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Potential treatments of technology addiction: insights for information systems scholars

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Abstract

Purpose – In this current review, we aimed to understand technology addiction interventions and provide guidelines for IS scholars to use IT to prevent or attenuate technology addiction.

Design/methodology/approach – We systematically reviewed articles associated with technology and substance addiction interventions. These articles included review articles, peer-reviewed articles, conference proceedings, and online articles.

Findings – We propose a roadmap for technology addiction intervention development and testing based on the review. Next, we summarize the similarities and differences between substance addiction and technology addiction in terms of antecedents, negative consequences, and neurobiological mechanisms. Based on this, two types of potential interventions for substance addiction were reviewed to explore how they can be used for technology addiction. To conclude, IT-mediated interventions were summarized, and promising avenues for future research were highlighted.

Originality/value – Technology addiction has a broad range of adverse impacts on mental health and well-being. With the knowledge and insight from this review, the Information Systems community can become part of the solution to technology addiction.

Keywords Technology addiction, Substance addiction, IS theories, Research framework, Interventions without consciousness, Interventions with intention

Paper type Literature review

1. Introduction

While the rapid advances in technology have brought about a variety of benefits, repeated, frequent, rewarding, and reinforcing use can lead to various negative consequences, including technology addiction (Kuss *et al.*, 2014; Turel *et al.*, 2011, 2019; Venkatesh *et al.*, 2019). Technology addiction refers to a state of maladaptively seeking and using technology to a point where typical behavioral addiction symptoms emerge, and normal functioning is infringed upon (Turel *et al.*, 2018a, b). Six core symptoms are associated with technology addiction, including salience, mood modification, tolerance, withdrawal, conflict, and relapse (see Griffiths, 2018). Thus, technology addiction is a type of behavioral addiction where people conduct addictive behaviors via means of technology artifacts (Serenko and Turel, 2020). Consistent with prior research (Turel *et al.*, 2011), we use the term "technology addiction" as opposed to similar terms, such as "excessive" or "problematic" use, for convenience reasons. Meanwhile, we acknowledge that the terminology for describing such symptoms is yet to be finalized (Carbonell and Panova, 2017). Examples of technology addiction include, but are not limited to, internet use addiction (Venkatesh *et al.*, 2019), online gaming addiction (Xu *et al.*, 2017), online social networking addiction (Xu *et al.*, 2022), and smartphone addiction (Kuem *et al.*, 2021; Ning *et al.*, 2018, 2022). Notably, these are all technology artifacts that have been core elements in information systems research.

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The importance of technology addiction stems from its associations with a broad range of adverse phenomena such as sleep disturbances, depression, low life satisfaction, increased body mass, decreased academic performance, and family-work conflict (Liu *et al*., 2017; Kuem *et al*., 2021; Samaha and Hawi, 2016; Venkatesh *et al*., 2019). Consequently, technology addiction has brought increasing concerns for public health (Block, 2008), and calls have been issued for finding effective treatments for technology addiction (Zhang *et al*., 2020).

In response, both Information Systems (IS) scholars and practitioners have studied IT addiction. Table 1 summarizes such efforts and points to leading theories (e.g. attachment theory (Venkatesh *et al*., 2019); dual-system theory (Turel and Qahri-Saremi, 2016); identity theory (Gong *et al*., 2021); incentive-sensitization theory (Kuem *et al*., 2021); stimulus-response-reinforcement theory (Wang and Lee, 2020)) that have been used for explaining technology addiction. In addition, IS scholars (e.g. Gross *et al*., 2020; Lee *et al*., 2016; Purohit and Holzer, 2021) have also proposed approaches for detecting (e.g. resting-state electroencephalography recordings) and treating (e.g. gaming features that enhance users' self-regulation; apps that enhance users' mindfulness of social media use) technology addiction.

While appreciating the IS field's unique contributions, we need to acknowledge that research on addictive behaviors, including technology addiction, originated from substance addiction research (see Appendix for key similarities and differences between substance and technology addictions). For example, most of the IS theories above are based on substance addiction theories and models (e.g. Agogo and Hess, 2018; James *et al*., 2017; Ning *et al*., 2022; Polites *et al*., 2018; Vaghefi *et al*., 2023; Xu *et al*., 2017; Xu *et al*., 2022) and have a common thread: they explain the psycho-physiological processes that underlie addiction development (as sometimes exacerbated by technological affordances), and the manifestation of addiction in various negative outcomes. Despite this reliance on substance addiction theories and models, it has been shown that there are also notable differences among the types of addiction in pathogenesis and treatments (Marci, 2022; Turel *et al*., 2014; Xu *et al*., 2021). As such, we conclude that IS scholars could attempt to reduce technology addiction by leveraging substance addiction interventions, but not doing so blindly. Instead, they should build on the understanding of the technology artifact, its affordance, and the needs it caters to in order to adjust traditional substance addiction interventions to the case of technology addictions. Thus, the IS field can benefit from and supplement substance addiction research.

Therefore, this review paper has two purposes. First, we develop a research framework that serves as a basis for intervention development and testing in the context of technology addictions. Second, we review and present potential interventions for technology addiction as adaptations of substance addiction interventions. These aims are important because it is imperative for IS researchers to join and guide intervention efforts, as the IS artifacts and business models we develop not only afford such addictions (Turel, 2015), but can also help in preventing them and ameliorating their outcomes (Osatuyi and Turel, 2020). Thus, as a discipline, while we might be part of the problem (Tarafdar *et al*., 2015), we also have an opportunity to be part of the solution. IS scholars can make unique contributions to treating technology addiction by using the framework as a road map as well as the interventions and their implications in this study. For example, we can develop music apps that attract more music users and prevent or reduce their smartphone addiction.

In the following section, we first describe the methodology used for our review. Then, we describe our research framework and review potential interventions for technology addiction adapted from those used for substance addiction. Finally, we initiate a discussion on how technology can become part of the solution in light of these non-IT and IT-mediated interventions.

2. Methodology

To review the effect of interventions on technology addiction, we used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Figure 1; Moher

Table 1. Leading IS theories on technology addiction

Theories	Arguments	Suggested interventions
Attachment theory (Venkatesh *et al*., 2019)	Parenting behaviors influence children's internet addiction Parenting behaviors (e.g. control and monitoring) are only effective in reducing children's internet addiction when there is a good parent-child attachment	Parents should build a good parent-child attachment by fostering good communication and mutual understanding Online service providers can request parents' consent on children's internet service sign-up and offer online activity tracking features
Dual-system theory (Turel and Qahri-Saremi, 2016)	Strong emotional-cognitive preoccupation (i.e. system 1 or impulsivity) and weak cognitive-behavioral control (i.e. system 2 or inhibition) explain social networking sites (SNS) addiction System 2 moderates the relationship between system 1 and SNS addiction SNS addiction and other problematic behaviors are etiologically similar	IT artifact designers should develop monitoring and warning functions to reduce users' system 1 and enhance their system 2 engagement IS users should learn to enhance their system 2 and avoid stimuli that activate system 1 In severe cases when system 2 malfunctions, IS users should use psychological therapy (e.g. cognitive behavioral therapy)
Identity theory (Gong *et al*., 2021)	IT identity positively predicts obsessive online social gaming archetypes (i.e. impulsive use, compulsive use, excessive use, addictive use) IT identity fully mediates the impact of social identity on the archetypes	Family members should communicate with users on the four archetypes Educational institutions and governments should use non-profit websites to increase users' awareness and knowledge of the archetypes Game providers should alter the information of IT identity and social identity by monitoring and reducing user-to-technology and user-to-user interactions
Incentive-sensitization theory (Kuem *et al*., 2021)	Heightened desire and mobile social interaction are two correlates of smartphone addiction Personal innovativeness in IT and perception of loneliness are two main antecedents of smartphone addiction, with the latter having more predicting power	Health professionals can assess risk for smartphone addiction with these two elements Parents and school counselors should pay attention to children and teenagers' loneliness
Stimulus-response-reinforcement theory (Wang and Lee, 2020)	Technological factors, such as interactivity, serve as incentive stimuli that are associated with positive reinforcements, negative reinforcements, and compensation Urge fully mediates the effect of emotional relief on compulsive mobile SNS use Urge partially mediates the effect of positive and negative reinforcements on compulsive mobile SNS use	Professional and formal communication channels should be instituted to counteract compulsive mobile SNS use in schools, universities, and the workplace Individuals should be trained to regulate behaviors to reduce compulsive mobile SNS use Service providers can develop IT features such as activity monitoring and notification systems to reduce compulsive mobile SNS use

Source(s): Table created by authors

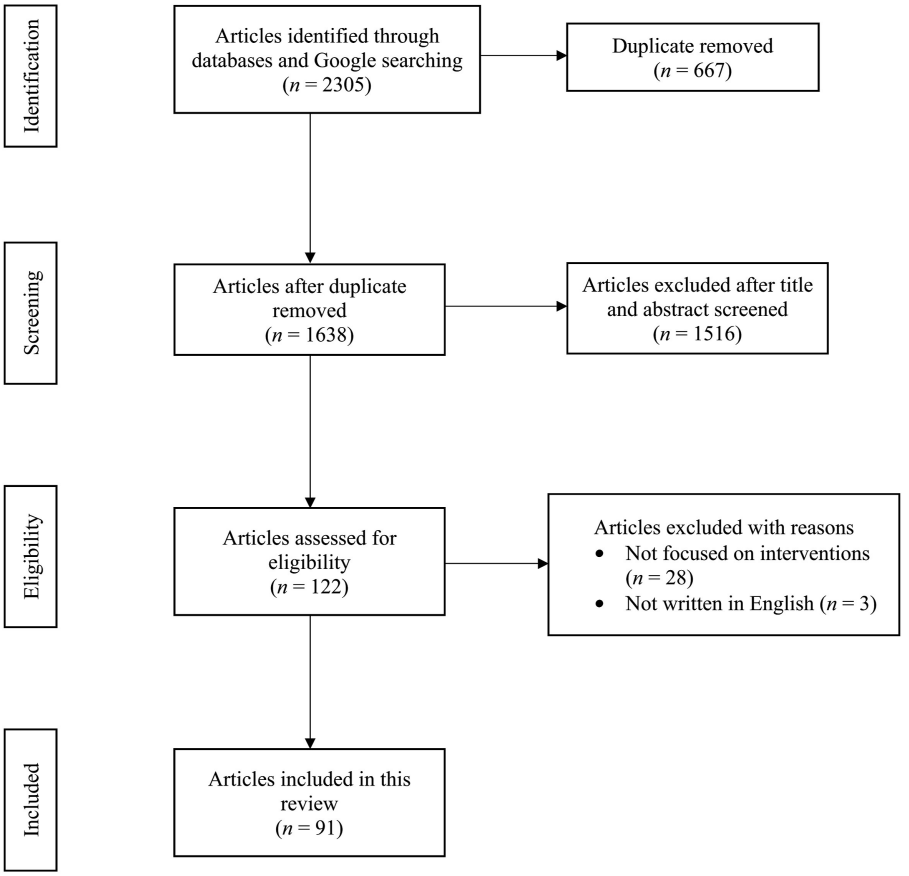

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Figure 1. PRISMA flow diagram for article selection

et al., 2009) for our study, which includes eligibility criteria and literature search strategy and study selection.

2.1 Eligibility criteria

Built upon the research purposes, we established the eligibility criteria: articles that study the interventions for technology addiction and substance addiction, and articles including review articles, peer-reviewed articles, conference proceedings, or online newspaper articles that were published in the English language.

2.2 Literature search strategy and study selection

The search strategy includes two steps. In the first step, we used Web of Science and Scopus databases to search for articles. The keywords we used for the search include "Internet Addiction", "Online Gaming Addiction", "Online Social Networking Addiction", "Smartphone Addiction", "Substance Addiction", and "Behavioral Interventions". In the second step, we used Google to search for "Technology Addiction Interventions" to locate the articles about interventions that are considered promising but may not have been scientifically

examined. After that, we evaluated those articles with the eligibility criteria and included 91 in this study. Finally, we used these articles to develop the research framework and identify the potential interventions for technology addiction in the following two sections.

3. Research framework

Figure 2 displays our framework. The development of this framework is based on the ideas about the IT artifact and its immediate nomological net by Benbasat and Zmud (2003) and the previously mentioned leading IS theories and empirical research in both technology and substance addiction (e.g. Agogo and Hess, 2018; Gong *et al*., 2021; Kuem *et al*., 2021; Ning *et al*., 2022; Turel and Qahri-Saremi, 2016; Vaghefi *et al*., 2023; Venkatesh *et al*., 2019; Xu *et al*., 2017; Xu *et al*., 2022; Wang and Lee, 2020). Benbasat and Zmud (2003) suggested that IS research should contain two significant elements to make greater contributions to the field. First, we should focus on the IT artifact, its usage, and its impacts. For example, the problematic use of IT artifacts (e.g. social media, video games) can lead to technology addiction and the associated negative outcomes (e.g. poor cognitive performance; Ning *et al*., 2018). Second, we should include necessary non-IT variables to fully understand the IT artifact's usage and impacts, and put the IT artifact in a sociotechnical context. For example, if the outcome variable is IT-related, technology addiction in our study, non-IT variables including personal and environmental factors (e.g. children's anxiety and their parents' control of their smartphone use; Boumosleh and Jaalouk, 2017; Venkatesh *et al*., 2019) and non-IT interventions (e.g. physical activity participation; Ströhle, 2009) should be considered. The inclusion of these non-IT variables is vital so as not to restrict the solutions to IT artifacts. That is, while the problem is about IT, its treatments and prevention can include the broader sociotechnical context. This should allow scholars to consider the relative efficacy of IT and non-IT interventions or their joint impact on personal factors such as IT user's anxiety or technology addiction.

Our framework, firstly, indicates that technology addiction is predicted by personal (e.g. cognitive functions or emotions; Ansell *et al*., 2013; Baler and Volkow, 2006; Boumosleh and Jaalouk, 2017; Kayis *et al*., 2016; Kotov *et al*., 2010; Kuss *et al*., 2014; Turel and Bechara, 2016), environmental (e.g. parental mediation or social influence; Gorsuch and Butler, 1976; Turel and Osatuyi, 2017; Venkatesh *et al*., 2019), and technological (e.g. IT features; Turel and

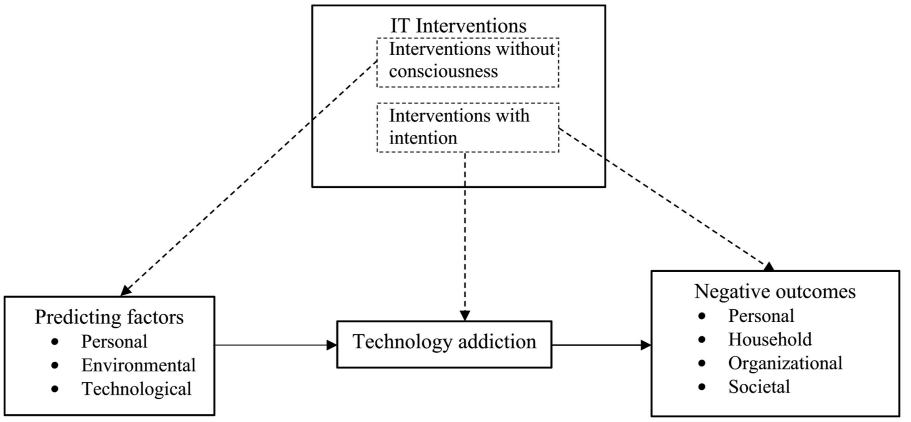

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Figure 2. Relationships between predicting factors, technology addiction, negative outcomes, and interventions

Ferguson, 2021) factors. Secondly, once addiction has developed, it can lead to four categories of negative outcomes, including personal (e.g. sleep deprivation and withdrawal-related anxiety; Kaptsis *et al*., 2016; Ko *et al*., 2012; Lam, 2014; Serenko and Turel, 2020), household (e.g. family conflicts; Venkatesh *et al*., 2019), organizational (e.g. employees' poor work performance; Hessari and Nategh, 2022), and societal (e.g. an increase in crime; Herrero *et al*., 2022). Lastly, borrowing ideas from substance use interventions, our framework suggests two families of possible IT interventions: with intention vs. without consciousness. The former can be used for treating technology addiction or reducing its negative outcomes, while the latter can be employed for mitigating the causes of technology addiction. Such interventions can have two properties: they can target aspects of addiction development and maintenance as guided by our framework, and they can build on interventions developed for other addictive behaviors that have shown to be efficacious.

4. Potential interventions on technology addiction

Addiction interventions follow two philosophies. One focuses on deliberate intentions to reduce addictions. The other stresses the role of unconsciousness during the intervention process as a means to promote positive lifestyles and cognitive functions, and indirectly reduce addiction symptoms and outcomes. Note that our intent is not to provide a comprehensive list of interventions. This is a "moving target" as the field is developing. Instead, we aim to present key interventions by focusing on introducing the interventions for substance addiction and exploring how they can be used individually or jointly for technology addiction. This is a novel aspect that has been thus far neglected in IS research, and at the same time, paves the way for a new stream of IS studies focusing on the role of the IT artifact in such interventions.

4.1 Interventions with intention

Intentions are the key to changing behaviors (Prochaska *et al*., 1994). Thus, psychological interventions have been used for both substance- and technology addiction-driven behaviors. The description of the interventions starts with the interventions that have been applied to technology addiction. It is followed by select interventions that have been widely used for substance addiction but appear promising to reduce technology addiction.

The most commonly used intervention in the context of addictive behaviors (including technology addictions) has been *cognitive-behavioral therapy (CBT)*. This intervention, which uses either an individualized or group approach, has been used to heal Internet addiction (e.g. Young, 2013). CBT has many forms, including multimodal school-based group, multi-family group therapy (MFGT), traditional family therapy, and multi-level intervention model. Consistent with substance addiction findings, the treatment effects for internet addiction were mixed, with only three studies that used the group approach showing significant impact (Liu *et al*., 2015; Young, 2013; Zhang *et al*., 2020). For example, Young (2013) developed a unique form of CBT called CBT for Internet Addiction (CBT-IA) and tested its effectiveness. The study found that CBT-IA ameliorated internet addiction symptoms during a 12-week therapy and over six months afterward.

Mindfulness meditation is a complementary psychological treatment to CBT for substance addiction. Mindfulness meditation has three distinct features (for a review, see Creswell, 2017; Quaglia *et al*., 2015). First, it draws attention and awareness to the present-moment experience of people having an addiction in different forms (e.g. body sensations, emotional reactions, mental images and talk, and perceptual experiences). Second, this approach emphasizes actively, rather than passively, accepting one's everyday experience, such as addiction. Third, it requires deliberate effort from the people having an addiction to turn away from mind wandering and direct attention toward present moment-to-moment experience. This effortful deliberation can thus boost self-control skills. There are many types of mindfulness meditation programs ranging from mindfulness-based stress reduction (MBSR) programs to smartphone

application mindfulness programs (Boettcher *et al*., 2014; Bowen *et al*., 2015; Kabat-Zinn, 1982). Bowen *et al*. (2015) indicated that mindfulness meditation has dramatic potential in tackling substance craving and addiction, and the associated negative consequences. Beyond its impact on fostering self-control skills and reducing craving and relapse in addiction, mindfulness meditation can also lessen negative emotions, including depression, anxiety, and perceived stress (Eisendrath *et al*., 2016; Strauss *et al*., 2014; Tang *et al*., 2015).

A psychological intervention designed exclusively for alcohol addiction is *cognitive bias modification* (CBM), which aims to reduce the attentional bias toward alcohol cues (Wiers *et al*., 2010). This computerized intervention consists of two types of images (alcohol vs. soft drink) and two actions toward a joystick (avoidance-push vs. approach-pull). When seeing the alcohol images, participants are instructed to push the joystick, and vice versa. The mechanism of the effect of this intervention lies in the change of the impulsive system. Several studies using CBM for alcohol addiction have shown that the attention bias and relapse of the people having an addiction were significantly reduced with a moderate effect size after 4 to 12 training sessions, with each session lasting 20 min (Eberl *et al*., 2013; Wiers *et al*., 2011).

Another type of psychological intervention, called *real-time fMRI-based neurofeedback* (rt-fMRI NF) training, is being used for populations such as patients with depression and smoking and alcohol addiction, and healthy people. In these sessions, which can last as short as 20 min per session, participants receive feedback on their brain activation of a specific region and are instructed to control it volitionally (Weiskopf, 2012). Growing evidence has shown that both patients who have depression and smoking and alcohol addiction, as well as healthy people, can learn to control their emotional and cognitive processes toward addiction-relevant cues (Karch *et al*., 2019; Kirsch *et al*., 2016; Marxen *et al*., 2016; Sherwood *et al*., 2016).

4.2 Interventions without consciousness

A review of decision-making literature by Newell and Shanks (2014) indicated that behavioral changes are more significant if participants' attention is diverted away. Accordingly, if an intervention can unconsciously increase cognitive functions (e.g. self-control) and positive emotion and lead to the associated neural plasticity (e.g. see reviews of brain changes associated with recovery from cocaine use in He *et al*., 2020, 2017a, b, 2018a, b), it should be introduced for treating technology addiction. Three potential indirect and subconscious treatments, including physical activity intervention, music therapy, and playing computer games, are discussed below.

Physical activity (PA) is any body movement produced by skeletal muscles, resulting in a substantial increase over resting energy expenditure (Bouchard and Shephard, 1994). Typically, PA consists of exercise, sports participation, work, and leisure time activities. Extant research in neurosciences and cognitions revealed that regular exercise and sports participation are associated with epigenetic mechanisms and brain plasticity, such as an increase in striatum volume and activation of the anterior cingulate cortex and prefrontal cortex, as well as an increase in executive control (Hillman *et al*., 2008; Mandolesi *et al*., 2018). Other benefits of PA participation include mood regulation, reduced anxiety and depression, and decreased stress (Mandolesi *et al*., 2018; Mikkelsen *et al*., 2017; Ströhle, 2009). Apparently, people who have addictive behaviors can obtain these benefits from PA participation that requires no intention of treating addiction. People without addiction should have a minimum risk of becoming addicted if they participate in PA regularly. By now, there are a few studies on the impact of PA participation on drug addiction, most of which are limited to correlational designs (e.g. Zschucke *et al*., 2012) and contain mixed results (e.g. Carroll and Smethells, 2016). In the past few years, the emergence and adoption of fitness apps have been in rapid proliferation. Both users and researchers have used these apps as PA participation catalysts. Using secondary data from a national survey, Carroll *et al*. (2017) reported that fitness app users had more intention to participate in PA and meet PA recommendations of at least 150 min per week. While admitting the fitness apps' motivating potential in promoting

PA participation, their actual efficacy is far lower than expected. For example, Payne *et al.* (2015) showed that PA interventions with fitness apps hardly increased participants' PA levels and decreased their Body Mass Index (BMI) or body fat.

Music intervention/therapy refers to a systematic application of music to improve individuals' emotional and/or physical health (Bonny, 1986). Bednarz and Nikkel (1992) classified music therapy as music discussion, music instruction (e.g. learning musical skills), group participatory music (i.e. playing music together), music listening, and expressive music interventions (e.g. writing songs). Prior research has established that music is a useful therapeutic tool in treating psychological disorders, including stress, depression, anxiety, and social phobia (e.g. Maratos *et al.*, 2008). By reviewing the biological impact of music listening, Finn and Fancourt (2018) have reported the biomarkers to be significantly affected. As a widely analyzed biomarker, the stress hormone cortisol is sensitive to music therapy, which indicates the effect of music on stress reduction. Although the impact of music on other biomarkers (e.g. epinephrine, blood glucose, inflammatory proteins, and genes) is mixed due to inconsistent research approach, these biological findings cross-link the psychological benefits of listening to music in decreasing stress and depression. Currently, the application of music in the arena of substance addiction is emerging. A review study by Mays *et al.* (2008) showed that music therapy was an adjunct treatment to an existing treatment program in clinical settings. Another recent review by Hohmann *et al.* (2017) also indicated the limited effectiveness of musical interventions on substance addiction and suggested that long-term outcomes of the intervention on both the addiction and other associated outcomes should be investigated.

Cognitive Video Games are another intervention aimed at improving people's executive functions. Such cognitive benefits resulting from playing video games are called multimedia learning. Surprisingly, only a limited number of video games are identified to effectively promote cognitive skills in non-game contexts. These games are first-person shooter (Bediou *et al.*, 2018) for perceptual attention skills ($d = 1.2$), Tetris (Boot *et al.*, 2008) for two-dimensional mental rotation skills ($d = 0.8$), and All You Can ET (Parong *et al.*, 2017) for shifting ($d = 1.4$). Besides, video games can shelter people from other problematic behaviors, such as aggressive behaviors (Turel, 2020) and substance use (Turel, 2020), as long as they are played in moderation. Hence, if the video games intervention is employed, therapists need to be mindful of the need to prevent excessive gaming (Evans *et al.*, 2018).

4.3 Summary of interventions

For the interventions that engage intentions, robust evidence on substance addiction has indicated that mindfulness meditation may likely be a better treatment for reducing technology addiction over other types of psychological interventions after considering its mechanisms, efficacy across various types of substance addiction, and cost (Creswell, 2017). Its superior effectiveness may not only be limited to the addictive behavior itself, but also extends to increased self-control and decreased negative emotions, which have a strong association with technology addiction (Eisendrath *et al.*, 2016; Quaglia *et al.*, 2015; Strauss *et al.*, 2014; Tang *et al.*, 2015).

Regarding treatments without consciousness, there are no randomized controlled trials and longitudinal research on its efficacy in treating technology addiction. Nevertheless, the initial studies on substance addiction imply that PA intervention and music therapy may be instrumental in treating technology addiction, at least when used with other types of treatments (Hohmann *et al.*, 2017; Rawson *et al.*, 2015). Furthermore, video games aimed at improving cognitive skills can be better designed to be alternative tools to treat technology addiction (Mayer, 2019).

5. Promising research directions for IS scholars: becoming part of the solution

As noted earlier, the difficulty to self-regulate the use of technology has led to various addictive online behaviors and the associated negative consequences. Current research has

shown that many similarities exist between technology addiction and substance addiction in terms of their antecedents, negative consequences, and neurobiological mechanisms. Therefore, interventions that were originally developed to reduce substance addiction, attenuate psychological disorders, and enhance cognitive functions might help reduce IT use time and/or addiction symptoms.

Like substance addiction, technology addiction may be difficult to recover from fully, and relapse from abstinence is likely (Turel and Vaghefi, 2019). Thus, treatments of technology addiction that have longer-term effectiveness and reduce the risk of relapse are in great need. Here, we outline promising opportunities to change the IT artifact, and through this, change use patterns. We first summarize the IT that has been used for the previously mentioned interventions. We then discuss opportunities for future research on IT's role in the treatment of addictions for IS researchers interested in this topic, which is followed by a summary.

5.1 Summary of IT-mediated interventions

In section 4, we summarized the potential interventions for technology addiction, as described in various disciplines. These interventions can be categorized into two groups: IT interventions with intentions and IT interventions with unconsciousness. These two categories are also displayed in our theoretical framework in Figure 2. Accordingly, we identified the widely used IT apps for these two types of interventions from different sources, including scientific articles. On one hand, the IT apps that are applied to interventions with intention are more reactive as we use them to provide treatments to people who are already addicted to technology. On the other hand, the IT apps that are employed for interventions with unconsciousness are inclined to be preventative because we can use them to prevent technology from occurring. In this section, we list the interventions for each category, their purposes, and IT app examples in Table 2. As shown, many IT apps are widely used in interventions for substance addiction, mental health issues such as anxiety, technology addiction, PA promotion, emotion regulation, and cognitive performance. These IT apps serve different roles, such as stand-alone interventions conducted by individuals in need, primary interventions with the therapist's support, supplements to traditional non-IT interventions, and a medium to deliver interventions administered by the therapist.

We hope that IS researchers and practitioners will better understand how each IT app can be effectively used to treat or prevent technology addiction. For example, the first intervention listed in Table 2 is *cognitive behavioral therapy* (CBT), which treats both substance and internet addiction. We listed IT app examples for both substance addiction (e.g. s-Health) and mental health issues (e.g. eCBT Mood), which were developed based on CBT. Although not developed for treating technology addiction, those IT apps should be considered because substance addiction has similarities with technology addiction, and mental health issues are associated with addiction. We hope to provide opportunities for IS scholars and practitioners to explore the development and testing of CBT-based IT apps exclusively for technology addiction. When developing CBT-based IT apps, we can take into account the features of those for substance addiction and mental health issues.

5.2 Future research directions

Prior research has focused on predictors and theories of technology addiction (e.g. Serenko and Turel, 2020; Turel, 2019). This study focuses on practical interventions, which has not been taken by extant research agenda papers. At the same time, it is important to do so because it can pave the way for a new stream of IS studies. Although the abovementioned technologies and interventions have the potential to treat technology addiction, some research questions await further investigations by IS scholars.

First, randomized controlled trials and/or longitudinal studies should be conducted to examine the causal and long-term effects of IT on treating addiction. Studies on different aspects of the framework presented in Figure 2 have primarily focused on cross-sectional

Table 2. Categories of interventions, purposes, and IT applications

Category of interventions	Purposes	IT apps examples
1. Interventions with intention (more reactive)		
Cognitive behavioral therapy	To treat both substance and internet addiction	Substance addiction apps (e.g. Gustafson *et al*., 2014; Liang *et al*., 2018) • s-Health • Addiction–Comprehensive Health Enhancement Support System (A-CHESS) Mental health issues apps (e.g. Huguet *et al*., 2016; Rathbone and Prescott, 2017) • eCBT Mood • Depression CBT Self-Help Guide • PTSD coach • MoodHacker • MEMO • The Sleepcare app
Mindfulness meditation	To foster self-control skills and reduce craving and relapse in addiction, and lessen negative emotions including depression, anxiety, and perceived stress	Meditation apps (Mani *et al*., 2015) • Headspace • Smiling Mind • iMindfulness • Mindfulness Daily
Cognitive bias modification (CBM)	To treat alcohol addiction by reducing the attentional bias toward the cues, and reduce stress and anxiety by building positive habits of attention	Alcohol addiction apps (Cox *et al*., 2015) • ChimpShop Anxiety apps (Dennis-Tiwary *et al*., 2017) • Personal Zen
Real-time fMRI-based neurofeedback (rt-fMRI NF) training	To treat patients with depression and smoking and alcohol addictions, and healthy people by enhancing their volitional control over both emotional and cognitive processes	Self-regulation apps (Watanabe *et al*., 2017) • Decoded neurofeedback (DecNef) • Connectivity-based neurofeedback (FCNef)
2. Interventions without consciousness (more preventative)		
Physical activity (PA) intervention	To treat substance addiction, and improve cognitive functions (e.g. increased brain plasticity and executive controls) and affective functions (e.g. mood regulation, reduced anxiety and depression, and decreased stress)	Wearable devices with apps • Fitbit tracker • Galaxy wearable Mobile phone fitness apps • Official 7 Minute Workout for short workout • Nike Training Club for on-demand workout • Map My Fitness for activity tracking Exergames • Just Dance • Ring Fit Adventure Virtual reality exercise (e.g. Zeng *et al*., 2018) • VirZoom
Music intervention	To treat substance addiction, and reduce psychological disorders including	For emotion regulation skills (Hides *et al*., 2019)

(*continued*)

Category of interventions	Purposes	IT apps examples
	stress, depression, anxiety, and social phobia	• Music eScape
Cognitive video games intervention	To train the brains and enhance cognitive skills such as executive functions, and shelter people from other problematic behaviors, such as aggressive behaviors and substance use	Cognitive video games • First-Person Shooter (Bediou *et al*., 2018) for perceptual attention skills • Tetris (Boot *et al*., 2008) for two-dimensional mental rotation skill • All You can ET (Parong *et al*., 2017) for shifting • Makey Makey for creative invention

Source(s): Table created by authors

design or short-term outcomes of interventions. It is imperative to examine the efficacy of IT-mediated and non-IT interventions to produce lasting effects because people can easily relapse post-addiction treatment.

Second, user engagement (e.g. attitude toward the IT), IT use habits, technology addiction, emotions, PA levels, cognitive performance, and even personal traits should also be evaluated during the IT intervention. Studies on different aspects of the framework presented in Figure 2 have primarily focused on the intervention *per se* and did not unpack the mechanism through which it exerts influence. Similarly, at the moment, clinicians focus on recovery metrics and less so on variables of significance for IS scholars. There is, therefore, an opportunity to examine patterns of IS use and various IS-induced emotion and perception fluctuations during IT-based interventions. For example, to examine the added value of changed features in the IT artifact (e.g. New Your City has just blocked social media providers from using algorithms to drive addictive social media use by children), future research can compare participants' PA levels and situational motivation for jogging before vs after the change, and between people with different addiction levels.

Third, the impact of IT-mediated intervention can be compared with non-IT, traditional interventions, and with combinations of intervention types. For example, IS scholars can examine the impact of mindfulness training as delivered by an instructor vs as delivered by app cues (e.g. cues that remind people to breathe deeply).

Fourth, the effectiveness of patient-oriented versus therapist-oriented therapy as well as laboratory-based versus remote intervention can be examined, again by considering how such interventions may involve monitoring through the IT artifact and cues provided by the IT artifact. For example, IS scholars can provide a virtual reality exercise bike to the participants who will use it at home for PA intervention and test the efficacy of this approach in comparison to physical exercise, with and without activity monitoring technologies.

Fifth, the value of artificial intelligence and big data to IT treatment is worthy of investigation. For example, IS scholars can examine whether the general and personalized feedback provided by a smartphone use tracker app can reduce teenagers' weekly screen time. They may also explore how different cues provided by the smartphone (e.g. automatically silencing new message notifications) influence screen time and screen behavior.

Sixth, the effectiveness of community-based IT interventions in comparison to individual interventions can be ascertained, again, while considering IT-mediated vs. non-IT approaches. For example, IS scholars can implement an exercise video game program in the physical education class of an elementary school and test its efficacy compared to non-IT exercise plans for schools.

Seventh, the benefits of using more than one type of IT in treating addiction can be evaluated. For example, the efficacy of a smartphone use tracker app to reduce smartphone

addiction can be compared to when it is used alone vs when it is used together with a meditation app.

Eighth, individual differences (e.g. personality, profession) should be examined as they determine the effect of the treatments. For example, researchers can compare the effect of musical treatment on musicians and normal people.

Last, the quality of the IT used for treating technology addiction, including usability, reliability, validity, security, and user privacy, can be objectively and subjectively tested; the effects of such metrics on the app's efficacy should be examined. Besides these general recommendations, the IT interventions using the different approaches mentioned above should be examined explicitly to optimize each approach's effect.

5.2.1 Internet- and smartphone-based cognitive interventions. Internet and smartphone cognitive applications have attracted millions of users for their inexpensiveness and portability. One category of cognitive applications is mindfulness applications. Using Mobile Application Rating Scale (MARS), Mani *et al*. (2015) showed that mindfulness applications, including "Headspace", "Smiling Mind", "iMindfulness", and "Mindfulness Daily" are of great quality in terms of engagement, functionality, visual aesthetics, information quality, and subjective quality. Thus, IS scholars can evaluate how these mindfulness programs influence technology addiction. Besides focusing on addiction, it would also be an exciting research endeavor to compare the efficacy of mindfulness applications in developing mindfulness with traditional mindfulness programs. Looping back to the intentional interventions previously described, cognitive applications should have a maximal impact on reducing technology addiction if they integrate with other functions such as goal management, physiological feedback, and CBM, and gradually increase users' self-control and cognitive skills. Keeping these ideas in mind, IS scholars and professionals can use the MARS as criteria and develop cognitive applications that contain these functions. Thus, we look forward to the research that studies the joint effect of MARS (e.g. engagement), intentional interventions (e.g. building positive habits of attention), and cognitive applications (e.g. enhancing self-control) on technology addiction.

5.2.2 Smartphone usage tracker applications for constraining smartphone overuse. Nowadays, there is a plethora of tracker apps in the market, such as "Social Fever App Usage Tracker", "Quality Time-My Digital Diet", "Habit Time Tracker and Controller", and "Forest: Stay Focused". As previously discussed, a desire for social connection is a significant driver of technology addiction (Turel and Osatuyi, 2017), and real social bonding can attenuate the addiction (Venkatesh *et al*., 2019). On one hand, researchers can investigate the moderating effect of these apps (e.g. smartphone usage tracker) on the impact of the CBT approach on smartphone addiction. On the other hand, to make these apps more effective, using the CBT approach with peer and parental engagement can be the key to success. IS scholars and software developers can consider upgrading these tracker apps by adding group interaction features. As such, therapists use these apps to build a user group where users can monitor their smartphone use time and compare it with peers. For children and teenagers, therapists can also work with parents to monitor and block the kids' online life, such as which apps they use and online shopping by using "mSpy", "Mobicip", etc. Such an approach may have a much better effect when it is implemented in a multi-family-group setting.

5.2.3 Embrace the "magical effect" of music. Existing preliminary literature on music therapy has shown some of its undertaking effects on substance addiction by increasing cognitive functions and positive emotion. Although the extent to which the music intervention can be applied to technology addiction is unknown, it can be embraced by more well-designed research. First, IS scholars can consider the heterogeneity in music (e.g. genres and styles), and the type and length of music intervention for improving cognitive functions. For example, research that examines the long-term impact of listening to music and singing karaoke with the smartphone and using music apps for music creation is warranted. Second, integrating music with IT for emotion management is worth adding to the future IS research agenda. For example, embedding music into websites to reduce technostress should be an interesting topic.

Previous studies have found that individuals who have neuroticism and smartphone addiction and are open to experience tend to have higher musical emotion and musical consumption (e.g. Liljeström *et al*., 2012; Ning *et al*., 2022). Thus, artificial intelligence can be used to provide personalized songs that enhance one's positive emotion.

5.2.4 Video games to improve cognitive functions. So far, previous studies have shown that most video games cannot effectively improve cognitive skills, especially executive functions (Bainbridge and Mayer, 2018; Bediou *et al*., 2018). Therefore, game developers should design cognitive video games based not only on motivation theories but also on learning and cognitive principles. Mayer (2011, 2014, 2019) proposed that video games should foster players' generative processing (i.e. exerting effort to understand materials) to maximize instructional effectiveness. IS scholars can upgrade cognitive video games by taking this proposal as a guideline for introducing certain game features that enhance instructional effectiveness and examining their effect on cognitive functions. Such game features include modality (i.e. spoken text), personalization (i.e. conversational language), pretraining (i.e. pregame information), coaching (i.e. in-game feedback), self-explanation (i.e. players' explanation and reflection), etc. (Mayer, 2019). More effort should also be devoted to designing video games that are age-appropriate and that train players on a specific cognitive skill in various contexts and at increasing levels of challenges, as well as game features that prevent excessive gaming. Finally, the effect of other genres (e.g. arcade games) and platforms of video games (e.g. virtual reality) on cognitive skills should also be examined. For example, IS scholars can selectively use commercial video games, such as arcade games that are not designed to improve cognitive skills, as a treatment for technology addiction because these games can moderately reduce the craving for smoking (Schlam and Baker, 2020).

5.2.5 Fitness/health technology and exercise games to promote PA. First, emerging persuasive technologies and big data analysis have provided vast opportunities for PA promotion. For example, wearable devices (e.g. Galaxy wearable, Fitbit tracker) and mobile fitness/health apps can be used to record data (e.g. steps, daily calorie consumption) and synchronize these data to an online community for social interaction to increase time spent in moderate-to-vigorous PA. Addiction therapists can take advantage of the big data analysis by requesting their patients to report their medical records (e.g. perceived stress, sleep quality, time of smartphone use) so that they can provide a personalized PA participation portfolio to them. Second, given the fact that continuous adaptation of fitness/health apps is challenging as a substantial proportion of users quickly lose interest in, do not want to spend money on, and enter much data into the apps (Krebs and Duncan, 2015), more research on the continuous adoption of fitness and health apps and their long-term efficacy on technology addiction is highly encouraged. Third, exergaming is another useful and motivating approach to promote PA. Despite its weaknesses (e.g. technical constraints and increased screen time), exergaming has many benefits, including increased PA enjoyment, decreased BMI, and increased muscular strength for various populations (Benzing and Schmidt, 2018). These benefits, no doubt, will motivate individuals to engage in PA continuously.

5.2.6 Conjoined agency for more efficacious addiction interventions. Conjoined agency is a shared capacity between humans and technologies (e.g. tools and artifacts) to exercise intentionality, which includes developing protocols and selecting actions (Murray *et al*., 2021). According to Murray *et al*. (2021), the model of conjoined agency includes agency with assisting technologies (i.e. with the assistance of technologies, humans develop protocols and select actions), agency with arresting technologies (i.e. technologies have the ability to select actions), agency with augmenting technologies (i.e. technologies have the ability to develop protocols), and agency with automating technologies (technologies have the ability to develop protocols and select actions). Although used for the practice of organizational routines, the conjoined agency should be embraced to treat technology addiction in the future. In specific, the model of conjoined agency can be used in the following two domains. The first domain is therapist-technology conjoined agency. For example, therapists, together with smartphone use trackers, can create various types/levels of agency. An interesting future research question for IS

researchers is which type/level is more efficacious. The second domain is the addicts-technology-conjoined agency. For example, people having an addiction can either have control over and override the time limits set by the technology, or they cannot override what the technology prescribes in terms of use time. What works best is also a fascinating future research.

5.3 Summary

IT is a double-edged sword for technology addiction. On the one hand, the repeated technology use habit that spirals out of control can lead to technology addiction. Technology addiction does not only counter the benefits of "normal" technology use and life habits, but also negatively influences the development of these good habits and strengthens bad technology use and life habits. Technology addiction is associated with various negative personal (e.g. neglected hygiene), household (e.g. family conflicts), organizational (e.g. poor work performance), and societal consequences (e.g. increased crime rate), as depicted in Figure 2. These personal and environmental consequences may potentially be linked back to technology addiction. On the other hand, IT can be used as both reactive and preventative tools to treat and prevent technology addiction. Normal people can develop good habits of technology use with IT and enjoy abundant benefits from it. Examples include regular exercise and mind-body health, such as cognitive functions. People having technology addiction should also gain benefits from using IT appropriately. For example, methadone is a substance that can help people having drug addiction avoid withdrawal symptoms and gradually avoid opioid use. Similarly, people with technology addiction can use technology at moderate levels or with variations to trip off technology's negative effect potential or have more moderate effects while allowing them to still feel that they are engaged with it. Reciprocally, these benefits will further accelerate and consolidate the good habits, counter the bad habits, and reduce one's risk of having technology addiction.

In response to the double-edged sword role of technology in technology addictions, in this study, we discussed and classified several IT-mediated and non-IT interventions aimed at preventing and alleviating technology addictions. To do so, we built on clinical substance addiction intervention studies, and studies on technology addiction. Notably, the suggested interventions are not a panacea for different types of technology addiction. Thus, to reach the maximum IT intervention effect, IS scholars should consider both personal (e.g. habit, motivation, self-control) and environmental factors (e.g. persuasive technology, big data analysis, family and school support) when applying these interventions. Ultimately, we call for IS scholars to actively partner with scholars from other disciplines, including, but not limited to, management science, computer science, psychology science, addiction science, exercise and health science, and music science, to develop and unpack the overlooked piece of technology addiction research, namely, interventions.

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Appendix

Table A1. Main similarities and differences between technology addiction and substance addiction

Similarities	Technology addiction and substance addiction
Antecedents	• Habit (Everitt and Robbins, 2016; Turel and Qahri-Saremi, 2016) • Poor self-control (Baler and Volkow, 2006; Turel and Bechara, 2016) • Neuroticism (Kotov *et al*., 2010; Kuss *et al*., 2014) • Perceived stress and anxiety (Ansell *et al*., 2013; Boumosleh and Jaalouk, 2017) • Social influence (Gorsuch and Butler, 1976; Turel and Osatuyi, 2017)
Negative consequences	• Withdrawal symptoms (Reed *et al*., 2017) • Associated addictive behaviors (Black, 2007; Müller *et al*., 2014)
Neurobiological mechanisms	• Abnormal brain structures due to exposure to rewards/dopamine release generated by repeated use/consumption (He *et al*., 2017a, b, 2018a, b; Montag *et al*., 2017; Volkow *et al*., 2009)

Differences	Technology addiction	Substance addiction
Accessibility	• Almost used anytime and anywhere (Turel and Ferguson, 2021) • Legal and largely unregulated for children (Turel and Ferguson, 2021)	• Restricted places (Turel and Ferguson, 2021) • Illegal for children (Turel and Ferguson, 2021)
Withdrawal symptoms	• Only psycho-emotional (e.g. anxiety; Serenko and Turel, 2020)	• Both physical (e.g. nausea) and psycho-emotional (e.g. anxiety; Serenko and Turel, 2020)

Source(s): Table created by authors

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