehensive age spectrum. Consequently, despite nomophobia being conceptualized as a pathological symptom, current investigative approaches continue to examine the phenomenon through a standard psychological lens, eschewing epidemiological methodologies and thus misaligning with a pathological interpretation.

Should nomophobia be construed as a pathological condition substantially impairing individual functionality, the current research subjects and their prevalence rates significantly exceed the anticipated diagnostic boundaries. A meta-analysis study conducted up to September 15, 2022, utilizing random-effects meta-analysis, evaluated nomophobia prevalence across diverse populations. The findings revealed a globally aggregated prevalence of 93.92% encompassing mild, moderate, and severe nomophobia (Jahrami *et al.*, 2022).

This empirical evidence suggests that nomophobia is more accurately conceptualized as a normative life experience rather than a clinical disorder. Considering the pivotal role of digital networks and electronic devices in contemporary society, concerns about being unable to communicate and access information can be considered a normal reaction when an individual's social needs are not met. Nomophobia merely reflects the standard communicative requirements of modern social interactions (Sui & Sui, 2021). One could argue that digital dependency does not constitute an extreme or pathological condition, but rather a normative phenomenon with biological foundations and functional advantages (Konok *et al*., 2016).

In summation, this study employs the term "nomophobia", and adopts the definitional parameter of "the anxiety experienced due to the inability to effectively connect to the internet". Concurrently, the research posits that if one merely examines the objective phenomenon of "individuals experiencing anxiety upon separation from mobile devices or networks", nomophobia is, in essence, a normative occurrence rather than a pathological condition. Its potential associations with adverse consequences may be more compellingly explained through alternative covariate analyses. Within the contemporary societal context, mobile devices have transcended their status as recreational accessories to become indispensable functional instruments. Their ubiquity, criticality, and necessity are not fundamentally rooted in negative psychological addiction, but rather in the essential functionality these devices provide to modern life. Consequently, beyond the problematic usage perspective, it is imperative to interpret nomophobia through a non-pathological interpretative lens.

THREE PERSPECTIVES OF EXPLANATIONS FOR NOMOPHOBIA

After clarifying the definition of nomophobia, the next step involves understanding the concepts used to explain this phenomenon. Various concepts, including addiction frameworks, FoMO, online vigilance, mobile attachment, and self-extension theory, have been employed to elucidate the causes and mechanisms of nomophobia. Broadly, these theories can be grouped into three perspectives based on their attitudes toward digital technology and its role in human life.

Negative Perspective views the human-technology relationship through a critical lens, characterizing technology as an "addictive substance". Neutral Perspective emphasizes unmet informational needs and interprets technology as a "donut" where the quality and quantity of its use determine its impact rather than the technology itself. Positive Perspective highlights the beneficial psychological connections between individuals and digital devices, likening technology to a "comfort object" or an "extended self".

Negative perspective: explanations based on problematic use

Numerous specific concepts are associated with the problematic usage framework, including mobile phone addiction, internet addiction, problematic internet use, and media dependency. These concepts' definitions and applicability remain subjects of ongoing academic debate, with no consensus yet achieved. In the domains of mobile and internet usage, the most significant impediment is the diversity of available terminologies, standards, classifications, and conceptual frameworks (Panova & Carbonell, 2018). A proliferation of similar terminologies has emerged, yet the boundaries between these terms remain ambiguous, with their applications being nearly indistinguishable or virtually identical. This complexity exacerbates the field's conceptual confusion and generates substantial heterogeneity across research studies (Panova & Carbonell, 2018). Consequently, this study will select three archetypal concepts—internet addiction, mobile phone addiction, and problematic mobile phone use—for detailed exposition and critical differentiation.

Internet addiction

Internet addiction was first systematically studied by Young (2000), who categorized it into five subtypes: addiction to computers, information retrieval, compulsive interaction, online gaming/shopping, and cybersexual activities. Among these, online gaming addiction has been recognized as a diagnosable condition in the DSM-5 (2013) and International Classification of Diseases, 11th Revision (ICD-11) (2018). Despite ongoing debates regarding whether internet addiction should be equated with substance addiction, it remains a prominent topic in both academia and public discourse (Brand *et al*., 2016).

Although initial conceptualizations of internet addiction originally encompassed five distinct subcategories, contemporary research predominantly approaches internet addiction as a holistic construct. Internet addiction is framed as a behavioral addiction and impulse control disorder (Young, 1998). It is often explained using the Interaction of Person-Affect-Cognition-Execution (I-PACE) model, which attributes addiction to the interplay of predisposing variables, emotional and cognitive responses to specific stimuli, and executive functions like impulse control (Brand *et al*., 2019). Over time, behaviors driven by positive reinforcement (*e.g.*, enjoyment) transition to those motivated by negative reinforcement (*e.g.*, anxiety

reduction). However, the anxiety and irritability experienced by users upon disconnection from the internet differs from substance addiction, as it does not induce severe physiological or medical withdrawal symptoms (Brand *et al.*, 2016). This withdrawal-like state, which lacks clear pathological characteristics, bears remarkable similarity to nomophobia.

Smartphone addiction

Following the recognition of internet addiction as the earliest and most prototypical form of technology addiction, smartphones have increasingly been identified as a potential source of behavioral addiction (Lin *et al.*, 2015). Given the global replacement of traditional mobile phones by smartphones, this study exclusively uses the term "smartphone" to refer to these devices and focuses solely on smartphone usage. Excessive and uncontrolled engagement with smartphones has been characterized as an addictive behavior, with smartphone addiction being described as one of the most severe addictions of the 21st century (Shambare, 2012). This form of addiction is defined by six core features: habitual use, compulsivity, voluntary engagement, dependency, coercion, and addictive patterns (De-Sola Gutiérrez *et al.*, 2016).

Nomophobia and smartphone addiction share many overlapping characteristics, the most significant being that smartphones serve as a source of relief and comfort (Harkin, 2003). The relationship between smartphone addiction and anxiety has been well-documented. A 2017 meta-analysis reviewed nine studies evaluating anxiety symptoms, eight of which reported a significant association between anxiety and smartphone addiction/use (Elhai *et al.*, 2017). When separated from their smartphones, many individuals exhibit heightened anxiety (Cheever *et al.*, 2014) and symptoms resembling physiological withdrawal (Clayton *et al.*, 2015). Additionally, studies have demonstrated a strong positive correlation between nomophobia and smartphone addiction (Buctot *et al.*, 2020; Yildiz Durak, 2019). From this perspective, it is reasonable to interpret nomophobia as a withdrawal symptom of smartphone addiction.

Problematic smartphone use

The tendency to label popular technological behaviors as addictive appears to be on the rise (Panova & Carbonell, 2018). However, the concept of smartphone addiction emerged a priori from a non-theoretical perspective, and researchers caution against pathologizing excessive smartphone use (Billieux *et al.*, 2015). Even in the context of substance use, evidence suggests that certain levels of usage can be harmless and even adaptive (Schulenberg *et al.*, 2000). Given the potential for overuse of the term "addiction"(La LaRose *et al.*, 2003) and the fact that smartphone addiction has not yet been formally recognized as a clinical diagnosis, "problematic smartphone use" may be a more appropriate term. This terminology serves as a non-clinical descriptor of smartphone dependence, bridging the gap between normal and pathological use.

Remarks on the negative perspective of explanations

Despite their contributions, these negative frameworks share significant overlaps and often fail to clearly distinguish between their respective constructs. The causal models of all three concepts—internet addiction, smartphone addiction, and problematic smartphone use—are rooted in the reinforcement framework of internet addiction, employing similar theoretical foundations of positive and negative reinforcement (Elhai *et al.*, 2017). In the case of smartphone and internet addiction, some researchers argue that individuals are addicted to the content rather than the device itself—analogous to being addicted to alcohol rather than the glass used to consume it (Panova & Carbonell, 2018). In this sense, people are "addicted through smartphones" rather than "addicted to smartphones"(Griffiths, 2020). Moreover, smartphone and internet addictions are conceptually intertwined, as smartphones now serve as the primary gateway to internet access. Similarly, the concept of problematic smartphone use seeks to avoid the clinical implications of addiction but largely describes the same phenomena. Overall, the three concepts exhibit substantial similarities, and this lack of conceptual clarity limits their utility in understanding nomophobia.

The current state of this field is marked by an overreliance on correlational studies, cross-sectional designs, convenience sampling, self-reports, and research conducted on generally healthy populations. These methodological limitations hinder substantial advancements in understanding the phenomena. While it is undeniable that a small proportion of individuals experience genuine addiction, dependence on networks and smartphones has become a widespread norm rather than a pathological condition, as these technologies are indispensable for work, communication, and entertainment. As Griffiths (1998) noted, excessive internet use does not constitute a problem in most cases. Although individuals may experience discomfort when separated from electronic devices (SecurEnvoy, 2012), they rarely exhibit severe psychological symptoms or significant adverse outcomes (Chou *et al.*, 2005).

Furthermore, these frameworks often overlook the normative nature of technology dependence in contemporary life, disproportionately emphasizing harm while neglecting the essential and beneficial roles of

technology. The negative perspective, as one of the earliest theoretical approaches to examining the human-technology relationship, has provided substantial insights into internet usage behaviors and related psychological health issues. However, for most individuals who function normally, these negative constructs fail to adequately describe their reliance on networks and smartphones. Consequently, while the negative perspective is valuable for understanding extreme cases, it offers an incomplete picture of nomophobia for the general population.

Neutral perspective: explanations based on connectivity needs

FoMO

FoMO is operationally defined as the anxiety, worry, or unease stemming from the perception of being excluded from social events, conversations, or experiences within one's broader social network (Przybylski *et al.*, 2013). Research indicates a strong correlation between FoMO and nomophobia, as both can drive compulsive social media use and trigger anxiety during periods of disconnection (GezgİN *et al.*, 2019). For example, FoMO has been shown to explain 30%-41% of the variance in nomophobia (Eskin Eskin Bacaksiz *et al.*, 2022). Conceptually, some definitions of nomophobia explicitly incorporate elements of FoMO, framing it as the discomfort or anxiety associated with being unable to engage with digital communication (King *et al.*, 2010).

However, differences between the two concepts are also considered. FoMO primarily addresses the fear of being excluded from social interactions, whereas nomophobia encompasses broader anxieties, including those unrelated to social media, such as access to entertainment, information, or utilities (Lin *et al.*, 2021). Additionally, while FoMO research primarily focuses on social networks, smartphones have far more functions than social networking, suggest that FoMO alone cannot fully explain nomophobia.

Habitual internet use

Emerging research highlights the role of habitual behaviour in technology use. Habitual internet use refers to automatic, routine engagement with digital platforms, often requiring minimal cognitive effort (Bayer *et al.*, 2022). Some studies have found that habits are a better predictor of smartphone use than the outcome expectations associated with using the phone (Peters, 2009). For example, smartphone usage habits, such as checking notifications or social media, are positively correlated with nomophobia (Okur *et al.*, 2022).

Habitual internet use does not necessarily imply harmfulness. The habitual nature of internet use provides a plausible explanation for the discomfort individuals feel when disconnected. When familiar behavioral routines are disrupted, individuals may experience cognitive dissonance or anxiety. Unlike addiction, habitual use is not inherently pathological but represents an efficient use of cognitive resources, as habits reduce cognitive effort (Oulasvirta *et al.*, 2012). For habit control, the motivation for self-control is more important than the individual's self-control ability (Schnauber-Stockmann *et al.*, 2018), which also means that habits come from uncontrolled motives (for example, there's plenty of time, so there's no need for control), rather than a failure of self-control. Understanding media habits at different levels can help to achieve a more nuanced understanding. Some researchers have classified media habits into five levels: platform, device, interface, behaviour, and action (Bayer *et al.*, 2022). Understanding media habits from a hierarchical perspective can help to understand the consequences of habitual Internet use, because it is possible that some specific sequences of habits affects an individual's well-being, rather than the Internet itself being harmful.

Online vigilance

Online vigilance is a relatively new concept that builds on attentional and instrumental learning theories. It refers to individuals' psychological inclination to remain constantly connected, internalised from technical connectivity to exist as psychological connectedness (Johannes *et al.*, 2021; Reinecke *et al.*, 2018). Unlike specific devices, online vigilance reflects a broader digital ecosystem in which connectivity becomes an ingrained psychological state (Reinecke *et al.*, 2018).

Checking habits, *i.e.*, frequent, brief interactions with smartphones, such as checking notifications or scanning for updates, occupy a large portion of mobile phone usage and can be considered specific behaviors developed by individuals driven by a tendency to remain continuously connected and perpetually online (*i.e.*, online vigilance). These behaviors are not necessarily goal-directed but are reinforced by the perceived benefits of staying informed and connected (Oulasvirta *et al.*, 2012). Importantly, online vigilance emphasizes the continuous integration of digital connectivity into daily life, providing a comprehensive framework for understanding nomophobia in the context of modern communication ecosystems. This theoretical perspective has the potential to answer the question of possible device differences in the psychological connection between the internet and people. More specifically, the reason why the mobile phone has such an important position among today's connected devices may be that it is currently the only device that can meet the need for uninterrupted online vigilance and practice high-frequency checking habits - more portable than

computers and tablets, and more comprehensive than smart watches. Compared to laptops, mobile phones have shorter single-use times, longer total use times, and more evenly distributed use times, which also shows that mobile phones are more suitable for devices with universal checking habits (Oulasvirta *et al.*, 2012).

Digital stress

In this study, digital stress refers specifically to the pressures associated with maintaining connectivity and managing excessive digital information. This concept,established by Steele et al. (2020), is defined as "the stress and anxiety induced by communication technologies, including notifications and usage through mobile and social media platforms". It emphasizes the subjective experience of receiving digital input that exceeds an individual's capacity to manage or respond to societal expectations. Among its five subdimensions are FoMO and online vigilance.

Within this framework, Vanden Abeele *et al.* metaphorically describe digital stress as a "donut". The impact of a donut on health depends not on its inherent nutritional value or an individual's self-control, but on whether its quantity and quality match the person's capacity, resources, and situational context. Similarly, the concept of digital stress posits that neither network connectivity nor digital information is inherently good or bad. Instead, the psychological impact of digital engagement depends on whether the quantity and quality of information align with an individual's ability to process it and their expectations (Vanden Abeele *et al.*, 2022).

Although Steele and Hall's definition of digital stress focuses on social media usage, it is more accurate to interpret it as the pressures of a "permanently online" lifestyle. These pressures arise from the demands of information acquisition, social engagement, constant presence, and self-presentation in the digital age, rather than from any specific social media platform. Accordingly, the scope of digital stress extends to the entire online environment, with the potential to explore the deeper impacts of networks on personal life. This perspective aligns closely with insights from self-extension theory, which will be discussed later in this study.

Remarks on the neutral perspective of explanations

The four theories within the neutral perspective exhibit a degree of overlap and inclusion. Habitual internet use can be integrated into the broader concept of online vigilance, while both online vigilance and FoMO can be subsumed under the umbrella of digital stress. Habits are generally understood as outcomes of cognitive processes (Rosenstein & Grant, 1997) or intentional behaviors (Rubin, 1984), which cannot fully account for the irrational and uncontrolled aspects of media use (La LaRose *et al.*, 2003). Habit formation alone is insufficient to explain media use, as it encompasses both resource-efficient habits and purposeful, deliberate actions (La LaRose *et al.*, 2003). Similarly, internet use cannot be entirely attributed to habitual behavior. The concept of online vigilance extends beyond habits that are low in cognitive resource consumption to include goal-driven and intentional internet usage. In this sense, it represents an update and expansion of habitual internet use. Both FoMO and online vigilance can be understood as manifestations of the pressure to stay constantly connected and informed. These overlapping pressures highlight the shared elements between the two concepts, making them suitable for integration into the broader framework of digital stress.

The four theories within the neutral perspective emphasize the human need for connectivity, offering a cognitive lens to interpret societal phenomena such as "permanent online presence" and the "unceasing flow of information". From this standpoint, nomophobia can be seen as a response to unmet connectivity needs. Using digital stress's metaphor of the "donut" to represent the boundless flow of information in digital society (Vanden Abeele *et al.*, 2022), nomophobia can be likened to the hunger that arises when this need is not satiated. This framework is uniquely positioned to address potential differences in how various devices support connectivity. The demand for constant connection drives habitual checking behaviors, and the convenience of different devices influences the ease with which these habits are maintained. For instance, integrating FoMO and digital stress offers a comprehensive explanation for both information scarcity and information overload.

However, internet use is not exclusively social in purpose, nor is it entirely habitual. While these concepts effectively describe the cognitive needs driving individuals' reliance on the internet, they fall short of exploring the deeper psychological relationships between humans and digital networks.

Positive perspective: relational interpretation

Phone Attachment

The deep relationship between humans and smartphones stems not only from their functionality but also from their ability to alleviate negative emotions, making them a form of "comfort technology" that functions as an attachment object (Diefenbach & Borrmann, 2019). Empirical studies indicate that users are drawn to smartphones not merely because of their utility but also due to deeper emotional benefits. Smartphones have been likened to an "adult pacifier", providing psychological comfort to users (Melumad & Pham, 2020). Under stress, users are more likely to seek comfort in their smartphones, finding relief that

mitigates their anxiety. This emotional benefit is not a broad positive impact but specifically tied to a sense of comfort (Melumad & Pham, 2020).

In recent years, the concept of smartphone attachment has gained attention. Researchers argue that smartphones, as tools for maintaining relationships and storing social interactions, qualify as objects of attachment and are more likely to become compensatory attachment targets than other material possessions (Konok *et al.*, 2016). Like other forms of object attachment, compensatory attachment to smartphones often stems from the unreliability of primary attachment figures. For example, studies have shown that young people view smartphones as sources of security (Fowler & Noyes, 2015). Among individuals who experience uncertainty in their relationships, smartphones elicit proximity-seeking behaviors and separation anxiety (Keefer *et al.*, 2012).

Existing studies provide four key pieces of evidence supporting the concept of smartphone attachment: (1) Smartphones offer comfort and a sense of security in stressful situations (Melumad & Pham, 2020); (2) Users exhibit proximity-seeking tendencies toward their smartphones; (3) Separation from smartphones triggers stress responses (Konok *et al.*, 2017); (4) Other communication tools cannot substitute smartphones as attachment objects during separation anxiety (Nie *et al.*, 2020).

However, this emotional bond between individuals and phones is not limited to comfort and security. A 2005 focus group conducted across four countries revealed that people's experiences with smartphones are often contradictory (Jarvenpaa & Lang, 2005). For instance, while individuals enjoy the benefits of staying connected, they also resent the constant effort required to maintain such connectivity. Smartphones' ability to facilitate continuous communication is simultaneously their most appreciated and most disliked feature (Baron, 2011). To capture this ambivalence, researchers have proposed a dual-factor model of smartphone attachment comprising "refuge" and "burden." The former represents the positive aspects of smartphone use, such as heightened security and discomfort following separation, aligning with attachment anxiety. The latter reflects the negative aspects, such as relief upon separation and frustration over smartphones disrupting the enjoyment of present experiences, aligning with attachment avoidance (Trub & Barbot, 2016). This model draws on interpersonal attachment theory to emphasize that individuals' experiences with smartphones are not uniform but qualitatively diverse.

Similarly, research indicates that individuals use smartphones in varying ways. For example, users can be categorized as either instant communicators, who prioritize contact with close acquaintances, or information seekers, who engage with broader online platforms. These differences reflect personalized approaches to smartphone use and self-identity construction. Some smartphone usage patterns are more likely to foster attachment than others (Fullwood *et al.*, 2017). This perspective raises the ongoing debate over whether the object of attachment is the device itself or the functionality and content it provides.

Current research on mobile phone attachment is very subtly divided into three perspectives: (1) Smartphone attachment as a form of object attachment, providing comfort through reliability; (2) Smartphone attachment as analogous to interpersonal attachment, highlighting the complexity of feelings toward smartphones, including secure and insecure attachment types. This perspective conflicts with the premise that object attachment depends on reliability and controllability; (3) Smartphone attachment as a function of usage patterns rather than the device itself. However, given the lack of theories and evidence supporting attachment to intangible functionalities (even virtual goods tend to have tangible representations) (Belk, 2013), this perspective may not align well with attachment theory as a foundational framework.

Evaluation of the attachment frame

The attachment framework moves beyond viewing networks and electronic devices merely as tools or objects, delving into their deeper emotional connections with humans. This framework highlights the comforting and stress-relieving functions of networks and devices, emphasizing their psychological benefits. Compared to the negative and neutral perspectives, the attachment framework offers a more positive lens through which to examine dependency on networks and devices (Konok *et al.*, 2016).

However, the concept of human-device attachment remains difficult to fully explain. First, the complex psychological connection people form with smartphones primarily stems from their functionality rather than solely their emotional appeal. Unlike other objects of attachment, smartphones are indispensable tools with significant practical value. In everyday life, separation from necessities often disrupts normal routines, inherently triggering anxiety and other negative emotions. For instance, money provides comfort and security, evokes ambivalent feelings, and can foster proximity-seeking behaviors, separation anxiety, and even serve as a symbol of identity and self-awareness. Yet, few researchers discuss the concept of "money attachment" because the strong emotions associated with money arise primarily from its utility and necessity. The same rationale applies to smartphones.

Second, attachment theory typically posits that an attachment object is fixed and specific for each individual, with varying degrees of attachment to different objects within the same category. However, in the case of smartphone attachment, the target is the general category of smartphones, not a specific device. As long as the functional needs are met, the specific phone model is largely irrelevant. When other objects of attachment are damaged—such as a toy bear cherished by a child—the individual is likely to feel nostalgic and unwilling to replace it. In contrast, smartphone users readily switch to newer models that offer better performance and seamlessly transfer data and memories from the old device. For example, a Counterpoint Research study reported that the global average smartphone replacement cycle is just 21 months, despite a typical smartphone lifespan of 3-4 years (Lu, 2017). This indicates that people often replace their phones while the old ones are still functional, a behavior inconsistent with attachment's defining characteristics.

Third, smartphone attachment is primarily discussed as a form of object attachment, which Bowlby (1969) defined as a compensatory strategy when primary attachment figures are unavailable. However, given the ubiquity of smartphone use, people maintain a high level of dependence on their devices even when their primary attachment figures remain intact. This contradicts the notion of object attachment as a compensatory or substitute strategy.

Therefore, although it is an attractive explanation, it seems that considering the mobile phone itself as an attachment object is not very convincing.

Smartphone self-extension

In addition to smartphone attachment, self-extension theory offers an alternative explanation for separation anxiety, providing a new perspective on human relationships with electronic devices. Self-extension and attachment are not mutually exclusive in understanding human interactions with communication technologies and devices; in fact, self-extension can play a role within attachment (Hoffner *et al.*, 2016). When an object is perceived as an extension of one's identity and characteristics, individuals tend to form stronger emotional bonds and attachment to that object (Han *et al.*, 2017). However, the scope of self-extension is broader than attachment theory, encompassing not only tangible people or objects but also intangible entities such as perspectives, experiences, and knowledge. Moreover, self-extension is considered a fundamental psychological need shared by all individuals (Aron *et al.*, 2022), rather than a compensatory strategy arising from unmet primary needs. Thus, when exploring the relational and positive aspects of human connections with networks and devices, self-extension may offer a more comprehensive framework than attachment theory.

The specific targets of self-extension include not only people but also properties, places, body parts, ideas, emotions, experiences, money, pets, and more (Belk, 2016). As carriers of rich information, resources, emotions, and interpersonal communication tools, electronic devices are increasingly seen as a means of self-extension, akin to relationships with other people. For instance, smartphone users often perceive their phones as extensions of their physical bodies, shaping their identities and ways of existing (Belk, 2016). Research has shown that participants experiencing high levels of nomophobia are more likely to use self-related terms (Han *et al.*, 2017). Consequently, forced separation from electronic devices may resemble relationship disruptions, reducing self-concept clarity (Slotter *et al.*, 2010) and inducing anxiety, making it a plausible explanation for nomophobia.

Current research on incorporating electronic devices into self-extension primarily focuses on smartphones. Smartphones are often considered a "digital umbilical cord", representing an extension of the physical self (Han *et al.*, 2017). This perception stems from several factors: (1) Smartphones can be personalized to reflect their owners' attitudes, values, identities, and social status, with expensive devices serving as status symbols (Wu *et al.*, 2017); (2) Smartphones are bundled with various components that facilitate self-extension, making the device itself a source of self-extension (Ross & Bayer, 2021); (3) As tools for storing, sharing, and accessing personal and collective autobiographical memories, smartphones represent an individual's past self while also serving as references for present and future selves. This contributes to self-construction and enhances the sense of self-extension (Han *et al.*, 2017).

Empirical studies support the connection between smartphones and self-awareness. For example, individuals report higher levels of self-extension when they have access to their iPhones, while their self-awareness decreases during periods of separation (Clayton *et al.*, 2015). Additionally, self-identity has been found to predict smartphone usage frequency (Walsh & White, 2007; Walsh *et al.*, 2010). In some cases, participants have subjectively perceived smartphones as part of their bodies under the rubber hand illusion paradigm, though implicit measures did not yield significant results (Gertz *et al.*, 2021). These findings suggest a potential association between smartphones and individuals' self-awareness.

Researchers categorize the motivations for smartphone self-extension into two types: identity and functionality (Ross & Bayer, 2021). Functional motivation involves using the smartphone as a tool to achieve goals and

extend oneself. In contrast, identity motivation reflects viewing the smartphone as part of one's self-concept, expanding oneself by reinforcing identity (Ross & Bayer, 2021). These motivations align closely with the functions of self-extension, which is understood as an expansion of one's capabilities and self-concept (Leary, 2007). By definition, functional motivation corresponds to the former, while identity motivation aligns with the latter. Identity motivation involves a higher degree of self-concept integration, while individuals with stronger functional self-extension motives are less likely to incorporate smartphones into their self-concept.

Research on smartphone self-extension often simplifies the device to a type of property, without fully exploring how the digital age impacts self-construction. Analogous to heroin addiction, where individuals may develop strong responses to needles due to their association with heroin, the addictive behavior is ultimately attributed to heroin, not the syringe. Similarly, smartphones may elicit strong emotional and psychological responses, but the core issue lies in their role as connected devices. If a more convenient alternative to the syringe appears, the "needle addiction" typically dissipates, and the same reasoning may apply to smartphones. While viewing smartphones as sources of self-extension is compelling, future research should delve deeper into the essence of smartphones as networked devices and the implications of these networks for self-construction.

Remarks on self-extension theory

Self-extension theory posits that networks and devices expand individuals' horizons, enabling them to access more resources, perspectives, and capabilities, thereby enriching their experiences. This perspective offers a positive and logical framework for examining the relationship between humans and network technologies or electronic devices. However, existing research on this perspective has several limitations.

First, the division of smartphone self-extension into identity and functional dimensions presents challenges. As the authors of this framework themselves note, functional self-extension may not represent a true component of self-extension but rather a precursor or subset of identity-based self-extension (Ross & Bayer, 2021). Purely functional extensions involve minimal psychological connection and little impact on self-concept, which does not align with the definition of self-extension. Empirical studies have also demonstrated significant differences between these two dimensions (Ross & Kushlev, 2023).

Second, the roles of electronic devices and networks in self-extension remain unclear. Previous research has not adequately differentiated their respective contributions to self-extension or clarified their similarities and differences in this process. Furthermore, the application of self-extension theory to networks and smartphones is overly vague, failing to specify what aspects or characteristics of these entities integrate into the self and which parts of the self they influence.

Finally, current research merely treats smartphones and networks as generic objects of self-extension, overlooking their distinctiveness. According to Belk (2016), any possession can be part of the extended self. To propose self-extension as an independent concept, the objects involved must possess unique or systemic characteristics. Otherwise, trivial concepts such as "car self-extension" or "water cup self-extension" could emerge, leading to terminological inflation.

Unlike other possessions, networks are both systemic and distinctive. They have deeply infiltrated modern life, globally and comprehensively transforming traditional ways of living while aggregating numerous sources of self-extension. Networks are intangible, indispensable, and unbound by specific physical carriers, distinguishing them from other extension objects. The systemic and distinctive nature of networks suggests that network technology warrants recognition as an independent source of self-extension. Future research should explore these unique attributes in greater depth and differentiate them from other objects of self-extension.

COMPARATIVE ANALYSIS OF THE THREE THEORETICAL PERSPECTIVES

As discussed earlier, the various concepts are built on distinct theoretical perspectives, each with its own focus, explanatory approach, strengths, and weaknesses. This section compares them across dimensions such as theoretical foundation, views on smartphones/networks, underlying causes, and explanations for nomophobia, in order to clarify the relationships between these concepts (Table 1). It is important to note that these theories are not mutually exclusive. Instead, they represent different entry points or emphases and can coexist within the same individual. For instance, a person with problematic smartphone use may simultaneously exhibit smartphone attachment. While smartphone attachment provides positive feelings of security, problematic use may lead to functional impairments with negative consequences.

Broadly speaking, concepts such as internet addiction, smartphone addiction, and problematic smartphone use—representative of the negative perspective—are grounded in a problematic use framework. These theories view nomophobia as a "symptom" of a psychological "problem", interpreted as a form of withdrawal (Tran, 2016). This perspective is rooted in neurobehavioral theories, attributing nomophobia to decision-

Table 1: Comparative Interpretative Concept of Nomophobia

	Negative Perspective				Neutral Perspective			Positive Perspective		
Item	**Internet Addiction**	**Mobile Phone Addiction**	**Problematic Smartphone Use**	**Fear of Missing Out**	**Habitual Internet Use**	**Online Vigilance**	**Digital Stress**	**Phone Attachment**	**Smartphone Self-extension**	**Internet Self-extension**
Theoretical Foundation	Behavioral Addiction	Behavioral Addiction	Positive and Negative	Self-Determination Theory	Cognitive Resource Conservation	Attention Learning	Quality Stress Model	Object Attachment	Self-Extension	Self-Extension
View of Mobile/Internet	Addictive Substance	Addictive Substance	Harmful Substance	Necessity	Daily Habit	Connectivity Tool	Donut	Comfort Object	Part of Self	Part of Self
Cause	Lack of Self-Control	Lack of Self-Control	Lack of Self-Control	Unmet Needs	Cognitive Resource Conservation	Unmet Needs	Information Overload	Insufficient Primary Attachment	Universal Motivation to Extend Self	Universal Motivation to Extend Self
User Description	Pathological	Pathological	Problematic	Anxious	Unconscious	Staying Awake	Unbalanced	Positive	Positive	Positive
Explanation of Nomophobia	Withdrawal Reaction	Withdrawal Reaction	Withdrawal Reaction	Fear of Missing Out	Habit Disruption	Connectivity Disruption	Connectivity Disruption	Separation Anxiety	Loss of Part of Self	Loss of Part of Self
Device Differences	Focuses Only on Internet	Focuses Only on Mobile Phone	Focuses Only on Mobile Phone	Different Convenience of Habit Practice	Different Convenience of Checking Habits	Different Convenience of Checking Habits	Different Convenience of Habit Practice	Focuses Only on Mobile Phone	Focuses Only on Mobile Phone	Focuses Only on Internet
Applicable Scope	Pathological	Pathological	Negative Life-Impacting	Mild Disturbance	Normal Use	Normal Use	Mild Disturbance	Benign Dependence	Benign Dependence	Benign Dependence
Advantages	More Empirical Evidence	Targeted at Primary Device	Avoid Over-Pathologizing Daily Behavior	Captures "Always Online" Social Feature	Recognizes Purposeless Network Use	Captures "Always Online" Social Feature	Can Integrate Concepts to Explain Both Information Insufficiency and Overload	Positive Perspective, Deep Exploration of Human-technology Psychological Connection	Positive Perspective, Deep Exploration of Human-technology Psychological Connection	Positive Perspective, Deep Exploration of Human-technology Psychological Connection
Disadvantages	Over-Pathologizing Daily Behavior, Whether it is an Addiction is Still Controversial	Similar to Internet Addiction, Lacks True Psychiatric Discussion	Still Approaches Daily Behavior Negatively	Internet Not Just for Social Purposes	Network Use Cannot Be Entirely Habitual	Lacks Discussion of Internet and Individual Psychological Connection	Lacks Discussion of Internet and Individual Psychological Connection	Logically Unexplained Areas	Ineffective Dimensional Division, Fails to Use Self-Extension Theory Advantages	Unaware of Internet's Specificity

making deficits and behavioral inhibition failures (Vanden Abeele *et al*., 2022). In this view, the negative emotions experienced when separated from network technology are framed as maladaptive "problems" tied to individual vulnerabilities and excessive dependency. These classic theories benefit from a robust body of research and empirical evidence. However, they often treat network dependency as inherently harmful, overlooking the ubiquity and necessity of this phenomenon in modern society.

Today, network technologies and electronic devices are no longer mere tools; they have become integral to daily life. Viewing them solely through the lens of harm is increasingly outdated and fails to capture the complexity of smartphone use. While these theories provide valuable insights, they need to be complemented with alternative perspectives to reflect the nuanced relationship between individuals and their devices.

The neutral perspective—including concepts such as FoMO, habitual internet use, online vigilance, and digital stress—focuses on the need for informational connectivity and its fulfillment. These theories emphasize the human need to stay connected and attribute the psychological outcomes of technology use to mismatches between needs and fulfillment. For example, if individuals fail to meet their needs to "keep up", "stay online", or "remain updated"(online vigilance) (Johannes *et al*., 2021; Reinecke *et al*., 2018), they may experience FoMO. Similarly, if the amount of information received exceeds their capacity to process it, this can lead to digital stress (Steele *et al*., 2020). While these concepts also highlight negative outcomes, they adopt a more neutral stance compared to traditional problematic use frameworks. Instead of emphasizing restrictions on technology use, they focus on addressing associated psychological factors, making their approach less clinical and more balanced.

Looking across the theories, it becomes apparent that most research neglects the positive psychological aspects

of network usage. Concepts such as smartphone attachment and smartphone self-extension represent a positive perspective, emphasizing the deeper emotional and psychological connections between individuals and electronic devices. Smartphone attachment interprets nomophobia as separation anxiety from an attachment figure (Konok *et al.*, 2017), while self-extension theory frames it as the negative experience of being separated from a part of oneself. These theories argue that the tight dependency on networks is a widespread and inevitable social phenomenon, stemming from the integration of technology into everyday life. By adopting a relational perspective, they explore the psychological connections between humans and networks, recognizing the potential psychological benefits of these relationships.

Although we try to distinguish concepts such as internet addiction, smartphone attachment, and nomophobia, as well as to clarify their relationships, many studies fail to clearly define the underlying psychological structures of these concepts. Without precise definitions, exploring their interrelationships through survey measurements or statistical modeling is unlikely to be productive, as such measurements are built on unclear conceptual foundations. Many existing studies use these concepts without careful differentiation, and research into their correlations often resembles a combinatorial approach, further compounding the confusion in this field.

A NEW EXPLANATION BASED ON SELF-EXTENSION THEORY: INTERNET EXTENSION OF VIRTUAL CAPACITY

The Introduction of internet extension of virtual capacity

After a comprehensive comparison of the aforementioned theories, it is evident that self-extension theory offers a positive lens for exploring human-machine psychological connections without the logical inconsistencies associated with smartphone attachment. However, research based on self-extension theory remains limited in scope. Given the pervasive nature of networks, which have profoundly infiltrated and transformed traditional lifestyles, these changes are systemic and comprehensive, unlike the localized impact of inventions such as the watch. Compared to other objects of extension, networks are intangible, indispensable, and cannot be tied to a single product to satisfy user needs. These unique characteristics set networks apart from other objects incorporated into self-extension, highlighting the need for further exploration in future research.

This study aims to address this gap by reflecting the distinct role of network technologies in self-concept construction within the theoretical framework of self-extension. Building on previous research, the concept of "Internet extension of virtual capacity" is proposed as a complementary enhancement. Internet extension of virtual capacity is defined as the integration of networks as part of an individual's capabilities, unrestricted by specific devices. Based on the foundations of self-extension outlined earlier and the functional and device-independent characteristics of networks analyzed in this study, the core assumptions of this concept are as follows: (1) Device Independence in Virtual Self-Extension: As long as effective network access is ensured, the type of device used does not influence the outcome of self-extension. Self-extension through networks is a virtual process, with mobile devices acting as tools for this extension. Since the actual content of the extension resides in the network, the determining factor for the outcome is the device's ability to facilitate effective network access. Beyond this condition, the device itself does not affect the results of self-extension. (2) Impact of Networks on Self-Efficacy: Mobile devices transform networks into essential human capabilities, serving as carriers for this functionality. Metaphorically, mobile devices can be viewed as virtual organs, like legs, while the network represents the capability of walking. The ability to extend through networks affects an individual's holistic perception of self-efficacy, combining instrumental utility with the identity-based self-extension of "becoming part of oneself." These two dimensions are not mutually exclusive but rather complementary components of a unified system. (3) Networks' Dominant Influence on Self-Efficacy: Virtual capability extension affects the self not just broadly but with a particular emphasis on self-efficacy. While this functional extension may yield secondary effects related to identity, emotions, and other non-functional aspects, these are ancillary and less pervasive in influencing the psychological construction of the self. As of now, such secondary effects have not been extensively or deeply integrated into people's self-concepts.

Under these three assumptions, the relationships between the concepts are illustrated in Figure 1.

The explanation of nomophobia through the internet extension of virtual capacity

The concept of the internet extension of virtual capacity provides a robust explanation for the phenomenon of nomophobia. Enez & Yalçınkaya-Alkar (2022) found that even when individuals are not physically separated from their smartphones, they may experience separation anxiety if communication—the primary purpose of smartphone use—is disrupted. Viewing the smartphone (as a representative of electronic devices) itself as part of self-extension cannot adequately explain this phenomenon. Hoffner *et al.* (2016) suggested that "the

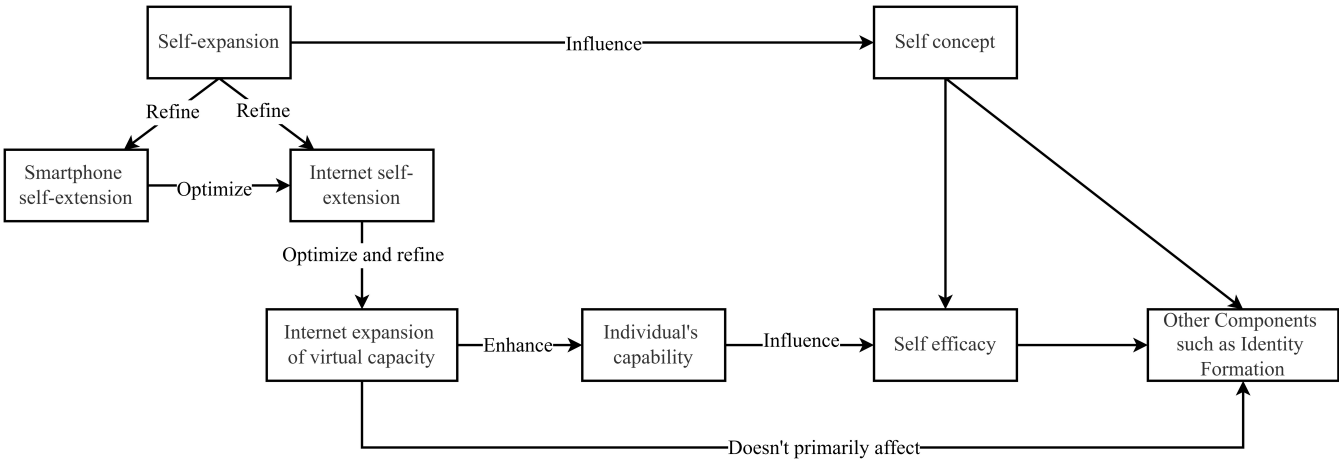

Figure 1. The relationships between the concepts.

negative emotions associated with losing a phone (in part) stem from the loss of the ability to extend one's resources, perspectives, or identity through its use". This aligns closely with the perspective proposed in this study. According to the assumptions of this study, self-extension is not tied to the smartphone itself but to the network as a form of virtual capacity. When individuals are unable to effectively connect to the internet (even if their smartphone remains present), part of their extended self becomes forcibly detached. This disrupts their self-concept, diminishes their sense of self-efficacy, and hinders their ability to perform essential activities or access new information. Consequently, it disrupts routine life trajectories and induces anxiety.

Evidence supporting the internet extension of virtual capacity

The concept of the Internet extension of virtual capacity can be supported by three categories of evidence.

First, from a theoretical perspective, the Internet, as a crucial—if not primary—medium for work, communication, and entertainment, has become indispensable for individuals to exercise their capacities (Hoffman *et al.*, 2004). When individuals have Internet access (even if not *via* mobile phones), they can often accomplish significantly more than when they lack connectivity. Conversely, when deprived of Internet access (even if still in possession of their devices), individuals struggle to perform many routine activities. As discussed earlier in the context of habitual Internet use and Internet vigilance, using the Internet is often habitual and unconscious. It has been deeply internalized by individuals (Johannes *et al.*, 2021; Reinecke *et al.*, 2018), which logically supports the notion that the Internet has become an integral part of individual capacity. This evidence, to some extent, supports Hypothesis 1.

Second, existing research has already incorporated the Internet into the framework of self-extension (Niu *et al.*, 2021). Regarding the aspect of capacity, empirical evidence demonstrates a connection between Internet usage and self-efficacy, supporting Hypothesis 2, which posits that the Internet influences individual self-efficacy. For instance, research has shown that mobile phone dependency has a significant positive effect on students' self-efficacy in autonomous learning (Chen *et al*., 2021). Similarly, social self-efficacy has been found to positively predict mobile phone addiction (Chiu, 2014). These findings support the inclusion of the Internet as a component of self-efficacy. On the other hand, mobile phone addiction has been associated with negative correlations with emotional self-efficacy and coping self-efficacy (Morovati & Yadegari, 2019; Xiao & Huang, 2022). These contrasting results suggest that the negative outcomes of mobile phone use may stem from the researchers' negative framing of mobile phone usage. Therefore, adopting a positive perspective to construct human-computer relationships is crucial. If we continue relying solely on theories based on negative attitudes, such as mobile phone addiction, the positive effects of mobile phones on self-efficacy will remain unexplained.

Finally, regarding Hypothesis 3—that the Internet's impact on self-efficacy is more significant than its influence on other components of the self—direct evidence is scarce. However, prior research using a 7-point Likert scale (1-7) on mobile phone self-extension reveals that functional self-extension scored the highest (mean = 5.58, variance= 0.82), followed by anthropomorphic self-extension (mean= 3.92, variance= 1.36) and ontological self-extension (mean = 3.96, variance = 1.36) (Ross & Bayer, 2021). The questionnaire used to measure Internet self-extension comprises three dimensions: acquiring new experiences and perspectives, a sense of personal growth and new identity, and enhanced abilities and resources (Niu *et al.*, 2021). These

dimensions are closely aligned with the concept of individual capacity rather than emotional or other self-concept components. Even the second dimension, "acquiring a new identity," merges with "a sense of personal growth", which is more aligned with concepts of individual development and enhanced efficacy.

Contributions of the internet extension of virtual capacity to existing theories

The concept of the Internet extension of virtual capacity refines and extends the theory of Internet self-extension, with its contributions to existing theories manifesting in two primary ways: (1) A Theoretical Perspective Emphasizing Self-Extension: By adopting self-extension as the theoretical lens, this approach offers a more positive perspective on Internet use behaviors and provides a more logical alternative to attachment theory. The self-extension perspective highlights the societal dependence on the Internet, a defining feature of the digital information age. It supplements previous theories by focusing on the experiences of the majority of ordinary users, reframing "dependence on the Internet" from a negative state to a neutral or positive phenomenon. This reframing aligns with the evolving societal trend toward closer human-technology integration, providing theoretical guidance for the future. (2) Refinement of the Conceptual Framework: Compared to theories of mobile phone self-extension, the Internet extension of virtual capacity captures the unique characteristics of the Internet. It identifies and emphasizes its virtual nature while distinguishing it from devices like mobile phones. This perspective explains which aspects of the self are extended by the Internet and refines the broad description of the Internet as part of the self into a more targeted conceptualization. By emphasizing "capacity", this approach underscores the functional nature of the Internet and differentiates it from other emotionally charged objects. It highlights the functional essence of the Internet as a tool for extending individual abilities, which sets it apart as a unique concept.

FUTURE DIRECTIONS

The outcomes of Internet use have been shown to vary across different studies, with both positive and negative effects. This inconsistency may stem from the lack of a robust theoretical framework for understanding Internet use. For instance, if social media is conceptualized as a stress-coping strategy, its outcomes may differ depending on context—just as distraction can be an effective strategy in uncontrollable situations but counterproductive in controllable ones (Wolfers & Utz, 2022). Against this backdrop, it becomes particularly important to review and develop theories addressing the use of the Internet and electronic devices. This study systematically examines and clarifies concepts related to nomophobia (no-mobile-phone anxiety) and introduces the concept of the Internet extension of virtual capacity to address the gaps in existing explanatory theories.

While this study focuses on concepts relevant to explaining nomophobia, it is worth noting that many related topics, such as social stress and communication overload (Reinecke *et al*., 2017), the "mobile trap"(Hall & Baym, 2012), and digital flourishing (Janicke-Bowles *et al* ., 2023), have been excluded due to their limited direct relevance to this topic. However, these concepts remain valuable for understanding the psychological connections between humans and Internet technologies and merit further exploration and discussion in future research.

It is evident that the relationship between humans and online technologies is evolving from purely functional connections to more complex psychological associations. People's perceptions of technology are multifaceted, often reflecting a "love-hate" dynamic that warrants special attention. Future research should further investigate the nature of the human-technology relationship, identify appropriate conceptual frameworks to describe it, and explore the various impacts of technology on different aspects of human life. Additionally, it is important to recognize that technology is constantly advancing, and humanity may still be in a "transition period" in adapting to these changes. The ultimate effects and transformations brought about by technology may depend on future innovations and improvements in the technologies themselves.

This study introduces the concept of the Internet extension of virtual capacity, which lays the foundation for future research. Subsequent studies could employ methods such as surveys and experiments to explore the validity of this concept, examine its psychological antecedents and consequences, and investigate its relationships with other variables. Such work would deepen our understanding of the psychological significance of the Internet in contemporary society and its connections with individuals, providing theoretical and empirical support for recommendations on Internet use.

DECLARATION

Author contributions

Li JY: Conceptualization, Writing—Original draft preparation, Writing—Reviewing and Editing. Chen WF: Conceptualization, Writing—Reviewing and Editing, Supervision, Project administration. Liu ZK: Writing—Reviewing and Editing, Supervision, Funding acquisition. All authors read and approved the final

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