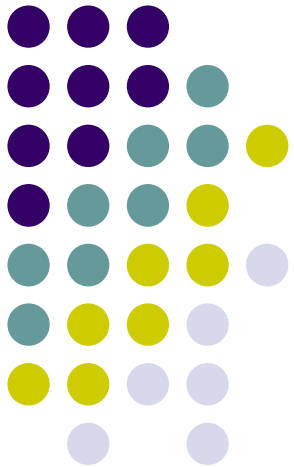
Ubiquitous and Mobile Computing
CS 528: *Hooked on Smartphones: An Exploratory Study on Smartphone Overuse among College Students*

Nan Zhang

Computer Science Dept.

Worcester Polytechnic Institute (WPI)



Introduction

Smartphone Overuse

Introduction

- How long do you spend on your smartphone?

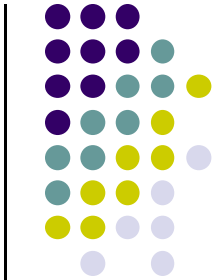
Introduction

we are overusing our phone.

Introduction

The negative aspects of smartphone overuse on young adults, such as sleep deprivation and attention deficits, are being increasingly recognized recently.

Introduction



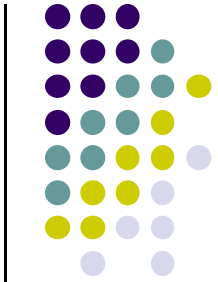
This paper is to analyze the usage patterns related to smartphone overuse by dividing the participants into risk and non-risk groups based on self-reported rating scale for smartphone overuse.

Risk group: whose scores indicated a potential for smartphone overuse

Non-risk group: whose scores didn't indicate a smartphone overuse

We identified several usage patterns that were closely related to smartphone overuse. These findings were supported by the results of our analytic modeling and the analysis of our interview data.

Related Work



- **Technological Addiction and Smartphone Overuse**

The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), which was released in May 2013 by the American Psychiatric Association (APA), officially recognized behavioral addictions for the first time and recommended further research into existing technological addictions for later inclusion.

Previous studies of Internet addiction showed that excessive use of online communication and games occurs often, which is related to various **psychological factors**, including social anxiety, depression, impulsivity, self-esteem/identity deficits, and situational stress during life changing events.

This paper perform an **exploratory data analysis of real usage datasets** to uncover the usage features related to smartphone overuse, and **validate the differences between usage patterns** using analytic modeling and analysis of interview data.

Related Work

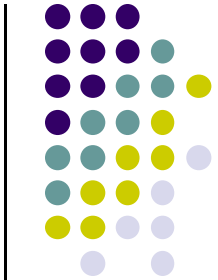
- **Smartphone Usage Studies**

Main use of smartphones was task-oriented with goals of information seeking, communications, online transactions, and managing personal information.
Usage pattern of Android and Windows Mobile phones.
Users typically spent almost one hour per day on smartphones.

Above all, these studies provided **general overviews of smartphone usage**, they did not investigate the usage patterns related to smartphone overuse.

This study examines the **similarities and differences** between the smartphone usage among **users with overuse risks and those without**.

Related Work



- **HCI Research into Addictive Behavior**

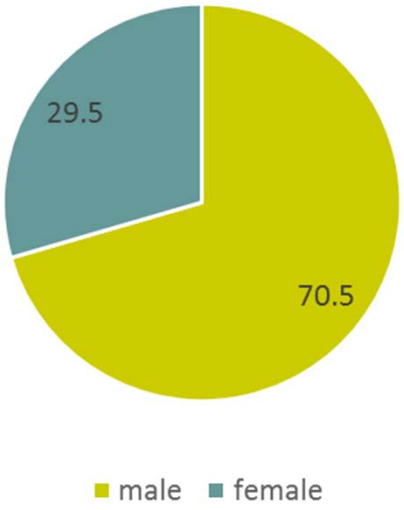
A major goal of studies in the HCI community is to explore the main factors to **develop effective addiction intervention mechanisms**. One study showed that self-regulation is critical for controlling online gaming behaviors, and they considered how it can be **incorporated into the game designs to prevent addictive behaviors**. The other direction is to design new computing services or to simply use existing services to **mitigate problematic use** and **assist traditional treatments**.

Our study attempts to **identify the usage patterns** related to smartphone overuse and to **provide several guidelines to facilitate the design of intervention software**.

Methodology

Participants

95 college students
Average age: 20.6
Total time:26.8days



Smartphone usage logging

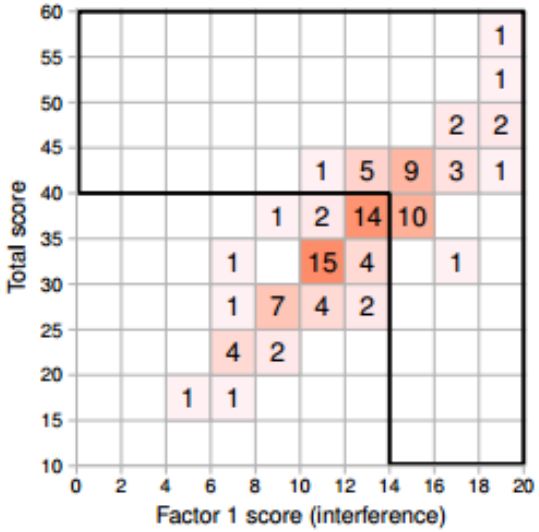
Smartphone Usage Logging
We developed the **SmartLogger** software to **log a variety of application events** (active/inactive apps, touch and text input events, web browsing URLs, and notification events), system events (power on/off and screen on/off/unlock), and phone events (calls and SMS). SmartLogger operates as an Android accessibility service. After an accessibility service has been enabled in the system settings, it runs automatically in the background.

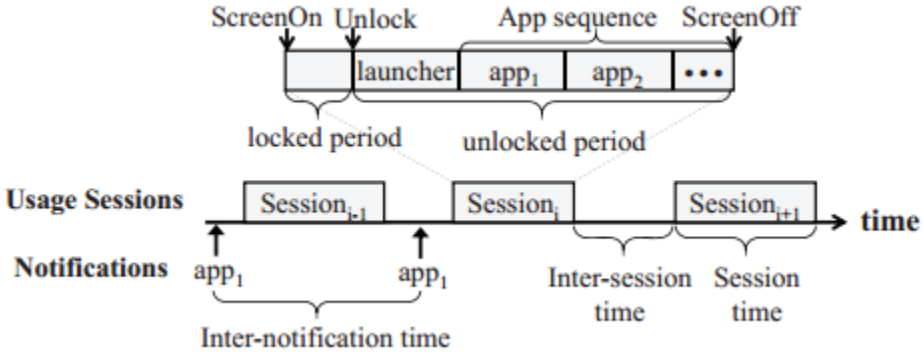
Methodology

User surveys and interviews

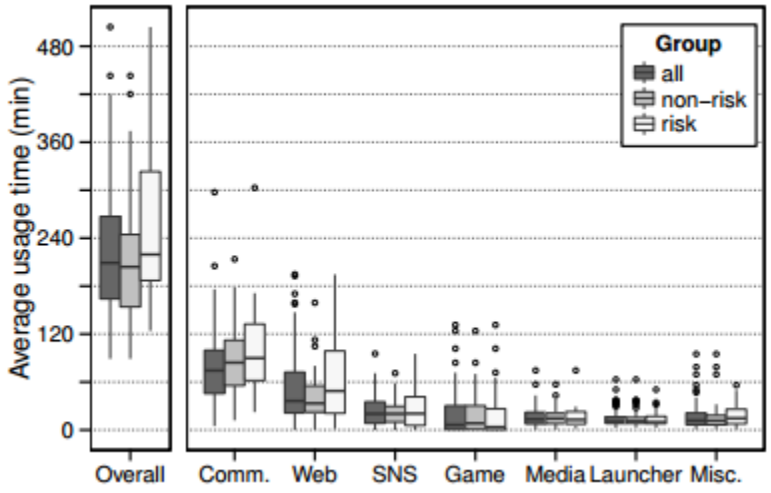
Data Analysis Model

By using Smartphone Addiction Proneness Scale for Adults, total score>=40 or interference score>=14

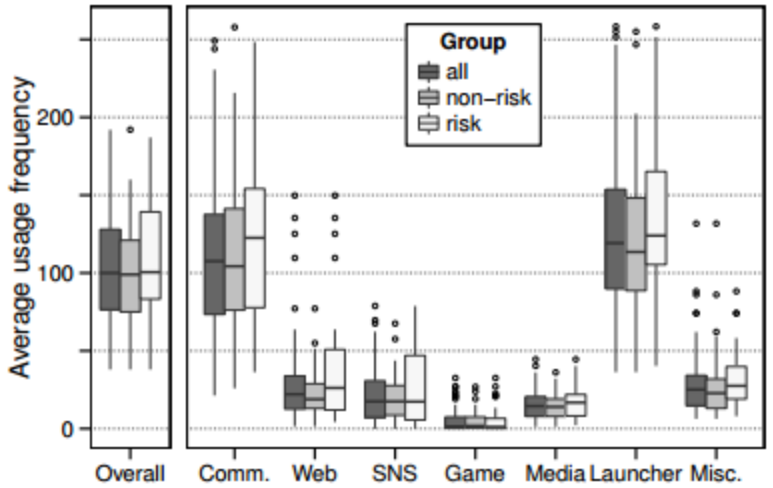




Overall differences in usage patterns



Usage amount: overall and app-specific results



Usage frequency: overall and app-specific results

Overall differences in usage patterns

Aggregated Usage

Daily time usage:
Risk group(253.0 min, SD: 90.9, p = .011, Cohen's d = 0.54)
non-risk group (207.4 min, SD: 77.2)

How often the participants interacted with their smartphones:
mean session frequency per day:
risk:111.5 *vs.* non-risk: 100.1, p = .146, Cohen's d = 0.31
mean inter-session time:
risk: 729.1 s *vs.* non-risk: 816.6s, p = .216, Cohen's d = 0.26

Overall differences in usage patterns

Session-level Usage

Number of apps during each session:
risk: 3.53 *vs.* non-risk: 3.16, p = .072, Cohen's d = 0.43

Number of unique apps used during the experiment:
risk: 66.1 *vs.* non-risk: 65.5, p = .885, Cohen's d = 0.03

Using **entropy metric** to examine the top used apps.

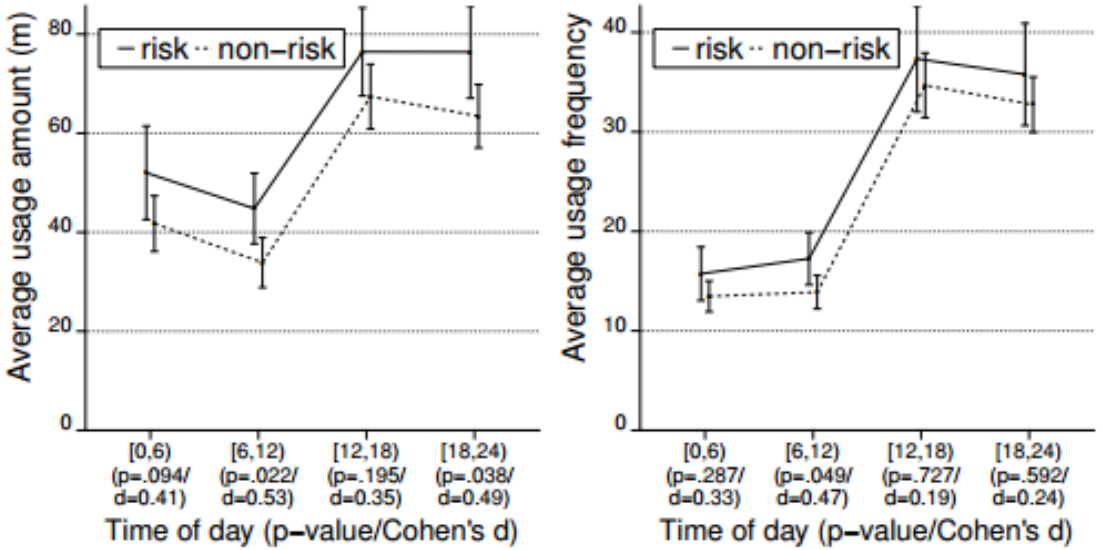
Entropy has the following property. The lower the entropy, the higher the level of focus on certain apps. For example, if a person only uses a single app, the entropy becomes zero. If she spends an equal amount of time on every app, the entropy is maximized.

Significant difference in top-5 app usage(p = .046, Cohen's d = 0.42)
Risk group spend more time on first and second ranked apps(Primarily KakaoTalk, Facebook, and browsers)
First ranked: 97.8 min and 69.9 min (p = .003, Cohen's d = 0.66)
Second ranked: 47.4 min and 37.5 min (p = .058, Cohen's d = 0.43)

Overall differences in usage patterns

Diurnal Usage

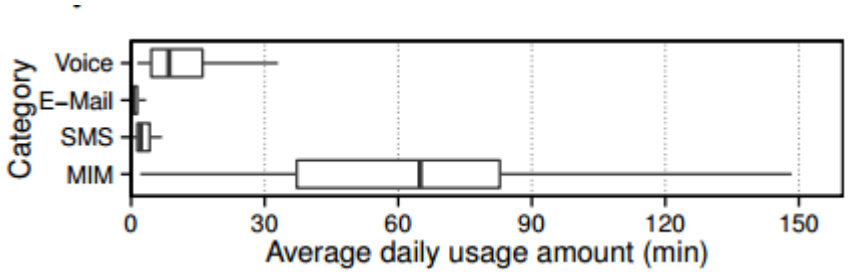
night: [0,6), morning: [6, 12), afternoon: [12, 18), and evening [18,24)



Category-specific usage patterns

Communication App Use

Mobile Instant Messaging Usage

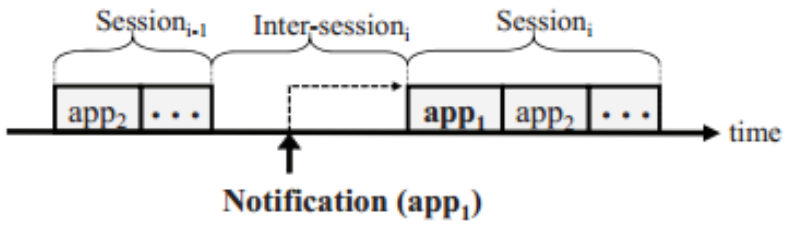


By calculating the mean daily usage time and frequency for Kakao Talk, the result showed that the risk group is longer(risk: 75.6 min *vs.* non-risk: 65.8 min)and more frequently(risk: 91.2 *vs.* non-risk: 76.9)

Mean inter-app time:(risk: 21.0 min *vs.* non-risk: 25.6 min; p = .228, Cohen's d = 0.23)
inter-notification time: (risk: 6.87 min *vs.* non-risk: 9.46 min; p = .351, Cohen's d = 0.17)
Number of notification per day: (risk: 451.8 *vs.* non-risk: 378.5; p = .353, Cohen's d = 0.16)

Analytic modeling of usage behavior

Notifications as External Cues for Usage



Mean usage time per day:p = .037, Cohen's d = 0.44
Aggregated sequence length of the usage sessions per day (p = .033, Cohen's d = 0.45)
The number of sessions did not differ significantly (p = .192, Cohen's d = 0.28)

significant usage differences only for KakaoTalk cued sessions with respect to the mean usage time per day (p = .030, Cohen's d = 0.50) and the aggregated sequence length of usage sessions per day (p = .029, Cohen's d = 0.50)

Usage time of MIM-initiated sessions was **significantly greater** for the risk group compared with the non-risk group.

Analytic modeling of usage behavior

Web Browsing App Use

Usage Pattern Analysis

The daily usage times for the risk and non-risk groups were 67.14 min (SD: 55.25) and 41.14 min (SD: 28.87)

the daily usage frequencies for the risk and non-risk groups were 38.50 (SD: 37.77) and 22.30 (SD: 13.96)

inter-app times of web browsers: The risk group showed a shorter mean inter-app time: risk: 71.4 min (SD: 53.3) *vs.* non-risk: 80.9 min, (SD: 48.2)

Analytic modeling of usage behavior

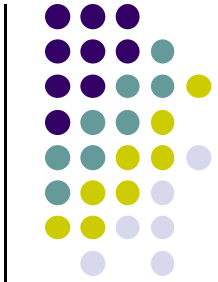
Content Consumption Pattern Analysis

Only consider the participants who used the default web browser, there were 24 participants from the non-risk group, and 18 from the risk group

	Community	Portal	News	Search	Entertainment	School	Misc.	Total
Risk (SD)	43.7(101.7)	8.9 (14.8)	19.0 (59.2)	9.6 (9.2)	0.6 (0.8)	2.4 (3.8)	14.3 (11.3)	99.5 (130.6)
95% CI	[9.3, 78.1]	[3.9, 13.9]	[1.0, 39.1]	[6.5, 12.7]	[0.3, 0.8]	[1.1, 3.7]	[10.5, 18.1]	[55.3, 143.7]
Non-Risk (SD)	7.5 (13.2)	2.7 (3.1)	1.0 (1.4)	4.0 (5.3)	1.6 (3.6)	1.5 (2.1)	7.6 (11.6)	24.8(28.6)
95% CI	[4.0, 10.9]	[1.9, 3.5]	[0.6, 1.3]	[2.6, 5.3]	[0.4, 2.8]	[1.0, 2.1]	[4.6, 10.6]	[17.3, 32.2]
P (d)	.076 (0.53)	.049 (0.60)	.107 (0.46)	.013 (0.75)	.125 (0.42)	.189 (0.30)	.034 (0.57)	.014 (0.79)

risk group browsed the web more often and they tended to search for content updates more frequently. Moreover, a few of the risk group participants searched for and consumed online content in an excessive manner and they exhibited unique surfing patterns while searching for this content.

Category-specific usage patterns



Comm. Usage	Non-Risk [95% CI]	Risk [95% CI]	T	P	d
Usage time (m)	87.1 [75.8, 98.3]	98.8 [80.0, 118.6]	1.15	.257	0.24
Usage freq	112.5 [100.7, 124.2]	126.3 [107.4, 145.2]	1.32	.189	0.28
Voice time (m)	12.0 [9.4, 14.6]	14.5 [8.9, 20.0]	0.83	.411	0.20
Voice freq	6.2 [5.4, 7.0]	5.8 [4.6, 7.0]	0.51	.610	0.11
SMS time (m)	2.7 [2.1, 3.3]	4.4 [2.4, 6.4]	1.64	.108	0.41
SMS freq	6.9 [5.8, 8.0]	9.5 [6.7, 12.2]	1.75	.086	0.42
MIM time (m)	65.8 [56.1, 75.6]	75.6 [58.8, 92.3]	1.08	.281	0.23
MIM freq	76.9 [66.6, 87.2]	91.2 [73.9, 108.5]	1.53	.130	0.32
Inter-MIM time (m)	25.6 [19.8, 31.4]	21.0 [16.2, 25.8]	1.21	.228	0.23
Inter-MIM noti (m)	9.5 [4.9, 14.0]	6.9 [3.8, 10.0]	0.94	.351	0.17
MIM noti freq	378.5 [227.1, 529.8]	451.8 [449.1, 454.7]	0.64	.353	0.16

Web Usage	Non-Risk [95% CI]	Risk [95% CI]	T	P	d
Usage time (m)	41.1 [33.6, 48.6]	67.1 [48.4, 85.9]	2.60	.012	0.61
Usage freq	22.3 [18.7, 26.0]	38.5 [25.7, 51.3]	2.47	.018	0.61
Inter-web time (m)	81.0 [68.4, 93.5]	71.4 [53.3, 89.4]	0.90	.370	0.19

Analytic modeling of usage behavior

Regression Analysis

	Total	Inter.	Virtu.	Withd.	Toler.
Model Summary					
Adjusted R^2	.12**	.14**	.07*	.07*	0.14**
F	6.25	5.05	6.83	6.84	7.76
Standardized β					
Usage freq	.26**			.26**	
Top 1 app time		.30**			
6-12 usage time			.26**		
Web usage time	.21**				.31**
# ext. sessions					.23**
Ext. MIM agg. seq. len.		.48**			

*$p<0.05$, **$p<0.01$

Incoming MIM messages acted as external usage cues for smartphone use. The participants who experienced more interference tended to have longer session sequence lengths of MIM initiated sessions. Moreover, web usage and external cues were related to the tolerance factor

Analytic modeling of usage behavior

Classification Analysis

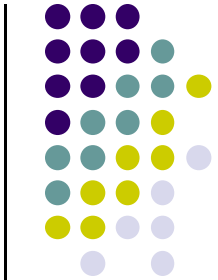
Feature set	Acc. (%)	Pre.	Rec.	F-score	Classifier
All	81.05	.816	.811	.813	DT
General	72.63	.723	.726	.724	DT
Category	87.37	.874	.874	.874	DT
Temporal	78.95	.792	.789	.790	DT
ExtCue	64.21	.622	.642	.632	NB
ExcludeGeneral	85.26	.863	.853	.858	DT
ExcludeCategory	80.00	.806	.800	.803	NB
ExcludeTemporal	77.89	.782	.779	.780	DT
ExcludeExtCue	81.05	.816	.811	.813	DT

In summary, we found that investigating various category specific usage patterns was of critical importance, and our classification model allowed us to accurately classify whether a person belonged to the risk group. The current study focused mainly on communications and web browsing, but our feature selection results indicated the importance of other features. Thus, other categories such as social networking and mobile games may be explored in our future research.

Problematic usage behavior

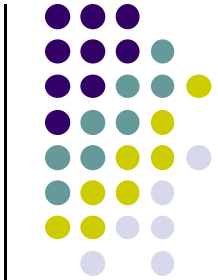
Overall Usage Behavior	Frequent Interferences	Habitual Usage and Limited Self-Control
In general, our participants concurred that smartphone usage tended to last longer during the night, in the morning, or at the weekend.	The data showed that 92% experienced interference in various situations. the degree of interferences attributable to instant messaging was probably greater for the risk group than the non-risk group.	In general, the risk group participants had difficulties in explaining the details of their content consumption behavior.

Conclusions



- Risk group spend **longer time** than non-risk group
- Risk group exhibited **highly skewed usage pattern** with respect to a few frequently used apps.
- **Significant diurnal usage differences**. Risk group used longer in the morning and evening.
- Overall, participants mainly used smartphones for communications.
- Risk group spent more time on **MIM-triggered sessions**.
- Risk group users spent more time on the web consuming online content that **provide instant gratifications**.

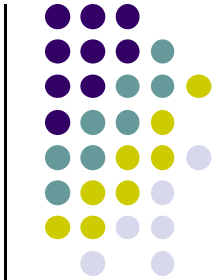
Conclusions



- Overall difference in the usage times between the risk/non-risk groups was **NOT** very high.
- Smartphone overuse is closely related to the content consumption function of smartphones.
- The risk group showed **limited self-control**, particularly when consuming online content.

These findings provide new insights into previous research on scale development and problematic usage behaviors.

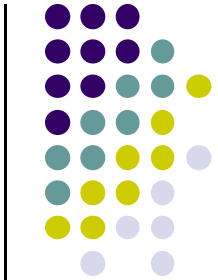
Conclusions



- The research supplements previous measurement studies by reporting recent smartphone usage patterns and by investigating problematic usage behaviors.

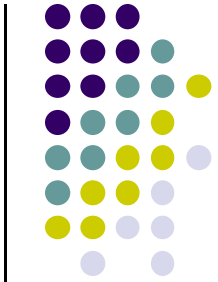
- Moreover the research extends the previous study by examining real usage patterns from the perspective of smartphone overuse, and we demonstrated the importance of externally-cued usage behavior.

Conclusions



- The study provides new insights into the usage practices related to mobile communications.
- Help to understand the impacts of semi-synchronous communication channels such as MIM, on the social expectations related to constant connectivity and interruption management practices.
- The study on usage analysis and automatic behavior assessment may be useful when designing mobile software that can moderate excessive use, or it could facilitate the design of intelligent parental controls.

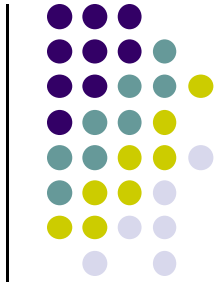
Future work



The research is limited by the characteristics of our participants. We suggest that further exploratory and confirmatory studies might consider different sites, demographics, mobile devices/platforms, and cultural backgrounds.

References

- ***Hooked on Smartphones: An Exploratory Study on Smartphone Overuse among College Students*** Uichin Lee, Joonwon Lee, Minsam Ko, Changhun Lee, Yuhwan Kim,Subin Yang, Koji Yatani, Gahgene Gweon, Kyong-Mee Chung, Junehwa Song in Proc CHI 2014
- Youtube video: Hooked on Smartphones: An Exploratory Study on Smartphone Overuse among College Students https://www.youtube.com/watch?v=pDx-5uy7gYA



Thank you