To Use or Abuse: Opportunities and Difficulties in the Use of Multi-channel Support to Reduce Technology Abuse by Adolescents

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Technology abuse among adolescents refers to the problematic use of technology devices, and the negative impact it can have on lifestyle and one's physical and mental health. This paper reports on in-depth interviews with 15 dyads of adolescent patients, their parents, and four experts with the objective of unraveling the issue of technology abuse. We conducted qualitative analysis aimed at unpacking the contextual factors affecting technology abuse, and differences between adolescents and their parents pertaining to this issue. Our discussions led us to formulate solutions to technology abuse: (1) motivating adolescents by sending timely reminders and providing interactive micro-incentives; (2) promoting communication between adolescents and their parents by sharing usage data related to device usage; and (3) incorporating social supports to complement parental support, while fulfilling the adolescent's social needs. This paper provides valuable insights into the design of technological solutions aimed at mediating technology abuse.

CCS Concepts: • **Human-centered computing → Empirical studies in collaborative and social computing**; **Empirical studies in HCI**.

Additional Key Words and Phrases: Technology abuse among adolescents; screen time; family support; multi-channel support

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1 Introduction

Technology abuse disorders, such as gaming disorders (addiction to video gaming) and internet addiction disorders (IADs), have been investigated by experts in multiple disciplines; however, the findings have been somewhat controversial. Only the gaming disorder is listed in the 11th Revision of the International Classification of Diseases (ICD-11) [38]. The fact that screen use is a necessary part of modern life makes the diagnosis of technology abuse more difficult than that of substance addiction. According to a survey by Common Sense Media [65], tweens (8-12 years) daily spend an average of 4.6 hours using media screens, and teens (13-18 years) spend an average of 6.67 hours. Researchers have reported that many adolescents engage in maladaptive internet usage to deal with psychological difficulties [68], many of which involve problematic relationships with parents and/or peers [44]. Screens are powerful distractions, which can have a profoundly negative impact on sleep patterns and other everyday functions [11].

Various monitoring systems have been developed to track screen time. Apple and Google have developed tools [77, 78] to measure total screen time or app usage time. Other third-party applications provide other monitoring features. Unfortunately, a lack of motivation to reduce screen time makes most adolescents unwilling to self-monitor their technology use. Under these conditions, it falls on parents to restrict device usage. Researchers have reported that parental involvement can ameliorate the negative effects of technology abuse [35]; however, many teens ignore their parent's please, often leading to conflict. Efforts to resolve conflict between adolescents and parents hinges on communication, working together to develop constructive solutions, and seeing them through [74].

Previous HCI researchers [42, 54] have emphasized the complexity of technology abuse behaviors. Simon et al. [54] described a lack of clarity in the way we perceive and discuss our relationship with technological devices. An investigation into the role of technology in parent-adolescent dynamics led Alex et al. [42] to conclude that the same technologies could be used to enforce boundaries pertaining to screen time. One approach to managing technology abuse is based on intervention. Seay and Kraut [72] incorporated self-regulation mechanisms in the design of games. Other researchers have posited the development of new platforms or add-ons to existing computing services to facilitate intervention. One browser extension is meant to curb excessive TV streaming [18], and one mobile application tracks relapse history and personal data of relevance to recovery [86]. Mediated intervention can mitigate addictive behavior; however, it is important for researchers to examine the overall context in which this behavior developed. To the best of our knowledge, no previous study has targeted participants receiving psychiatric treatment for the problem of technology abuse.

According to ecological systems theory proposed by Bronfenbrenner [17], individual development involves a complex system of relationships within a surrounding environment that includes broad cultural values. Thus, efforts targeting adolescents who lack self-control and are unwilling to monitor their screen usage behaviors should take into account existing resources (e.g., parents and other social supports) in fostering a healthy attitude toward technology. Value Sensitive Design (VSD) [28] considers values endorsed by all involved parties. Under this approach, the design process should begin with a conceptual investigation to identify stakeholders and their values [50]. Our objective in this study was to investigate the phenomenon of technology abuse by adolescents within the larger ecological context including parents and the community at large.

We conducted in-depth interviews with 15 dyads of adolescents and their parents as well as four treatment experts regarding technology abuse. Our aim was to elucidate the challenges adolescents experience when managing technology abuse and extract insights for the design of assistive systems

aimed at mediating technology abuse. The major contributions of the current paper are outlined in the following:

(1) We used installation theory to unravel the issues involved in technology abuse by adolescents and the intricacies involved in mediating their behavior.
(2) We examined the means by which relational and communication dynamics with parents influence addictive behaviors and methods by which to account for the values and needs of adolescents in the design of technological solutions.
(3) We sought to determine how supports outside the family could be used to complement parental support with the aim of circumventing negative communication patterns between adolescents and parents.

2 Background and Related Work

In the following, we review previous studies with the aim of operationalizing the term technology abuse and identifying the factors related to technology abuse in adolescents. We then summarize previous research focusing on mediated self-monitoring support, parental regulating support, and other types of support aimed at mediating technology abuse.

2.1 Technology Abuse

The advent of screen media as an integral (even necessary) part of our lives has rendered an enormous number of adolescent susceptible to technology abuse. Many adolescents use their phones and computers for academic as well as recreational purposes. As with chemical addictions, the excessive use of technology is a form of behavioral addiction with corresponding symptoms, such as tolerance, withdrawal, interference, and relapse [34]. The pathological effects of technology use have been widely studied and debated [11, 66, 69], and it has been established that this behavior is strongly associated underlying mental or social problems [66]. In an effort to offset the negative physical and mental health outcomes associated with this behavior, the American Academy of Pediatrics (AAP) recommended that screen use not exceed one to two hours per day [5]; however, this pronouncement appears somewhat arbitrary. There remains considerable controversy pertaining to the definition of technology abuse [69] and its impact on adolescents' well-being [11], particularly within the context of the profound changes in digital media since the early 1980s. In 2016 [40], the AAP revised their screen time guidelines to *place consistent limits* on-screen time, such that adolescents are able to maintain a healthy lifestyle.

Some scholars have questioned the validity of technology abuse, considering it no more than a bad habit [49] or a mainstream media narrative without much empirical evidence [55]. Other researchers have proposed concepts depicting behavioral characteristics related to excessive internet use and gaming [38] (e.g., internet addiction, screen addiction, gaming addiction, and technology abuse). Clinical practice has focused on persistent gaming associated with functional impairments in daily life over a period of at least 12 months [13]. Note however that the severity of these conditions cannot necessarily be determined using conventional diagnostic criteria, such that many cases go undiagnosed. Thus, we targeted a broader category of technology abuse behaviors, as outlined below.

In the current study, *technology abuse* refers to dependence on electronic devices of severity sufficient to negatively impact their social relations, school/work life, and/or psychological well-being. The core traits of technology abuse share a resemblance with the symptoms of addiction. As early adopters and heavy users of gaming, social media, or streaming, adolescents are an ideal group by which to examine technology-related behaviors [84]. In the current study, we focused on a group of adolescents (10 – 18 years of age), who were clinically diagnosed with technology

abuse based on the following symptoms: (1) excessive use of computers, mobile devices, or gaming devices, associated with a lost sense of time or a neglect of basic needs (i.e., to sleep, eat, or maintain personal hygiene); (2) a feeling of anxiety, irritation, or depression when their devices or the internet is inaccessible; (3) an inability to resist device upgrades; and (4) negative repercussions that jeopardize interpersonal relationships, educational/career opportunities, or health, including lying, arguments, aggression, and poor achievement.

2.2 Different Layers of Factors Associated with Technology Abuse

By integrating multiple services and mobile applications, smartphones represent the primary portal to games and media, and the ubiquity of smartphones makes them an ideal research target for addictive behaviors. Researchers have established that smartphones are a distraction while driving, studying, or working [12, 36], due to push notifications or the anticipation of incoming events [22, 67]. The overuse of smartphones has been implicated in negative mental health issues and social interactions [53, 60], stress [63], and loss of productivity [62]. Some researchers have shifted the focus away from the device toward the nature of the apps running on them, citing social media and communication applications as the main culprits in addictive behavior [25].

Lahlou [51, 52] developed a pragmatic framework called Installation Theory in which behaviors can be attributed to stimuli in three layers: 1) the material environment (i.e., physical layer), 2) interpretive competences (embodied layer), and 3) social regulation (social layer). Combinations of the three layers are referred to as installations, which act as scaffolds and constrains to channel behavior. Figueroa et al. [27] used the framework of installation theory to categorize smartphone usage behavior as environmental, psychological, and social. In their formulation, the physical layer refers to the device itself, the notifications, and an environment characterized as boring by the user. Contextual triggers in the embodied layer refer to skills in the use of the phone, the motivations underlying usage, and a lack of willpower. The social layer refers peer pressure (e.g., to remain reachable) and the imitation of usage patterns displayed by others. They claimed that the physical affordances of the digital environment and the embodied interpretive systems of the adolescents play important roles in funneling behavior.

The frequency with which an individual checks his/her smartphone is also determined by what is perceived as socially acceptable. Adolescents are in the process of developing psychological maturity and forming self-identity [71]; therefore, their technology use behaviors tend to be regulated by family members. Under these conditions, attempts to curtail device usage often lead to temper tantrums [64], necessitating assistance from other social or treatment interventions. We therefore conducted interviews with parents and treatment experts on the use of support sources to mediate technology abuse.

2.3 Mediated Self-monitoring Support

Technology addiction has been studied among adults [73], college students [59], and adolescents [81]. A variety of self-monitoring solutions have been developed to raise awareness of the time spent using desktop PCs, laptops, tablets, and smartphones [1, 6, 7, 9, 10, 77, 78]. However, the fact that many adolescents use multiple devices makes it difficult to obtain accurate assessments of screen time (as mentioned in the physical layer). Cloud technology can be used to pool data collected from different devices; however, the difficulty in setting up these methods and the fact that they rely on self-monitoring tend to undermine the effectiveness of this approach.

Forest [4] incorporated persuasive design concepts that use virtual trees to inspire users to improve their time management in terms of phone usage. Donut Dog [2] is an application that exploits gamification concepts and rewards users for their concentration. Note however that most persuasive applications are meant only for mobile phones. Moreover, adolescents lack impulse

control and self-regulation abilities (as mentioned in the embodied layer), which means that parents should be included in the process [8].

2.4 Parental Regulating Support

As primary caretakers, parents are in a good position to intervene in the life of the adolescents in their care. A number of applications have been developed to assist in parental mediation (e.g., Google Family Link [3]), by monitoring phone usage, posting reminders, and even setting limits on the use of specific applications. Researchers have also studied applications aimed at promoting online safety [31, 32, 82]. Wisniewski et al. reported that parental control is generally preferred over teen self-regulation and collaborative systems [82]. Gosh et al. reported that the overly restrictive and invasive nature of apps aimed at promoting online safety can have a profound negative impact on familial relationships [31]. Conventional methods include direct monitoring (i.e., in person), giving verbal reminders to take breaks, or manually confiscating devices. Several studies have found that the result of many such interventions is precisely the opposite of what was intended. Xu et al. [83] concluded that parental monitoring is not necessarily effective in dealing with online game addiction. Other studies [30, 56] reported that parental monitoring is positively correlated with the severity of the addiction [30]. It has even been posited that the perception of parental control can exacerbate smartphone addiction [58]. Parents find mediation difficult and frustrating [41], whereas adolescents find regulations intrusive [23].

Nevertheless, the effectiveness of parental controls depends on several moderating factors, including attitudes toward technology abuse, personality traits, problematic usage by parents themselves [29, 43], the quality of parent-adolescent relationships [47], and the openness of familial communication [39]. The approach adopted by parents largely determines the effectiveness of efforts to alter behavioral attitudes toward technology use. Promoting healthy technology use by recommending useful websites or promoting co-usage has been found to have a positive effect on online educational activities [57]. Overall, it appears that parental support is an important resource in curbing technology abuse.

Previous studies [33, 82] have noted that profound differences in the values of adolescents and their parents must be taken into account when seeking to promote meaningful and adaptive technology experiences [28]. Thus, we also investigated methods of support for parents in implementing interventions and fostering healthy communication. Note that none of the studies mentioned above targeted participants receiving psychiatric treatment for their addictions. The severity of technology abuse and the complexity of family dynamics among the participants in the current study differ considerably from those in previous studies, as reflected in the design of our study.

2.5 Other Forms of Support

Ding et al. [24] highlighted the need to consider peer affiliation when assessing the risks associated with internet addiction (as mentioned in the social layer). Some self-monitoring applications (e.g., Forest [4] and NGUN [48]) leverage social support (i.e., from peers and the community) to maintain healthy habits. He et al. [37] emphasized the importance of social support in mediating loneliness and depression among internet addicts. Health-related online support groups have emerged in response to the need for social support. Su et al. [79] reported that internet-based group interventions for internet addiction (i.e., Healthy Online Self-helping Center) are effective in reducing internet usage. The online support group provides informational support [21] as well as emotional support [20] via friending and sharing personal stories [85]. Note however that in many cases, internet-based support groups are unable to provide the emotional support that addicts require [61].

Table 1. Demographic data of recruited patients and their parents.

Patient						*Parent*		
ID	***Age (Gend.)***	***CIAS score***	***Age of owning the first device (years old)***	***Daily usage (Hour)***	***Devices owned***	***ID***	***Age (Gend.)***	***Relationship***
P01	16(M)	82	12	4.86	1 phone, 1 PC	F01	49(F)	P01's Mom
P02	14(M)	64	11	2.93	1 phone, 1 PC	F02	44(F)	P02's Mom
P03	15(M)	65	3	7.86	2 phones	F03	47(F)	P03's Mom
P04	16(F)	74	12	0.64	1 phone	F04	59(F)	P04's Mom
P05	16(M)	87	13	17.57	1 phone, 1 PC	F05	70(M)	P05's Dad
P06	14(M)	74	12	8.14	1 phone	F06	46(F)	P06's Mom
P07	18(F)	84	13	10.29	1 phone, 1 laptop	F07	34(F)	P07's Mom
P08	15(M)	60	11	8.43	1 phone, 1 laptop	F08	54(M)	P08's Dad
P09	15(M)	62	12	12.00	1 phone, 1 PC	F09	48(F)	P09's Mom
P10	13(M)	63	6	5.71	1 pad, 1 PC	F10	68(M)	P10's Dad
P11	10(F)	74	3	1.57	1 pad	F11	39(F)	P11's Mom
P12	18(M)	71	13	9.29	1 phone	F12	57(F)	P12's Mom
P13	18(F)	67	15	6.00	1 phone, 1 laptop	F13	54(F)	P13's Mom
P14	18(M)	61	13	8.00	1 phone, 1 laptop	F14	44(M)	P14's Dad
P15	17(M)	70	11	4.14	1 phone, 1 laptop	F15	43(F)	P15's Mom
AVG	15.53	70.53	10.67	7.16	-	-	50.40	-
STD	2.23	8.61	3.66	4.30	-	-	10.04	-

Combining professional guidance from psychiatrists or psychologists with improved parent-adolescent communication and healthy expectations has been shown to mediate addiction severity [87]. It appears that family therapy and family-based group interventions are more effective than individual psychotherapy in dealing with technology abuse [87, 88]. However, introducing parental support to regulate technology use can lead to tension [28]. Also, a scarcity of medical treatment resources makes it impossible for every adolescent to seek help from professional treatment teams. Technology solutions could be employed to facilitate the synergistic use of existing resources in social ecological systems to mediate technology abuse behaviors.

Based on our review of the literature, we formulated the following research questions:

- What contextual factors are associated with technology abuse by adolescent patients?
- How do adolescent patients communicate with their parents regarding technology abuse, and what barriers hinder mutual understandings?
- How can complementary support from the community be used to facilitate constructive communication and mediate the use of technology by adolescent patients?

3 Methods

In the current study, we conducted a qualitative interview study with Taiwanese adolescents undergoing treatment for technology abuse (hereinafter referred to as patients) as well as their parents and treatment experts (psychiatrist and clinical psychologists) to identify themes that motivate or demotivate technology abuse. This study was approved by the Institutional Review Board of Taipei City Hospital (IRB No. TCHIRB-10812024).

3.1 Participant

We used snowball sampling in Taipei City Hospital in Taiwan to recruit 4 treatment experts (1 male psychiatrist, 2 female psychiatrists, and 1 female clinical psychologist; T01 ~ T04), all of whom had over four years of experience in treating adolescent patients for technology abuse. Through these experts, we recruited 15 dyads of adolescent patients (11 males and 4 females; P01 ~ P15) aged 10 to 18 years old (mean age = 15.53 years; SD = 2.23) and one of their parents (4 male and 11 female parents; F01 ~ F15) aged 34 to 70 years old (mean age = 50.40 years; SD = 10.04). Table 1 summarizes the demographic information.

All of the patients obtained their first technology device between the ages 3 and 15, and developed their dependence gradually. Patients reported using their technology devices for an average of 7.16 hours per day (ranging from 0.64 to 17.57). Chen Internet Addiction Scale (CIAS) [45, 46] scores ranged from 60 to 87, exceeding the cut-off point of 58, indicating a tendency toward Internet Addiction (IA). Each participant was reimbursed with NTD 250 (about USD 9) for participating in our interview.

3.2 Procedure

The participating dyads (patients and parents) were recruited through hospital referrals. The psychiatrist began by randomly selecting patients who had undergone treatment for technology abuse or other behavioral disorders triggering technology abuse. We then screened the candidate patients using structured interviews to determine eligibility. The goals of the study were briefly explained to all eligible patients and their parent. Each eligible dyad was free to choose whether to participate in the study. After the patients and family members expressed a willingness to participate, they were asked to sign informed consent forms.

Semi-structured interviews were conducted with psychiatrists to characterize current practices in the treatment of technology abuse. The general interview questions focused on the following: (1) treatment expert opinions related to technology abuse, (2) their clinical experience in interacting with patients and/or parents, and (3) how they provide suggestions and reminders of technology abuse.

We then conducted interviews with patients and parents to obtain information about technology abuse behaviors and family interactions associated with screen use. General interview questions for patients and their parents focused on: (1) patient opinions related to technology abuse and their experience in managing their technology use behavior, (2) parent opinions related to technology abuse, the means by which the parent communicated with the adolescent about technology abuse, and the means by which they seek to mediate technology abuse, and (3) how patients (or parents) think about the role other stakeholders should play in helping patients manage the technology abuse problem.

The scope of these questions was based on the advice of treatment experts and our review of the literature. Interview questions were formulated in accordance with our research interest in technology solutions and information sharing. We also asked some of the participants follow-up questions. Note that the interviews with patients were conducted in the absence of the parent to alleviate pressure and encourage open discussion. Our objective was to collect information pertaining to technology abuse behaviors and characterize family interactions associated with screen use problems. Each interview was audio-recorded with permission and lasted between 90 to 120 minutes.

Table 2. Summary of themes with descriptions and occurrence frequency across participants. Contributing/preventing factors were grouped within the three layer framework of installation theory.

Themes	Description	Frequencies	Group
Section 4.1 Factors Contributing/Preventing Adolescents' Technology Abuse			
4.1.1.1 Pervasiveness of devices and internet connection	The physical characteristics of the technology (e.g., devices, internet services) that makes it easily to access.	14	4.1.1 The physical layer
4.1.1.2 Plentiful attention-grabbing stimuli online but not much offline	The physical characteristics of the technology (e.g., online activities) that draw participant's attention (in comparison with offline activities).	12	
4.1.1.3 Hard to keep track/monitor technology use	The difficulties encountered by participants in tracking/monitoring technology use behavior.	14	
4.1.2.1 Devices being part of adolescents' identity	The psychological needs and capacity (e.g., forming self-identity) of adolescents that drive them to excessive technology use.	11	4.1.2 The embodied layer
4.1.2.2 Sense of belonging	The psychological needs and capacity (e.g., interpersonal connection, accompany) of adolescents that drive them to excessive technology use.	14	
4.1.2.3 Improving Self-efficacy.	The psychological needs and capacity (e.g., sense of achievement, self-confidence) of adolescents that drive them to excessive technology use.	12	
4.1.2.4 A lack of willpower	The psychological needs and capacity (e.g., self-control) of adolescents that drive them to excessive technology use.	10	
4.1.3.1 Peer influence and social learning	The influences from others (e.g., peers, online community) related to technology use for learning experience.	14	4.1.3 The social layer
4.1.3.2 Social comparison	The behaviors of evaluating one's own situation in comparison with others (e.g., peers, online community) that related to technology use and its regulations.	13	
4.1.3.3 Restrictions about cell policy	The influences from the restrictions imposed by school policy and parent that lead to decreased/increased technology use behaviors.	13	
Section 4.2 Inconsistencies among Parents and Adolescents			
4.2.1. Inconsistent awareness and perceptions	The comparison between parent-child perspectives regarding the awareness and perception of technology use behaviors.	13	
4.2.2. Inconsistent perceptions towards the influences of technology use	The comparison between parent-child perspectives regarding the perceptions towards the influence of technology use.	15	
4.2.3. Inconsistent reasoning towards data collected by tech solutions	The comparison between parent-child perspectives on interpretations or reasoning towards collected screen time data.	8	

3.3 Analysis

Audio recordings of the semi-structured interviews were transcribed to facilitate the identification of salient themes based on thematic analysis [16]. Through iterative open coding, we sought to identify the factors that exacerbate technology abuse and the forces that reduce it. We then examined the codes and conducted axial coding to connect the major salient themes. Our analysis revealed inconsistencies between the accounts of adolescents and those of parents. Note that most of the discrepancies pertained to the awareness and perception of technology abuse.

4 Results

In this section, we first list the factors that lead adolescents to or away from technology abuse. We then outline inconsistencies between the narrative accounts of parents and adolescents, which provided intriguing insights into the means by which the problem should be tackled. We present our analysis of those inconsistencies in the second part of this section. A summary of the two parts can be found in Table 2.

4.1 Factors Associated with Technology Abuse

We grouped the identified factors into the three layers posited in installation theory, i.e., physical, embodied, and social layers [51, 52]. It has been proposed that contextual factors, including cultural and social influences, can easily affect attitudes and behaviors related to technology use. The psychiatrists noted several issues generally associated with technology abuse in adolescents, such as deficits in attention, emotional regulation, impulse control, and social skills:

> *"In my clinical experience, it appears that nearly all adolescents displaying technology abuse are diagnosed with other problems, indicating multiple underlying issues. Many adolescents become obsessed with the internet due to frustrations associated with schoolwork or relationships. Frustrations often leads to depression, anxiety, and/or attention deficit, which manifest in social interactions and relationships. It is easier for these adolescents to make friends on the internet than in the real world."*— (T03)

These issues may complicate the management of technology use and communication with parents. Based on the tenets of installation theory, we identified contextual factors that motivate or dissuade teenagers from engaging in technology use, which manifest in physical, embodied, and social layers.

4.1.1 The Physical Layer. The physical layer refers to the material properties of objects. In the current study, this layer included several factors that relate to technology abuse, including the pervasiveness of devices and internet connections, the abundance of attention-grabbing stimuli online and relatively meager availability offline, and the difficulties in monitoring technology use.

4.1.1.1 Pervasiveness of devices and internet connection. Nearly all of the patients and their parents mentioned the ubiquity of internet connections and devices, such as cell phones (Frequency = 14 in Table 2). Most of the patients mentioned that they owned multiple devices, which they use simultaneously or individually. Accessibility on this scale no doubt facilitates pervasive usage.

Parents mentioned taking active measures aimed at limiting device usage, such as constraining internet access or taking away their device(s). In such cases, most adolescents would have no difficulty borrowing a replacement from friends or siblings. For instance, parent P02 mentioned:

> *"When I picked him up, I found him playing video games in the convenience store, and I asked him where he had obtained the device. He told me it was his classmate's."* — (F02)

Parents can also limit access to devices by imposing restrictions on usage (i.e., placing a limit on screen time). Unfortunately, this means keeping an eye on the adolescent at unscheduled times and confiscating devices when the time is up. Due to a lack of emotional regulation among adolescents, this approach often triggers resentment and/or tantrums. Thirteen parents expressed frustration in implementing restrictions in the face of this kind of distress. Some parents reported limiting access to the internet. However, even this seemingly moderate approach can prompt the adolescent to act on their impulses by going out to find a public wireless network. For example, F04 and F09 made the following comment:

> *"I used to ask my child to turn off the computer before midnight. If my son didn't follow this rule, I would unplug it entirely and there was nothing he could do about it. Sometimes he got really mad, but again, a rule is a rule."* — (F09)
>
> *"Once she refused to hand over her phone so I cut off our internet at home. She was so mad that she went to the convenience store to use a public hotspot and did not come back until 2 am! Internet restrictions didn't work at all. Instead, they just forced her to go out, and that was dangerous."* — (F04)

Clearly, the pervasiveness of devices and internet access facilitates technology use in the first place and make it hard for parents to establish regulations.

4.1.1.2 Abundance of attention-grabbing stimuli online and meager availability offline. Twelve of the patients frequently mentioned that no other activities were as interesting as using their devices, and even their other interests were commonly linked to technology use (Frequency = 12 in Table 2). Essentially, the offline environment did not present sufficient stimuli to engage the minds of patients, who were already struggling with attention deficit. Nearly half of the patients

exhibited below average engagement with school life and the corresponding social interactions and stimulation that comes with such interactions. As P09 and F08 commented:

> *"I don't really have any interests other than playing games and chatting with friends. When I am not playing games or chatting with others, I just go to sleep."* — (P09)

> *"I think it all started with him not wanting to go to school, and then he began using his cell phone excessively at home. It's a vicious circle. There isn't much to do at home, so he feels bored and he does not want to study, and so he starts using the phone."* — (F08)

Parents reported that their efforts to interest the adolescents in offline activities were frustrated by a lack of motivation and unremitting excuses.

> *"I learned that why he has internet addiction is primarily because he has nothing to do - he gets bored. But I can't find anything that he is interested in. I had to take him with me to go shopping and watching movies so that he would not be on his phone all the time watching gaming videos."* — (F03)

> *"I used to help him arrange activities, like summer camp and hiking in the mountains. But now he just gives me excuses, saying that he doesn't want to do or that it doesn't sound interesting."* — (F01)

4.1.1.3 Difficulties in monitoring technology use. Difficulties may be exacerbated when parents lack the means by which to monitor technology abuse in their absence (Frequency = 14 in Table 2). Some parents mentioned they were too busy at work to watch the kids at home. The father of P05 described his work routine and how it affected his son's technology abuse as follows:

> *"I go to work at about 8 am in the early morning, and don't get home until around midnight. I know that when I am not home, my son keeps playing on the computer. He told me that he takes regular breaks, but I don't think he does. He was just saying that so that I would not be disappointed with him."* — (F05)

Even when parents are available to monitor technology usage, doing so requires considerable effort. P06 reported that his father would frequently check to see if he was using technology devices in his bedroom.

> *"One time, I had an argument with my dad. He was pissed off and asked me not to close my bedroom door because he wanted to see if I was playing mobile games in my room [...] He often walks past my bedroom door just to see what I am doing. [How often did he walk past your door?] Very often . . . About every 30 minutes."* — (P06)

When it is difficult for the parents to keep an eye on what the adolescents are doing, some parents resort to using a screen lock to do the job, but such restrictions are easily bypassed by crafty adolescents. For example, F02 made the following comment:

> *"The reason that I have him hand his device over to me is that, if we set a screen lock password for him, he can easily crack the code. I am not sure how he does it, but as long as he has the device, he can crack the code and access it without problems."* — (F02)

P02, explained how he figured out the password.

> *"My classmate told me this bug about the Android system, which allows you to bypass the lock. There are other bugs that haven't been fixed yet, but as long as I know the cell phone brand, I could pretty much bypass it."* — (P02)

Due to difficulties in monitoring technology use, adolescents receive few reminders of the time they have been using their devices.

4.1.2 The Embodied Layer. In installation theory, the embodied layer refers to the psychological aspects of individuals and their perceived competencies. Within the context of this study, this means that adolescents form their concept of self, based on their experiences, many of which are gained while using their devices.

4.1.2.1 Devices and identity. All of the patients in this study belong to the digital native generation, who see screen time as a necessary part of life rather than an option (Frequency = 11 in Table 2). From the perspective of parents, spending so much time on devices is absurd. For example, F07 made the following comment:

> *"She (P07) did not tell me what videos she watched. There are too many videos on YouTube. Also, I really wonder how Instagram can take up so much of her time. Isn't she just looking at other people's updates? It seems that's all. I do not get it."* — (F07)

Adolescents view their devices not only as a tool of communication, but as an extension of their self-identity. Parents who do not understand how teens can be so obsessed with their phones or laptops are unaware that teens use a variety of apps (e.g., games, social network apps, streaming apps) to engage in interpersonal relationships. F07 explained that her excessive phubbing was to respond to messages from contacts, including family members.

> *"I phub whenever I have time. I use my cellphone to respond to all the messages I have received on Instagram, Line, and Messenger from my classmates, family members, and people I met online. You can imagine how many messages there will be in total."* — (P07)

All of the patients reported that apps gave them access to crucial information and interactions, which enabled them to form the concepts of self and others through identification and differentiation. Social media serves as a platform for the construction of self-representations through the creation of online profiles and sharing photos. Parents, who are eager to know what happens in their child's life are likely to be excluded from the intended audience, due to the tendency of teenagers to maintain privacy and create boundaries from their parents. Nonetheless, parents often look for ways to take a peek. For example, F12 made the following comment:

> *"I created an Instagram account just to see his posts and get an idea about what he's up to. [. . .] He once posted a photo and it got two hundred likes! [. . .] But certainly, I will never let him know that I have been following his Instagram account. He would immediately block me if he knew."* — (F12)

P12 was suspicious about what his mom was doing, possibly by following his friends' accounts, and he further explained that he has nothing to hide but would wish to maintain personal space at the same time.

> *"[Why do you hide your posts from your mom?] My posts are something personal, which I only share with my friends. I guess it is not a big deal (if she sees those posts), but just a feeling that I do not want her to know too much about my life. I don't feel like letting her know everything about me."* — (P12)

4.1.2.2 Sense of belonging. A sense of identification and belonging to a group are important to the psychological development of adolescents (Frequency = 14 in Table 2). All of the psychiatrists reported that individuals with technology abuse issues have a below average capacity to form connections in the first place. Within this context, cell phones and the corresponding virtual connections provide a gateway by which to reach out, in a manner with which they feel comfortable. All 9 patients demonstrated this tendency, including P05 and P04, the parents of whom reported that they are marginalized at school.

> *"I always feel anxious or stressed in crowds, so I have like only four or five friends. . . I met them in an online game, and have been chatting with them since I was in junior high school. We sometimes hang out offline too."* — (P05)
>
> *"I would ask someone in an online card game if he feels like being a friend with me. Usually, he would say yes and we would add each other on Facebook. It feels good to make new friends. I've got several boyfriends online right now."* — (P04)

F04 attributed this to her desire to be socially recognized and accepted.

> *"I think what she really wants is a group where she can be accepted, as she has never been popular at school. She has emotional issues and really needs someone to be with her."* — (F04)

Adolescents reported that their need for companionship and a feeling of connection are fulfilled only by online friends via dating apps or games. For example, P09 made the following comment:

> *"[Why do you spend so much time chatting via a dating app?] Um. I guess it makes me happy because they sometimes joke around and they are fun. [Do you prefer to chat with them over your classmates?] Yes, because they are sillier and funnier. [Don't you think you can have this kind of interaction with your classmates as well?] Hmm, I have not thought about that."* — (P09)

4.1.2.3 Improving self-efficacy. Some participants shared the motivations and perceived rewards associated with technology abuse. One major motivation is a sense of achievement (Frequency = 12 in Table 2, which can act as a diversion away from the pressure and frustrations of real life. A sense of achievement may provide a diversion by which to alleviate pressure from the frustrations encountered in real life, which in fact may derive from lack of motivation to study or relationship difficulties. In many cases, immersion in a virtual world is one of few ways that adolescents can cope with those feelings, as described by psychiatrists T03 and T04:

> *"Most adolescent patients with technology abuse issues display specific behavioral patterns. Many have a reduced capacity to cope with stress and little tolerance for frustration. Due to their low self-efficacy, many of these individuals are unable to handle long-term pressure, which means that they prefer to escape into the internet or a game in which the rewards are immediate and direct."*— (T03)
>
> *"Many of these patients used to have problems with schoolwork and/or relationships before they developed technology abuse behaviors. Furthermore, many parents have difficulties setting boundaries and dealing with family issues. These aspects are basically the entire world in which adolescents reside. Any disturbance can be overwhelming. They need a space in which to gain some relief or a sense of achievement. That is why they turned to the internet."*— (T04)

Several patients explicitly acknowledged that escaping into the world of gaming is a way to cope with feelings of disconnection from peers and/or frustrations in class.

> *"I'll be honest, I started playing computer games because none of my classmates liked me. I tried to forget this by playing games; otherwise, I would keep thinking of it so much so that I have nightmares about it."* — (P03)

For teenagers facing setbacks in academic performance and interpersonal relationships, online gaming provides a sense of purpose in which to master skills, share with others, and even mentor others.

> *"[Do you play games just to kill time?] A little bit, yes. But recently I play to set records as well. The world records for the fastest clearance of all game stages."* — (P03)

> *"When he started playing games, his friends would coach him and refine his gaming strategies. But most of the time, he is the more experienced, and tends to do the teaching."* — (F06)

Some of the patients reported looking for information online with the aim of discovering new interests or topics related to subjects they encountered in class. P03 reported switching his focus from online games to cooking tutorials.

> *"I have begun using my phone more often [than Play Station) to watch videos on YouTube, like cooking tutorials. I am taking a cooking class in school and have already learned how to make pasta and curry."* — (P03)

4.1.2.4 A lack of willpower. Many participants (especially the parents) attributed technology abuse to a lack of willpower. Note that ten of the fifteen adolescents reported that they were aware of their problems, and some reported that they were willing to practice self-control (Frequency = 10 in Table 2). For example, P05 made the following comment:

> *"I know that I am spending too much time on my computer and cell phone. I am trying to change this, but it is very hard. I have tried to reduce my screen time by reading a book instead of looking for interesting things on the internet. It's working, but it's not easy."* — (P05)

Several of the other adolescents mentioned that when they are using the devices, they move into a flow state during which they are unable to estimate the time. For example, P07 made the following comment:

> *"If there were this reminder of how long I have been playing, I would probably use it, because I would like to know what I had been doing today. Time just passes when I am phubbing. I don't even know what I have been doing."* — (P07)

Many of the patients reported that technology abuse is hard to control due to the innate nature of the games they play. For one thing, the players are unable stop arbitrarily without being penalized in the form of decreased "credits" in the game. This is an indication that in-game status takes priority. In the context of game design, P02 commented on one particular gaming mechanism, as follows:

> *"It is harder than other types of games, which you can just stop playing whenever you want, because the game is round-based, and if you quit during a round, you get punished. "* — (P02)

4.1.3 The Social Layer. The social layer refers to the social norms that funnel individual behavior. In the context of technology abuse. It encompasses the three main themes elaborated below.

4.1.3.1 Peer influence and social learning. Peer influence is a common topic in discussions on technology abuse. Nearly all of the patients (Frequency = 14 in Table 2) felt it was necessary to comply with the actions of their peers, and to do otherwise would threaten their identity:

> *"I am part of a group and can't be the only one who doesn't do the same things as others. If I don't follow the group rules, we wouldn't have anything in common anymore or I could be ostracized."* — (P02)

Teens share trending topics online with their peers and spend time catching up on what their peers recommended. Some patients reported staying connected and interacting with friends via social network apps (i.e., LINE, Instagram), while at home:

> *"We talk about dramas and other things we saw online. If a drama sounds interesting and was recommended by a friend, I would definitely watch it. Otherwise, I would not. We*

also text one another after school, or comment on posts on Instagram and continue to chat afterward." — (P13)

Several of the parents expressed a preference for their children to interact with friends physically in the real world, instead of with friends in the cybernetic world. They also encourage their children to participate in other physical activities (e.g., summer camp) or spend more time studying (e.g., go to cram school after their regular studies). However, it is difficult to maintain their motivation to participate in these activities.

"Once, his classmates came to our house. I suggested they go to the park playing badminton, and they did, but the next weekend he refused. They just sat in the living room playing on the computer or lying in bed using their phones ..." — (F10)

4.1.3.2 Social comparison. In a related vein, social comparison also contributes to technology abuse (Frequency = 13 in Table 2). Several of the patients appeared sensitive to peer judgments. They claimed that all of their peers had better devices and that they felt ashamed, pressing their parents to upgrade their devices or data services:

"When he was in the 5th grade, I gave him a dumbphone just to make calls. He was unwilling to take that phone with him because it was not as fancy as the smartphones his classmates had, and he felt ashamed." — (F12)

Social comparison also applies to parental regulations pertaining to fair technology use. Nearly half the parents reported their children using it for bargaining. It is likely very difficult for parents to reason with their children or to maintain boundaries related to technology use.

"He knows which of his friend have unlimited data and those with unlimited tech use. Actually, many of his friends are allowed to use their phones whenever and however they want. I was like. . . do they cause trouble as you do? They still have good grades. That is why they can use their phone without limitations." — (F02)

4.1.3.3 Restrictions about cell policy. Parents also expressed a desire for support from other social groups (e.g., schools), and nearly all of the patients mentioned school policy on cell phone restrictions (Frequency = 13 in Table 2). As a final resort after finding out about her son's reduced vision, F15 sent her son to a boarding school where screen time was restricted. Note that stringent restrictions in school could potentially lead to overcompensation, wherein students do nothing but use their phones when they leave school. For example, F15 and P15 made the following comments:

"His vision declined during summer break because he was so immersed in games and never went out to exercise. I arranged for him to study in a boarding school where they had restrictions on phone usage. I was unable to regulate his screen time by myself at home without jeopardizing our relationship." — (F15)

"On weekdays, when I am in school, students can only use the phone from 9 to 10 p.m. [How about weekends?] There were no restrictions on weekends, so I would generally keep my phone with me use it all the time if I had nothing else to do." — (P15)

More than half of the parents mentioned that they had disagreements with their spouses regarding the regulation of technology usage. They worried that discrepancies in their attitudes toward cell policy could compromise the effectiveness of the discussion. For example, two of the parents made the following comments:

"My son's father is more open to technology use because he feels it is too difficult to even try. But I think you have to set up rules, and can't just leave it wide open. We have very different parenting philosophies. I finally gave up to avoid being the bad guy." — (F01)

> *"Since my son entered junior high, the family has been having conflicts about cell policy and bedtimes. His mom would ask him to stop using his phone and go to bed at 10:30 pm. He complied at the time, but he would come to me to complain. I did not entirely agree with my wife on this matter and I thought we should respect his autonomy, so I would argue for his right to have more screen time."* — (F14)

Some parents struggled to deal with the regulation style of their spouse; however, a few found an efficient way to reach a consensus involving the opinions of third-party professionals (psychiatrists).

> *"My husband and I listened to the psychiatrist's suggestion to maintain a consistent parenting style. I had previously talked to my husband about this, but he didn't listen. When the psychiatrist talked to us together, my husband found it more convincing and was willing to heed the professional's advice."* — (F06)

The participants reported that professional interventions helped to manage conflict between parents as well as the parent-adolescent dyad by facilitating the establishment of rules that were acceptable to both sides. F12 and P12 shared their opinions on the role of the psychiatrist in the discussion:

> *"The psychiatrist advised me to give him some rewards to encourage him when he honors the deal. So I told him that I would give him extra pocket money if he went to bed before 1 am."* — (F12)

> *"[What happened when the psychiatrist joined the discussion about cell regulation?] She (the psychiatrist) asked me what time I would prefer to stop my screen time and go to bed. I offered 1 am and my mom agreed. My mom never asked me about my preferences before. She just kept nagging about bedtime so I did not listen to her."* — (P12)

The results above revealed that the responsibility for excessive technology use cannot be attributed only to adolescents. Rather, the desire to engage in technology use is commonly triggered by the surrounding environment.

4.2 Inconsistencies among Parents and Adolescents

Despite extensive discussion pertaining to technology use, the patients and their parents both appeared to have a hard time considering the situation from the perspectives of their counterpart. We found that the two sides differed in their attitudes towards what denotes excessive technology usage. The psychiatrists reported that addressing barriers in parent-child communication is a primary objective of treatment.

> *"It is important to address the parent-child relationship. It can be a vicious cycle in which children escape into the internet because they feel stressed out by conflict, and this behavior itself is what triggers fights with their parents. Psychiatrists have to mediate the discussion and help them to reach a consensus."* — (T03)

4.2.1 Inconsistencies in Awareness and Perception. Thirteen dyads displayed inconsistencies in their awareness and perceptions of technology use behavior (Frequency = 13 in Table 2). None of the parents had a practical way to determine the amount of screen time deemed excessive. In many cases, it appeared to be an arbitrary assertion.

> *"[What is your child's average daily technology use this month?] I don't know . . . I think there should be more than 5 hours. . . 5-7 hours. . . or even 7-9 hours. It's a summer break now so it can be more. [how did you derive the number of 7-9 hours?] He didn't have to go to school. . . if so, it's possible that he spent all his free time on screen, including night times."* — (F12)

This kind of imprecision was evident at the adolescent's end too. Many did not feel that they were spending too much time on screens, and actually claimed that their usage patterns were no different than those of their peers or even their parents.

> *"I think they sometimes overgeneralize. . . For example, I might use my cellphone until very late for a few days but not all the time. I don't think I am addicted. I use my phone with them... like everyone's on their own phone in the living room... so they get the impression that I spent too much time on my phone. But they're using theirs too!"* — (P13)

> *"I found that teenagers do not see a problem and feel that their but parents are overreacting. Nonetheless, many patients admitted that they thought they had only spent roughly two hours on the internet, it had suddenly become very late. In such cases, a timely reminder could make them aware of the problem. They need feedback to understand the discrepancy between their perception of time spent on the internet and the actual time. Only then they would be willing to accept that this behavior has been affecting their lives and make adjustments."* — (T04)

Without a precise record of actual screen time, parents tended to overestimate technology use. They formed an impression that the adolescents were constantly online. Parents saw technology use as a whole, failing to see that only a portion of that time was frivolous. In many cases, the adolescent obtained benefits from using their devices, such as P13, who learned history by watching shows online. This made it easier for adolescents to characterize their parents' assertions as erroneous and their accusations as unconvincing.

> *"[Have you learned anything from binge-watching?] yeah . . . those shows are usually very long like 70-ish episodes. When I finished watching, I felt great about myself. I managed to watch them all. When I was in high school, I liked to watch history shows. So when I learned the subject at school, I felt more interested and I got good grades in history."* — (P13)

Note that some of the adolescents recognized that their technology usage was excessive. Nonetheless, this awareness did not necessarily help them to see a link between behavioral patterns and potential consequences, or to adjust their behavior.

> *"Sometimes I would check my daily screen time on my iPhone. When I saw that I was spending about 10 hours, I was shocked. That really is too much. I am thinking about cutting down by 2 or 3 hours. [what number do you think is decent?] Probably 8."* — (P12)

4.2.2 Inconsistencies in the Perceived Influences of Technology Use. One's perception of what constitutes excessive technology use can have real-life consequences. Despite the fact that many adolescents disagree, most parents believed that spending many hours engaged in technology use is an indication of indolence (Frequency = 15 in Table 2). The parents reported that a lack of self-control prevented their children from fulfilling their duties (e.g., school work) or disrupted their daily life. In the end, it caused the parents to mistrust their children.

> *"I don't think she's able to . . . [self-control]. She knows she's supposed to go to bed at a certain hour, but she's addicted. She can't control herself."* — (F11)

Adolescents lacking awareness of how long they have played tend to underestimate or downplay their technology use. In some cases, they are oblivious to their surroundings while phubbing. In other cases they fail in their duties as a student (e.g., sleeping in class) or take care of themselves (e.g., showering every day). All of the patients mentioned such incidents.

> *"[When and where would you use your phone?] I would keep playing games while walking down the road … I was totally focused on the phone. [Wouldn't that be dangerous?] Its*

> *generally fine, but I sometimes trip and fall . . . like once a week, because I do not watch my steps."* — (P07)
>
> *"I started staying up late to play games on weeknights, and my teacher caught me sleeping in class, so she told my parents. Afterward, my mom caught me playing iPad at midnight, so she just locked the device. I was so mad at her at that time, but then I realized that she was right and I shouldn't stay up so late playing games."* — (P11)

In some cases, the patients developed delinquent behavior to satisfy their need to access technology. This included buying credits for video games or buying a low-price cell phone behind their parents' backs.

> *"We even asked for help from the police to teach the kid a lesson. I forget precisely what the incident was about. . . probably stealing money or stealing his dad's cell phone and selling it. I forget. There were too many similar incidents. Then we became more alert and I told his dad to put his wallet away and make sure he knew how much money he had in the wallet. I also develop the habit of withdrawing money only when I was out of cash."* — (F02)

Without a precise record of technology use, adolescents often fail to observe the connection between technology use and the deviant behaviors their parents are trying to correct. It is difficult for parents to monitor their children's actual usage and implement rules to regulate excessive use.

> *"I don't think I can follow through with detailed regulations. I would need to watch him all the time. I told his dad and aunt how difficult it was. I can't do anything for myself if I need to watch him constantly."* — (F02)
>
> *"If you ask most teens under 15 whether he/she has issues with sleeping, the answer is no. Teenagers probably do not feel troubled by it (sleep problems) or are unaware of exactly what it is. Why? Because that is not something they think about."*— (T04)

4.2.3 Inconsistencies in Attitudes toward Data Collection. All psychiatrists reported that they focus on understanding technology use behavior as well as the means by technology abuse affects expected lifestyle patterns.

> *"The primary diagnostic criteria of any kind of behavioral addictions are similar ... that is ... loss of control [over the problematic behavior]. In the case of technology abuse, that means losing the ability to limit their gaming or internet surfing, spending more than the expected time, or tailing to fulfill daily obligations [e.g., school]."* — (T01)

Most existing technology monitoring solutions aggregate all device usage hours into a value indicting overall screen use or separate values indicating the time spent using apps of various categories (e.g., social networks). It is no doubt helpful for parents to have an accurate idea of screen use; however, many parents were unaware of how best to use the data (Frequency = 8 in Table 2).

> *"[Have you used any screen time monitoring software?] I didn't care about the screen time usage value ... I care more about the meaning behind the number. When your iPhone notifies you: 'You did great, you used 10 minutes less than the last week.' You would feel . . . what now?"* — (F01)

Many adolescents spend an inordinate amount of time online and it is difficult for parents to differentiate between productive and unproductive screen usage behaviors. Parents reported that they have their own way to interpret the productivity of time spent using specific apps.

> *"[Since your son spent time following YouTube channels, what influences would YouTubers bring to your son?] I think he can learn how to assemble or upgrade his computer. If he was*

> *learning things, I would not ask that much. I did not set a high standard for my children."* — (F09)

Complete awareness of app usage is not a complete solution. Parents and adolescents alike reported that presenting visualized data would exacerbate the negative connotations of technology usage.

> *"Currently, I can probably keep track of my child's technology use behavior, except when he is at school. However, when the monitoring system indicates technology abuse at school, I get very angry. For example, I have been informed that he used his phone for five hours while in school for 7 hours."* — (F13)

> *"I don't think that being able to view my technology monitoring data would improve communication between me and my parents. Sharing this kind of data would only cause arguments. I mean, my mom... we already fight from time to time when this issue comes up. If she saw that data every day, she would pick up a fight with me on a daily basis."* — (P14)

Conventional (i.e., manual) approaches to monitoring make it possible for adolescents to hide their use of technology; however, automated technology monitoring make it far easier to share usage data with the family or treatment team. Under these conditions, many adolescent feel pressured. The clinical psychologist expressed concern that collecting this kind of data would be seen as a burden by the patients.

> *"I would first assess the suitability of the family to these technological solutions. I have some patients who are otherwise stable, but would have a dramatic emotional reaction if I asked them to provide screen use data. In these cases, I would have to reconsider."* — (T04)

Moreover, most adolescents report having little motivation to use the data themselves. To alleviate the troubles related to sharing screen use data with parents, T04 suggested that technology monitoring solutions be brought in when the entire family (parents and adolescents) are aware of how the data will appear. It was also suggested that data sharing be introduced in stages to avoid triggering confrontations.

> *"Ideally, the parents would be able to tolerate not being provided all of the collected data. I don't think that the introduction of technology monitoring would go smoothly right off the bat. I think that breaking the process of sharing the data into stages would be preferable."* — (T04)

Introducing accurate data pertaining to technology could help to reduce the inconsistencies related to the issue of technology abuse and its influences. Nonetheless, the same data might also undermine the stability of the relationship between the adolescent and parents. Ideally, professionals would assist in the interpretation of the data, as discussed in the following section.

5 Discussion

5.1 Revisiting Installation Theory in Terms of Technology Abuse

Figure 1 illustrates the framework of installation theory when applied to technology use behaviors by adolescent patients under the influence of contextual factors. The pervasiveness and intriguing nature of technology make monitoring and regulation difficult (physical layer). Psychologically attachment to devices brings rich experience into conflict with underdeveloped self-control (embodied layer). Pressure from peers and restrictions imposed by parents or school further complicate the decision-making process (social layer). Most of the adolescents in this study lack the resources to recognize problematic habits or balance out the factors associated with technology abuse, eventually leading to maladaptive technology use.

Note that the in the current study, the study subjects (adolescents receiving treatment) were undergoing emotional, cognitive, and/or social struggles, which made it difficult to resolve the problem without assistance. We found that parents, psychiatrists, and the broader community comprising social layers echo the social systems in Bronfenbrenner's ecological systems theory [17], in which the development of an individual is scaffolded by complex interactions within and among surrounding systems. Note however that our study dealt with a socio-technical issue triggered by technology and the psychological state of the individual. In our study combining installation theory with ecological systems theory, the physical layer describes how adolescents with technology abuse problems are affected by technology services and products, the embodied layer describes how psychological needs drive technology use behaviors, and the social layer describes the effects of peers and school policy (see Figure 1). Our results suggest that in developing technology mediations or interventions addressing issues related to addiction, it is important to consider the triggers of addiction, the psychological state of the individual, and the social ecological system surrounding the individuals.

In the current study, we discovered that the influence of parents spans each of the layers. As primary caregivers, they can have a profound impact on the attitude toward technology abuse and corresponding behaviors. We found that parents are often involved in managing access to technology, shaping and monitoring the psychological needs of the adolescent, and interfering with other social forces in order to gain influence.

Parental interventions can lead to conflict in parent-adolescent communication, due primarily to inconsistencies between parent and child in the perception of technology abuse behavior, the evaluation of its impact and the interpretation of monitoring data (see Figure 1). Through the lens of Value Sensitive Design [28], these inconsistencies are manifestations of discrepant values. From the perspectives of the adolescent, technology abuse stems from psychological needs for stimuli, social acceptance by others, and a sense of achievement. From the perspective of the parents, children must fulfill their duties as students, listen to their parents, and prioritize health-related activities. The social dynamics within the family make it difficult to resolve conflict between patients and their parents. In the following section, we examine methods by which to mitigate conflict via mediation or redirection at the personal and family levels via assistance gained at the social level.

In the following section, we examine methods by which to mitigate conflict via mediation or redirection at the personal and family levels by providing assistance at the social level.

5.2 Opportunities to Integrate Supporting Resources

Installation theory can be used to identify opportunities to complement existing resources across the physical, embodied, and social layers with the aim of mediating the impact of contextual factors. We seek support for the patients at the personal-level, facilitate communication at the family-level, and incorporate support structures from outside the family (i.e., social- level). Our discussion focuses on leveraging the abilities of the adolescent and motivating them to avoid factors that could contribute to technology abuse. We also look for ways to facilitate constructive communication between the adolescent and their parents. Finally, we try to find support mechanisms to complement parental support.

5.2.1 Personal Level: The Context of Motivation and Leveraging Inherent Abilities. Adolescence is considered a critical stage in terms of psychological and physical development [19]. Not only do adolescents experience drastic changes, but their families also face numerous challenges. During this transitional stage, their functional impulse-control is ill-equipped to resist the stimuli provided by technologic devices [26, 75] (Section 4.1.1). The mastery adolescents develop over their devices through practice and emotional and temporal investment makes them eager to apply those skills to

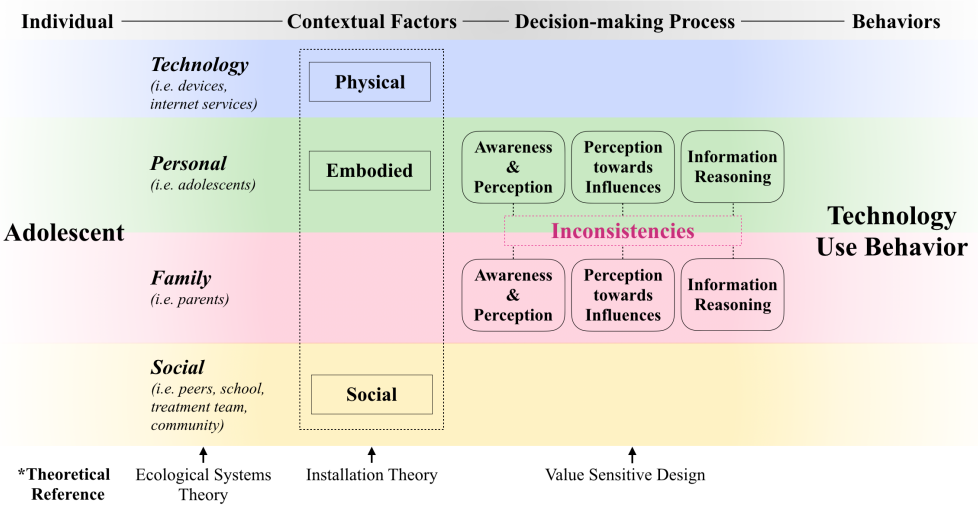

Fig. 1. Illustration showing influences of technology use behaviors, including contextual factors (informed by installation theory), and inconsistencies between the values of the individual and their parents in the decision-making process.

topics in which they are interested. Many of the patients in the current study described how they avoided interruptions by their parents by anticipating the length of application based on experience and strategically selecting one that they can finish within their allotted time slot. Nonetheless, it is not uncommon for adolescents using these devices to enter a state of flow (e.g., during online gaming or binge-watching), which overwhelms their awareness of temporal flow. Many of them have difficulty exercising self-control in these "affective" or “emotionally-charged” situations [15]. Researchers [70] have demonstrated that adolescents are capable of sound and reasonable decisions; however, individuals in emotionally and socially stimulating situations are often unable to fulfill their strategic plans due to a lack of willpower (Section 4.1.2).

Researchers [70] have also reported that adolescents are capable of rational decision making to achieve their goals, as long as they are able to avoid high-reward temptations. However, incomplete cognitive development and a lack of impulse control means that adolescents think and act differently than adults [76]. Many of the adolescents in the current study reported using technology devices to gain a sense of achievement. This suggests that incentives must be able to motivate adolescents (Section 4.1.2). In experiments aimed at figuring out what type of incentive adolescents prefer, Van den Bos et al. [80] found that they usually preferred to receive smaller rewards sooner, while adults preferred to obtain larger rewards later. We observed the same tendency. The patients in the current study mentioned that they might curtail the use of devices if they obtained incentives (e.g., a small monetary reward) from their parents or by earning better grades in school.

Design implication: Built on prior work by Ghosh et al. who also adopted a more teen-centric approach to online safety [31], we propose two design opportunities in the physical layer so as to channel potential contributing factors in the embodied layer into preventing factors that support self-control and productive tech use. Our findings revealed that adolescents have an overriding need for privacy and lack self-regulation. Promoting a contextualized assistive tool could improve the overall experience and thereby foster a sense of agency. Instead of constant out-of-context interventions that appear as meaningless nagging, strategies that are adapted to the state of the individuals and current circumstances may appeal to both parents and adolescents.

Our findings indicate that researchers should not rely too heavily on methods that develop self-control, particularly in situations that are affective or emotional charged (e.g., immersive video gaming). It should be possible for the intervention system to infer the state of the adolescent based on the type of app currently being used, perhaps in conjunction with physiological signals derived from sensors. The system would then be able to identify situations warranting a gentle reminder (in neutral situations) versus those that require a call to the parents for intervention (e.g., in affective or emotional-charged situations).

An interactive micro-incentive system is one approach to motivating adolescents. For example, the adolescent could work toward gaining real-world rewards (e.g., a new device) through the completion of small tasks. Updating such a system in real-time would maximize the motivation potential and maintain interest.

5.2.2 Family Level: Promoting Constructive Communication between Adolescents and Parents. As the core stakeholder in the support and regulation of adolescents, it is crucial that parents be considered in the design of any intervention. We determined that in terms of technology devices, the views of adolescents are often in stark opposition to those of their parents. For example, usage duration deemed normal by most adolescents would seem excessive to most adults. Furthermore, parents often consider in their assessment the real-life consequences of device usage, which are often overlooked or entirely disregarded by adolescents. These discrepancies figure prominently in identifying technology abuse, discussing it with others, and dealing with interventions.

Design implication: Echoing the design approach proposed by Wisniewski et al.[82] for online safety that aims to support the intangible needs of family systems, we focused on facilitating constructive parent-child communication by having adolescents use systems for the tracking and sharing of device usage data with the aim of eliminating the knowledge gap and corresponding misunderstandings. It should be possible to establish constructive technology-mediated boundaries aimed at making the adolescent responsible for themselves while respecting their autonomy.

Devices can be used for learning or recreation. It is important therefore that tracking applications automatically track the total screen time as well as the functions for which the device(s) are used. There are no doubt serious difficulties in implementing tracking technology in all digital devices or applications, particularly when dealing with non-wired game consoles. An alternative approach would see tracking technologies implemented in gadgets worn by the user, such as wristbands or rings.

For the sake of preserving privacy, we propose that reports on tracking data present broad usage categories (e.g., entertainment, education, or socializing), rather than listing individual applications. Ultimately, the issue of data granularity should be discussed and mutually agreed upon by parents and adolescents. It might also be useful to adjust the level of granularity in accordance with the situation and wishes of the user.

5.2.3 Social Level: Incorporating Right Support with Parental Support. Interventions in technology abuse by parents is fraught with difficulty. Even when dealing with adolescent who are motivated to reduce technology use, there are contextual challenges, distractions, and difficulties, such as bounded will power, the absence of parents due to work obligations, and the influence of peers. Technologies that track screen usage when the parents are unavailable make it difficult to differentiate between use and abuse (as mentioned in the previous paragraph), and many such systems are easily circumvented by adolescents bypassing the password lock or simply borrowing an unlocked or unmonitored device from friends.

Those problems do not necessarily mean that assistive technologies are ill-suited to the current situation or that parent-level interventions do not marry well with assistive technologies. Rather,

the problems identified in this study highlight a critical gap in the current practice of controlling technology abuse behaviors. Specifically, parents require support from other sources (e.g., school, peers, or medical supports; see Section 4.1.3). Many of the adolescents in our sample socialized or tried to socialize with people outside family or school, presumably motivated by the developmental need for autonomy and recognition from peers. Based on our findings, we propose the introduction of communal forces to deal with issues that lie beyond the grasp pf parents, physically (e.g., outside the family) and metaphorically (e.g., adolescents' social life).

Design implication: It is important that interventions address the needs of the adolescent for autonomy, while employing individuals with expertise or personal experiences dealing with these issues. It should be possible to establish a community of individuals (including family, peers, and experts) to provide support and practical advice in overcoming technology abuse (e.g., asynchronous online groups [14]). Our findings indicate that peer influence is a powerful force in the lives of adolescents (resonating with their feelings and perceptions); therefore, this kind of groups (e.g., online community) could help to reallocate the time and energy of the patient toward a more meaningful use of technology devices. It might even be possible for members to act as role models for the patients.

Note that if we are to delegate to the task of counselling to people other than the parents, then it is important that their power be commensurate with the responsibilities they shoulder. Specifically, we suggest offering them small and easy-to-understand tools to interact with the technology-abusing adolescents. For example, it would be preferable that outside parties send nudges or reminders rather than long-winded messages or calls.

6 Limitations

This study was conducted in Taiwan, a highly homogeneous society with a single ethnicity. Further research in other societies will be required to increase the generalizability of our findings. The sample size in the current study was small; however, all participants were diagnosed as heavy technology users of severity sufficient to warrant psychiatric treatment. Thus, we believe that the insights gained in this study could shed light on this population. This study did not cover parenting style or socioeconomic status. These factors could be covered in subsequent quantitative research with a larger sample size aimed at uncovering hidden patterns.

7 Conclusion

This paper explores the specific needs and challenges encountered by adolescents with technology abuse issues and their parents. In-depth interviews were conducted to gain insight into the development of assistive technologies aimed at reducing technology abuse. Our analysis based contextual factors (informed by installation theory [51, 52]) revealed inconsistencies between adolescents and their parents in cognizing technology abuse. Our analysis led us to formulate three solutions to dealing with technology abuse: (1) motivating adolescents by sending timely reminders and providing interactive micro-incentives; (2) promoting communication between adolescents and their parents by sharing usage data related to device usage; and (3) incorporating social supports to complement parental support, while fulfilling the social needs of the adolescent. Note that there are many adolescents who are experiencing similar technology-abuse problems have not yet realized that they need psychiatric attention. This work is a first step in uncovering and dealing with the challenges facing this population.

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