NUGU: A Group-based Intervention App for Improving Self-Regulation of Limiting Smartphone Use

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ABSTRACT
Our preliminary study reveals that individuals use various management strategies for limiting smartphone use, ranging from keeping smartphones out of reach to removing apps. However, we also found that users often had difficulties in maintaining their chosen management strategies due to lack of self-regulation. In this paper, we present NUGU, a group-based intervention app for improving self-regulation of limiting smartphone use through leveraging social support: groups of people limit their use together by sharing their limiting information. NUGU is designed based on *social cognitive theory*, and it has been developed iteratively through two pilot tests. Our three-week user study ($n = 62$) demonstrated that compared with its non-social counterpart, the NUGU users' usage amount significantly decreased and their perceived level of managing disturbances improved. Furthermore, our exit interview confirmed that NUGU's design elements are effective for achieving limiting goals.

Author Keywords
Social Support; Group-based Intervention; Smartphone Use

ACM Classification Keywords
H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

INTRODUCTION
As smartphones have become an integral part of our daily lives, negative aspects of smartphone use have emerged. For example, habitual checking/multitasking disrupts study, work, and social interactions [1, 18, 24], and consuming stimulating online content (e.g., social media, news) may lead to excessively long usage [16]. However, we still lack a holistic understanding of the interfering usage behavior/contexts, and the common management strategies and their effectiveness. This knowledge is critical for designing a software tool that can help users self-regulate their smartphone usage; this is the primary focus of this work.

Our survey results ($n = 114$) showed that diverse interfering contexts exist, and a majority of participants wanted to change their usage habits (60.2%). We identified several common management strategies for limiting usage such as physical separation, deleting/turning off apps, and limiting services (e.g., usage monitoring, notification setting, and blocking apps [20]). However, we also found that users often had difficulties in maintaining their chosen management strategies due to a lack of self-regulation.

In this paper, we propose a new approach for improving self-regulation in limiting smartphone usage that leverages social support; that is, a group of friends limit their smartphone use together and share their limiting information with one another. Our approach is based on *social cognitive theory* (SCT) proposed by Bandura [2]. From the SCT perspective, learning occurs in a social context and much of what is learned is gained through observation. Through social learning, people can have better awareness of normative behaviors and can also be motivated to self-regulate.

Based on our approach, we designed NUGU (when No Use is Good Use), which is a group-based intervention app that improves self-regulation of limiting smartphone use. It consists of three components: (1) self-monitoring, (2) goal-setting, and (3) social learning and competition. Each component is designed to support three sub-processes of self-regulation from the SCT perspective [2], i.e., self-monitoring, self-judgment, and self-reaction. Deficient self-regulation is attributed to a lack of personal/social awareness and attention to usage/limiting behaviors, and to failures of self-controlling usage. NUGU confronts these issues through visualizing objective usage/limiting behaviors, setting limiting goals, sharing limiting practices, and reinforcing desirable behaviors. We followed an iterative prototyping process; two working prototypes were developed and tested in field trials ($n = 10$, $n = 20$) to design the final version of NUGU.

In order to evaluate the performance of NUGU, we conducted a user study ($n = 62$) for three weeks. In this study, we analyzed the changes in the participants' smartphone usage and experiences after using our group-based intervention app. Also, for comparison, we implemented an individual-based intervention app and analyzed differences in the intervention effects by social support. The results demonstrated that the social support was critical in assisting the participants to limit their smartphone use (e.g., lowering usage hours/frequency and managing disturbance). Through the exit interview, we confirmed that our design elements were helpful in achieving the users' limiting goals.

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BACKGROUND AND RELATED WORK

Problematic Use of Smartphones

Many smartphone users have experienced interference in their lives that resulted from their smartphone use [8]. Ames [1] observed that the constant availability often demands multitasking that interferes with the current task such as study/work and social relationships. Levine et al. [18] found that mobile phone usage disrupts driving, pedestrian activity, and study/work. Oulasvirta et al. [24] and Bohmer et al. [4] presented the source of multitasking: the user's habit of checking updates involves brief and frequent content consumption (e.g., checking emails and SNS). Lee et al. [16] found that consuming stimulating online content (e.g., SNS, news) might lead to excessive smartphone usage.

Prior studies also have demonstrated that typical users wanted to manage the smartphone interference in their daily lives. For example, Shin and Dey [27] found that study participants who had normal usage patterns self-reported that sometimes they used smartphones too much and had concerns about their usage. The participants in Lundquist et al.'s work [21] also agreed that they needed to limit some of their smartphone use, but there was a lack of consensus on how to solve this issue. In this work, we investigate how users perceive usage interferences and what the current strategies are for interference management. We demonstrate that a lack of self-regulation causes the existing strategies to be less effective, and we propose a group-based intervention method.

Technology Non-Use

While HCI literature mostly regards non-users as potential users who have not yet adopted the technology, increasing attention has been drawn to non-users in recent years, and researchers explored the sociocultural, socioeconomic, demographic, and other issues related to non-use [3, 9, 25, 29]. Earlier studies attempted to categorize the diverse forms of non-use, which also significantly deepened our understanding about (non)users [25, 29]. Recently, Baumer et al. [3] demonstrated that Facebook exhibited more complicated non-use patterns, e.g., resisting (never using it), leaving (deactivating or deleting an account), relapsing (leaving it but subsequently returning), and limiting (e.g., filtering status-update emails).

Our work is along with the line of non-use research in the field of HCI. Compared with the other technology non-use cases, we believe that smartphone non-use is more complicated due to its accessibility and functionality. Smartphones are always carried by users and typically serve as gateways for numerous services ready at hand (e.g., information seeking and social networking). Discarding smartphones can be done at the significant expense of losing *in situ* digital assistance and instant social connectivity as clearly identified in prior work [1, 8]. Given that it is difficult to strictly practice non-use when compared with other technologies [3, 9], our study demonstrates that people tend to choose to limit its use via temporary non-use in which people actively regulate its use under various situation as a part of active resistance [17]. Therefore, it is necessary to more carefully consider in what specific contexts people do (and do not) want to use it and how to effectively support such behaviors. Our work complements earlier studies in that we deepen understandings of non-use of smartphones and explore design spaces in order to systematically support these behaviors.

Persuasive Systems

Fogg [7] defined *persuasive technology* as interactive technology designed to change users' attitudes or behaviors. Our work fits within the literature on persuasive technology because we aim to change smartphone users' problematic usage. Oinas-Kukkonen et al. [23] summarized the key principles of persuasive system design: primary task support, dialogue support, system credibility, and social support. First, the primary task support is about helping users conduct their tasks, e.g., by reducing the effort required for a target behavior, or by providing visual feedback to support self-monitoring. Second, the dialogue support is related to helping users continue to move towards their goal or target behavior via verbal information such as praise and rewards. Third, the system credibility describes the principles of designing more credible services such as displaying information in order to verify authority. Finally, the social support describes how to motivate users through leveraging social influences (e.g., comparison and competition).

Existing persuasive systems have leveraged information technologies primarily for health [5] and sustainable behavior [10]. We consider mobile apps that assist in changing problematic smartphone usage, as reported in recent studies [15, 20]. While our design can be considered as a synthesis of the key principles of persuasive system design (e.g., self-monitoring [14], social support [5]), the key contribution of this work lies in its integration into a new problem space based on a theoretical framework, i.e., social cognitive theory of self-regulation [2]. Toward this goal, we first characterized the limiting practices and demonstrated that the existing strategies often failed due to a lack of self-regulation. In order to overcome this problem, we design a system to harness social learning and comparison to help people learn from one another and to make sustained efforts to limit usage.

Smartphone Overuse Intervention Apps

We surveyed 41 smartphone intervention apps from the Google Play (using the keyword 'smartphone addiction') and the related literature [15, 20]. We classified the apps into four categories based on their purpose: (1) diagnosing smartphone addiction based on the smartphone addiction scales (e.g., All's), (2) intervening in smartphone overuse (e.g., Momo, BreakFree, SAMS [15], and AppDetox [20]), (3) supervising children's smartphone use/overuse through remote control, monitoring, and chatting (e.g., Net Nanny, Qustodio), and (4) assisting in focusing on the task at hand (e.g., StayOnTask, StudyLocker). There are various persuasive and intervention mechanisms for mediating smartphone overuse, such as locking apps/screens, self-monitoring (e.g., usage hours/frequency), using alarms, and repeatedly encouraging (e.g., "Show me your will power" in Smart Self Coach).

The dominant mechanisms for intervening in smartphone overuse belong to the primary task support principle; We

identified that 70.7% used locking and 68.2% supported self-monitoring. The only app that utilizes social support at the time of the survey was WatchApp, where group members determine apps to limit for a given period of time, and they are ranked based on usage time of the selected apps. The approach of WatchApp is similar to NUGU in terms of using social support to assist in regulating smartphone usage, but the method of implementing the social support is different. First, the competition in WatchApp is based on the amount of usage time (i.e., the user who uses their smartphone less wins), so contextual factors were not considered. Our study shows that most smartphone users perceive their problematic usage when their daily activities are disrupted. This indicates the necessity of encouraging users to practice temporary non-use when a primary activity begins. Even though a user limits their usage time to two hours per day, their usage could still disturb their daily activities, e.g., playing games in a classroom. On the contrary, NUGU allows users to share limiting time and contexts (activities), thereby facilitating the positive effects of social learning within and between groups.

SURVEY STUDY OF LIMITING SMARTPHONE USE

We investigated the usage habits that interfere with everyday life activities through analyzing the characteristics and consequences of these usage habits. Then, we classified the common management strategies and their effectiveness in limiting smartphone use. From our results, we drew several key design directions in order to develop an effective method for limiting smartphone usage. In the study, we adopted an online survey method because our focus is primarily on exploring representative contexts and general behaviors of people rather than understanding specific cases in depth. However, because the typical survey methods are often limited to shallow data, we designed the survey items to capture more detailed responses through several open-ended questions as well as five-point Likert scale questions. Our survey content consisted of three parts: usage habits, management strategies, and demographics. We posted this survey in large online communities. There were 114 participants (60 males and 54 females), and their ages ranged from 18 and 32 years ($M = 24.8$, $SD = 5.0$). Most participants were students: high school (6.1%), college (57.0%), and graduate students (20.2%), but office workers also participated (16.7%). We conducted open coding for the responses of the open-ended questions.

Usage Habits: Characteristics and Consequences

Many participants reported that they felt overusing their smartphones (64.0%; $M = 3.69$, $SD = 0.91$) and wanted to change their usage habits (60.2%; $M = 3.49$, $SD = 1.00$). The open-coding results illustrated that the usage that people wanted to change could be classified into two categories: (1) frequent short usage and (2) occasional long usage.

First, the frequent short usage was largely triggered by app notifications (e.g., instant messages, social media, and social games). One participant said, *"I belong to several group chat rooms because my business is in my mobile instant messenger, and notifications come very regularly"* (P40). Frequent checking of these notifications often disrupts the user's tasks, such as work and offline social activities. One participant said, *"When I receive a notification during work, I lose concentration easily"* (P18). When socializing, many participants had negative experiences with smartphone usage. For example, one participant commented, *"I wanted to search for information while I was meeting my friend. So I did it, but she got really annoyed with that"* (P1). Our participants also acknowledged that after a short checking session, they often spent time using a series of other apps. One participant commented, *"When I study, I often use a web browser to search. But, I get easily tempted to check the news whenever I open my browser"* (P27).

Methods	%	Examples
Physical Separation	31.5%	*"I just left my phone at home."* *"I put my phone out of reach."*
Turning Off	27.2%	*"I put it into the airplane mode."* *"I muted all notifications."*
Deleting	17.5%	*"I deleted Facebook, some games, and browsers."* *"I moved addictive applications into one folder."*
Limiting Apps	9.6%	*"I installed a monitoring app and checked my overall usage"* *"I used a study app that blocks app usage."*
Others	14.0%	*"I changed my data plans to a smaller data size."* *"I consciously tried not to use smartphone."*

Table 1. Common limiting strategies.

Another problematic usage type was the occasional long usage, which sometimes led to excessive usage. Interestingly, the participants concurred that excessive usage often involved web browsing and mobile gaming. When browsing web pages, the participants kept following hyperlinks and checking new content, which often led to excessive usage. One participant complained as follows: *"One day, I came across one interesting webtoon and read only one episode. But soon I found myself reading every episode and I could not do my work"* (P28). Many participants stated that they started playing social games for fun for a while, but as the competition become more intense, they were not able to stop playing the games. Consequently, they often spent 2 to 3 hours playing the game in order to win. This type of excessive usage was typically observed at night (e.g., in bed), during breaks between daily activities, or while commuting. Such usage primarily occurred when users were alone. Many participants were sleep deprived due to smartphone use; for example, they habitually used their smartphones to check updates while in bed, but this often led to excessive usage.

Management Strategies and Their Effectiveness

In our survey, 63.6% of participants attempted to limit their smartphone use. In Table 1, physical separation from smartphones was the most popular strategy that the participants had used (31.5%). This is because the physical separation is the simplest approach that participants could take. Some participants used different degrees of turning off strategies ranging from disabling notifications to disconnecting from mobile networks (airplane mode) and to turning the smartphone off completely (27.2%). Deleting addictive applications or making the applications less easily accessible was another direct method for limiting (17.5%). Limiting apps that help overcome overuse were also used (9.6%). The participants used various tools for limiting, such as self-monitoring of usage, notification management, and blocking apps during specified

times. The remainder of the specified management strategies included mindful efforts to avoid using the smartphone, downgrading to feature phones or changing data plans, removing the batteries or not charging phones, and focusing on alternative activities (e.g., reading books).

Then, we asked the participants about the effectiveness of these strategies. While some participants reported the usefulness of such approaches, they concurred that these strategies often failed and did not last long. The significant reason for this is related to these strategies relying on the user's self-control. However, the participants demonstrated that real situations were complex, and simple limiting strategies tended to be overridden by the urge to use the smartphones. One participant commented, *"I've tried to not spend time in useless online communities, so I deleted every bookmark. But the funny thing was that later I just entered the URLs myself. Taking the time to enter the URLs does not bother me at all"* (P43). Another reason is related to the social expectation of constant connection [1]. While the participants sometimes disabled the sound/vibration-based notifications, due to the social expectation of constant connection, they constantly checked whether new messages had arrived. One participant said, *"I adjusted the notification setting to mute in order to concentrate on my work. But the feeling that I might have received messages kept me checking my smartphone"* (P13).

Design Implications

Our results provide useful design insights. First, it is important to design a mechanism that can help protect daily activities from problematic smartphone use. According to our survey, people tended to perceive their problematic use when their primary activity was disturbed (e.g., working). The results address the necessity of considering usage contexts (activities) as well as daily usage amounts in order to help users' limiting behaviors. Using only the usage amounts could overlook different contexts. For example, even though users limit their usage time per day to two hours, this could still disturb their activities, e.g., playing games in a classroom. Therefore, instead of simply limiting the usage time per day, our design should allow users to activate a limiting goal that they limit the usage for some times (e.g., 10 minutes, 2 hours) whenever focus on an activity is required.

Second, the participants preferred to use less restrictive management strategies (e.g., muting, airplane mode) than downgrading to feature phones or changing data plans because they wanted to use their smartphones when really necessary (e.g., information seeking and urgent messaging). Therefore, flexible intervention should be employed such that limiting can be cancelled whenever users need to use phones. For this flexibility, the intervention app should be designed to let users pull back their limiting goal when really necessary, but it may need to have a procedure that can make it difficult to stop the limiting usage, e.g., by introducing reinforcing mechanisms including a point system or encouragement.

Finally, it is highly recommended to employ other mechanisms to boost individuals' self-regulation of smartphone usage. Our results indicate that relying on an individual's self-control to limit their smartphone usage is not much effective. In order to overcome this limitation, we can utilize social support functionalities specifically designed to limit usage, e.g., users share their limiting times and contexts to help them learn from one another about when no use is good use and to encourage continued usage moderation.

DESIGN OF THE GROUP-BASED INTERVENTION APP

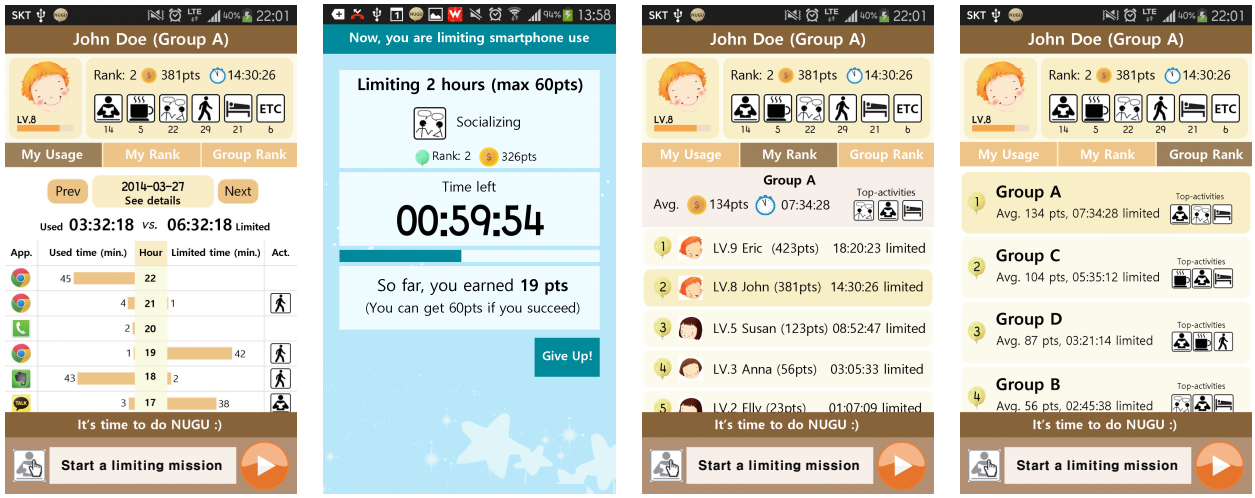
We propose a new approach of improving self-regulation of limiting smartphone usage through leveraging social support, i.e., a group of friends limit their smartphone use together and share their limiting information with one another (for learning and supporting). Our approach is based on the theoretical background of social cognitive theory (SCT) proposed by Bandura [2]. From the SCT perspective, learning occurs in social contexts and much of what is learned is gained through observations. Through social learning, people can have better awareness of normative behaviors, and they can be also motivated to self-regulate.

SCT perspective of self-regulation emphasizes three sub-processes [2]: self-observation, self-judgment, and self-reaction. First, self-observation indicates an individual's ability to monitor or track their own behaviors and their outcomes. Second, self-judgment is a process where individuals evaluate their actions based on personal, social, and collective norms. Finally, self-reaction occurs when they respond to the evaluations that they have made in order to revise their behaviors if their behavior falls short of their standards. Lack of self-regulation (or deficient self-regulation) is attributed to deficient self-monitoring/judgment (i.e., lack of awareness and attention to the behavior) and deficient self-reaction (i.e., failures of self-control) [13].

Based on our approach, we designed NUGU (when No Use is Good Use), which is a group-based intervention app that improves self-regulation of limiting smartphone use. The key features of the NUGU are to support the sub-processes of self-regulation in the SCT view, i.e., (1) self-monitoring to visualize objective usage/limiting behaviors, (2) setting goals and limiting usage, and (3) social learning and competition from sharing limiting practices with others. Our design encourages users to set limiting goals and sharing limiting information with one another (thereby improving self-monitoring/judgment), by assisting in limiting usage (e.g., locking apps), and by reinforcing desirable behavior with rewards (e.g., praise, points) and social support (thereby improving self-reaction).

Iterative Design Process

We performed rapid iterative prototyping: two working prototypes were developed in series, followed by a week-long field trial for each. This process occurred over a period of four months. We rapidly prototyped a working app that implemented the key features. In the first pilot test, we hired two groups of college students (five participants per group) who were interested in changing their usage habits with their friends. For the second pilot test, we recruited four groups of college students (five participants per group). The second test was also conducted for one week and focus group interviews were conducted afterward. In each pilot, after the par-



(a) Self-monitoring (b) Goal setting and limiting (c) Individual ranking (d) Group ranking

Figure 1. User interfaces of NUGU.

ticipants had used NUGU for one week, we invited them to focus group interviews. In these interviews, the participants were asked to discuss the advantages and limitations of the prototype. The interview data were transcribed and coded into a list of requests. Next, we prioritized the requests and implemented the most important ones.

NUGU Application Description

Figure 1 presents the three features of NUGU: *self-monitoring of usage behavior*, *setting goals and limiting usage*, and *social learning and competition*.

Self-monitoring of Usage Behavior

The first part is self-monitoring (see Figure 1(a)). This main screen displays a user's profile (screen name, level, points, weekly usage time, activity statistics of the week), which allows users to understand the overall status of usage/limiting behavior. It also has a comparative view of usage information (i.e., hourly usage time and the apps used in that hour) and limiting information (i.e., the amount of usage limiting time and the representative activity that a user performed while limiting usage). This comparative view helps users easily compare their usage and limiting behavior in recent hours. If a user clicks a date, the detailed usage information (ranked based on daily usage time per app) can be viewed.

The first pilot results demonstrated that the participants wanted to know more detailed usage and limiting information because they hoped to better understand their usage (e.g., app names) and limiting patterns (e.g., related activities when limiting usage). In the second prototype, we designed the following screens: mission history with related activities, daily usage hour graph (a bar graph for readability), activity frequency ranking, and app usage ranking (daily app usage and frequency). However, the participants in the second pilot used the information on these screens less and complained that navigating multiple screens was difficult. Thus, we carefully selected the minimal information that was required and aggregated the information related to self-monitoring into a single screen. This revised one-page view shows the hourly usage amount and limiting time with representative app and activity icons.

Setting Goals & Limiting Usage

The second part is goal-setting in Figure 1(b). This screen helps users set a limiting goal (called a limiting mission) through the start button at the bottom of Figure 1(a). A user can set a goal of limiting usage with information including the duration (ranging from ten minutes to two hours) and the current activity (e.g., work/study, socializing). When the mission is started, the app's mode is switched to the *goal-mode* that forbids the execution of any apps (except receiving incoming calls) and puts the smartphone into silent mode (see Figure 1(b)). In the following, we explain the detailed design of beginning a mission (or setting a goal), managing the current goal in progress, and the reinforcing mechanisms for continued participation.

Beginning a mission: From the field trials, we found that the participants wanted to begin their usage limiting as quickly as possible because they were in the process of starting a new activity (e.g., studying). Our final design attempted to minimize the cost of goal setting through trading the amount of freedom for simplicity. From the log data analysis, we found that the most popular time options were 10 m, 30 m, 1 h, and 2 h. Likewise, we coded the most frequent activities that the participants entered and reached the following activity categories: studying/working, resting, socializing/eating, getting up/going to bed, moving/commuting, and other.

Mission in progress: In the first prototype, when users unlock their smartphone, the NUGU app considered the action to be a mission failure. The participants had many mission failures due to their checking habits, and they wanted to be reminded that a mission was in progress. For this reason, we introduced the goal-mode screen that displays the current progress of a mission (e.g., remaining time, user's points/rank) with a give-up button. After unlocking, the goal-mode became the foreground activity because it always overrode all other apps, except checking the notification drawer (in order to allow users to make an informed decision about giving-up) and receiving

incoming calls. If smartphone usage is a real necessity, the users can give up on a mission by clicking the give-up button; the points are earned in proportion to the elapsed time of usage limiting.

Reinforcing mechanisms: In the first prototype, once a user failed a mission, points were not awarded. However, after the field trials, the participants strongly wanted to receive partial points particularly when they had failures near the end of executing a long mission, e.g., two hours. We assumed that enabling partial points would make users more likely to give up, thereby lowering mission completion rate. Therefore, in order to solve this issue, we decided to introduce bonus points when they successfully completed a mission. Another reinforcing mechanism that we introduced after the second trial was to include a praise/encouragement message when users finished a mission ("Wow! Congratulations! You accomplished your mission.") and an encouraging message when they were about to give up ("Do you really want to give up? Please be more patient.")

Social Learning and Competition

The social learning and competition aspects of NUGU have critical functions. One key function is to allow users to learn from each other (e.g., how much usage limiting a user should do or under which everyday life activities usage limiting should be undertaken). Another key function is to motivate users to continually participate. We designed two screens: the individual ranking (within-group) and the group ranking (between-group) screens, as displayed in Figure 1(c) and Figure 1(d), respectively. In the individual ranking screen, each group has a scoreboard where group members are ranked based on each member's weekly points. A group member can check other members' limiting activities (i.e., a list of limiting activities with frequency counts) when the user ID is touched. Furthermore, NUGU also supports between-group competitions with a scoreboard for groups; for a given group, the average weekly points earned per user is used for ranking; the average weekly limiting hours per user and the top three activities are displayed along with the group's score.

Initially, we provided the individual and global ranking (global ranking is a scoreboard of all participants). Our field trials revealed two findings. First, there were some highly motivated participants who always tried to achieve high scores. The highly motivated participants dominated the ranking, which discouraged participation from the lower ranked users. Second, there were cases where all participants were weakly motivated and did not make much effort. This behavior may form a group norm of low performance. In this group, while the top ranker may boast about their performance, their level could be much lower when compared with other users. We expected that the global ranking screen could have this function for relative comparison, but it transpired that the participants generally did not consider the global ranking because they were less concerned about strangers.

In order to overcome these limitations, in our final design, we replaced the global ranking with the group ranking where each group's rank was determined based on the group's aggregated weekly points. Like the individual ranking screen, a group's limiting hours and top activities are displayed. Here, we expected that the group naming and ranking would facilitate group cohesiveness (i.e., friendship-based bonds, group identity) such that both participants who have strong/weak motivation had certain roles in the group ranking, and the group members were likely to establish a collective norm of limiting usage, which would greatly encourage user participation.

		Within-subjects	
		Pre-intervention period	**Post-intervention period**
Between-subjects	**NUGU-Group**	NUGU-Group (pre-intervention)	NUGU-Group (post-intervention)
	NUGU-Alone	NUGU-Alone (pre-intervention)	NUGU-Alone (post-intervention)

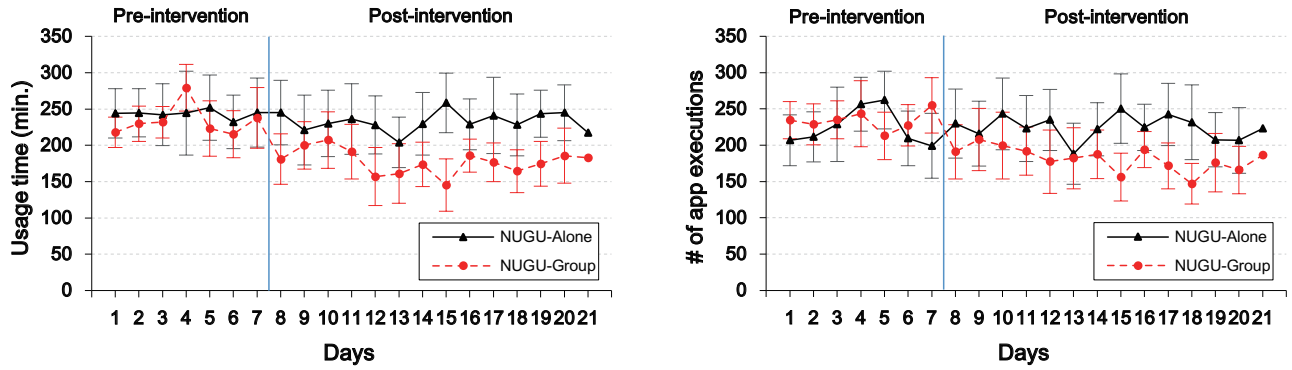
Figure 2. 2×2 quasi-experimental design: NUGU-Group and NUGU-Alone (without individual/group ranking screens).

EVALUATION

We set up a 2×2 quasi-experiment as depicted in Figure 2. Two variants of NUGU were considered: one with a group-based intervention (NUGU-Group), and the other with individual-based intervention where social support were not considered (NUGU-Alone). For NUGU-Group, we assumed that a group of friends participated in order to facilitate social learning and support. This assumption made it difficult to conduct randomized experiments.

Using online advertisements in a large Korean university, we recruited participants who were interested in improving their smartphone usage. For NUGU-Group, we hired 35 participants (total of eight groups: each group consists of 3–6 people); for the NUGU-Alone, we hired 27 participants. The NUGU-Group participants primarily consisted of close friends from the same department, laboratory, or academic club. In addition, there was a family group that included one brother and two sisters, and a group of acquaintances who met each other at church every week. The participants were 20 females and 42 males (age: $M = 25.74$, $SD = 0.53$). We found no significant difference in the demographics between the two groups (age: $p = .440$ and gender: $p = .876$). In the latter analyses, we conducted the standard t-tests in order to compare the group means on various dependent variables, ranging from survey data to usage data. Note that differences in the variances of the two groups cause the standard t-tests to be problematic, particularly when the sample sizes of the two groups were not equal [22]. F-tests did not find significant differences between the variances of the dependent variables from our two groups, and this indicates that standard t-test analyses can be conducted in our samples [22].

The experiments were conducted for three weeks: one week for the pre-intervention period and two weeks for the post-intervention period. First, we collected the participants' usage data by installing a usage logging app that collects the usage data about the start-up time of an app, its name, and its use duration. Before the pre-intervention period began, the participants had 2–3 days for an adaptation period, as recommended by an earlier measurement study [16]. The usage data collection continued during the entire experiment. At the end of the pre-intervention period, we asked the participants



(a) Daily usage time

(b) Daily usage frequency

Figure 3. Changes in smartphone usage over the duration of the study (Pre-intervention period: 1∼7 and post-intervention period: 8∼21).

	Within-groups						Between-groups	
	NUGU-Group			NUGU-Alone				
	Pre	Post	*p(d)*	Pre	Post	*p(d)*	*p(d)*	*p(d)*
Usage time (min.)	234.00 (67.12)	177.07 (68.13)	**.000 (0.99)**	242.97 (84.72)	232.34 (91.46)	.320 (0.20)	.654 (0.12)	**.012 (0.69)**
# of app executions	233.81 (100.00)	180.98 (84.64)	**.000 (1.14)**	224.89 (92.79)	228.42 (95.21	.529 (0.13)	.719 (0.09)	**.046 (0.53)**
Total SAS	3.02 (0.49)	2.49 (0.70)	**.000 (0.94)**	3.24 (0.69)	2.87 (0.67)	**.000 (0.99)**	.168 (0.38)	**.038 (0.54)**
Daily-life disturbance	4.05 (0.85)	2.73 (1.08)	**.000 (1.02)**	4.04 (0.88)	3.55 (0.99)	**.000 (0.93)**	1.000 (0.02)	**.017 (0.79)**
Positive anticipation	2.13 (0.67)	2.01 (0.77)	1.000 (0.17)	2.60 (0.93)	2.31 (0.99)	**.000 (0.87)**	.191 (0.59)	1.000 (0.35)
Withdrawal	3.10 (0.82)	2.69 (0.96)	**.012 (0.57)**	3.45 (0.94)	2.98 (0.80)	**.000 (0.87)**	.715 (0.41)	1.000 (0.33)
Cyberspace -oriented r.	2.45 (0.67)	2.16 (0.79)	**.005 (0.62)**	2.51 (0.92)	2.13 (0.83)	**.013 (0.66)**	1.000 (0.08)	1.000 (0.04)
Overuse	4.16 (0.85)	3.30 (0.89)	**.000 (0.84)**	4.33 (0.95)	3.98 (1.04)	.112 (0.45)	1.000 (0.19)	.054 (0.71)
Tolerance	3.32 (1.04)	2.70 (0.91)	**.002 (0.57)**	3.43 (1.13)	3.21 (0.96)	.186 (0.45)	1.000 (0.10)	.242 (0.54)
Self-efficacy	26.49 (5.32)	29.43 (4.45)	**.002 (0.57)**	26.56 (5.72)	28.11 (5.68)	**.012 (0.52)**	.961 (0.01)	.326 (0.26)

Table 2. Two-tailed *t*-tests on NUGU-Group and NUGU-Alone.

to complete two surveys (see below for details). The post-intervention period started with an orientation in which the participants learned about how to install and use the intervention app. After the orientation, the participants used NUGU for two weeks at their own discretion and further usage mediation like mindfulness training [19] was not conducted. After the post-intervention, we asked the participants to complete the same surveys and we conducted exit interviews. The interviews were semi-structured: we prepared questions about how they used NUGU and what features were effective (or not) for each step of limiting their smartphone use using the app, i.e., starting to limit, setting a limiting goal, and achieving the goal. The participants were compensated with USD 50–60 depending on their participation in the exit interview.

Metrics

First, we measured the smartphone usage amount, which is an objective outcome of smartphone usage behaviors; they included the total usage time and the number of app executions. Second, we measured the level of problematic smartphone usage using the *Smartphone Addiction Scale* (SAS) [12], which is an established scale for problematic smartphone usage. The scale comprises 33 six-point Likert scale questions. The higher the SAS score is, the more addicted the user is to their smartphone. The items in the SAS can be grouped into six sub-factors: *daily-life disturbance*, *positive anticipation*, *withdrawal*, *cyberspace-oriented relationship*, *overuse*, and *tolerance*. Third, we measured the users' self-efficacy of self-regulation of smartphone use in order to verify whether the self-efficacy had changed. Here, self-efficacy refers to the strength of belief in one's ability to complete tasks and reach goals. It has been reported that self-efficacy is associated with behavior changes [28]. In order to measure self-efficacy, we customized the Korean version of the *General Self-Efficacy Scale* (GSE) [26] to our context of self-regulation of smartphone use; the customized GSE consisted of 10 items using a four-point Likert scale. Examples include 'I am confident that I can efficiently manage unexpected disruptions due to the smartphone' and 'I can limit my smartphone use if I invest the necessary effort'.

Quantitative Results

Smartphone Usage Amount: Figure 3 presents the daily usage time and number of daily app executions. NUGU-Group's mean usage time tended to decrease after the intervention began while NUGU-Alone's mean usage time did not. Further analyses also revealed significant reductions in the NUGU-Group users' usage amount. First, we conducted two-tailed paired *t*-tests on the usage time/frequency between the pre-intervention period and post-intervention period of each group. Table 2 presents the results of these tests. The NUGU-Group users' usage time and number of app executions decreased significantly as they started to use the intervention app. However, we did not find significant differences in the NUGU-Alone users' usage amounts even though their usage time slightly decreased after the intervention.

Next, we conducted two independent samples *t*-tests in order to analyze the differences between the NUGU-Group and NUGU-Alone users in the usage time and number of app executions. Our analysis did not find significant differences between the groups during the pre-intervention period, but did in the post-intervention period: after the intervention

began, NUGU-Group's usage amount reduced significantly compared to that of the NUGU-Alone'.

SAS and Self-Efficacy Changes: Before the interventions, no significant differences were found in the SAS scores between NUGU-Group and NUGU-Alone (see Table 2); the scores were normalized by dividing them by the number of items, and multiple tests were adjusted using the Bonferroni correction. Similarly, we found no significant differences in the groups' sub-factors during the pre-intervention period. Among the sub-factors, *daily-life disturbance* and *overuse* tended to be higher, which indicates that these were important factors for the participants. In contrast, the scores on *positive anticipation* and *cyberspace-oriented relationship* were lower than the borderline (i.e., less than three points).

After the intervention, both groups' SAS scores changed, albeit differently. In common, their total scores and most sub-factors were significantly decreased after using the intervention apps. However, we also found sub-factors that did not change significantly. NUGU-Group did not exhibit significant decreases in *positive anticipation* probably because their score was already sufficiently low in the first survey. However, NUGU-Alone did not exhibit significant decreases in *overuse* and *tolerance* neither. When comparing the two groups, we found that NUGU-Group's decreases in their total SAS scores were significantly greater than those of NUGU-Alone's. This is related to *daily-life disturbance*; in the post-intervention period, NUGU-Group's scores on *daily-life disturbance* were significantly lower than NUGU-Alone's.

Then, no significant differences were found in the self-efficacy scores before the interventions between NUGU-Group and NUGU-Alone (see Table 2). When comparing each group's scores between the pre-intervention period and post-intervention period, we found significant decreases in self-efficacy scores in both groups. Contrary to expectations, no significant differences were observed in the self-efficacy improvements between two groups. Our further investigation using the exit interviews aided in understanding the results. Some NUGU-Group users reported that they realized they had difficulty with self-regulation through knowing their quantified usage amounts and comparing their limiting efforts with others. One participant stated, *"At first, I really thought that I could do very well. But, I found myself often giving up due to an instant message, while others appeared to be doing well. So, I think I lost my confidence"* (P24).

Qualitative Results

The interview results demonstrated that the NUGU-Group users perceived that limiting usage during various daily activities and for a long time is good for them through observing the top rankers' behaviors, unlike NUGU-Alone users who maintained their original limiting behaviors (i.e., a few of limiting contexts and short time limiting). Also, the social support offered by NUGU-Group was effective in strongly motivating the participants to limit their smartphone use. Finally, we confirmed that NUGU components were helpful to achieve limiting goals; the participants succeeded in completing goals at a high rate.

Limiting usage by learning when no use is good use

For the participants in both groups, the contexts of no use is good use were primarily when they wanted to concentrate on an activity and when they perceived their problematic usage. We asked the participants about the contexts in which they usually set a limiting goal. First, most participants stated that they usually set a goal when they wanted to concentrate on an activity such as studying, working, and sleeping. One answered, *"When I wanted to do something such as studying, meeting someone, or commuting; whenever I need to focus on something"* (P32). Another significant context was when they realized their problematic use, e.g., when they perceived their overuse or frequent checking use. Furthermore, some NUGU-Group users responded that the competition with friends encouraged them to limit their use; one response was *"When my friends were catching up with me in the ranking screen"* (P20).

However, we found differences between the two groups' limiting behaviors and contexts; the NUGU-Group users tended to set limiting goals in diverse contexts (selecting diverse daily activities for a goal) and they tried more challenging goals (i.e., long time limiting). According to the interview analysis, these differences are explained by the effects of social learning from top rankers' limiting behaviors. NUGU-Group users could share their limiting efforts (e.g., activities and times); in particular, the top rankers' behaviors (diverse contexts and long time limiting) tended to be a good reference for other users. However, NUGU-Alone users could not see others' behaviors, and each user tended to rely on their own original behavior (skewed limiting contexts and short time limiting). The details of the analysis results are as follows.

First, the NUGU-Group and NUGU-Alone groups exhibited a significantly different tendency for selecting activities (limiting contexts) while limiting use ($\chi^2 = 48.20$, $p < .001$, $df = 5$). Both groups preferred to select *studying and working* the most. This resulted from participants spending most of their daily time studying or working. However, the NUGU-Group users selected more diverse types of activities from *socializing* to *resting* while the NUGU-Alone users' selections were highly skewed toward studying and working. NUGU-Alone's entropy values of the activity selection ($M = 0.37$, $SD = 0.06$) were significantly lower than NUGU-Group's ($M = 0.70$, $SD = 0.03$; $p < .001$, $d = 1.51$). This could be an effect of social learning. NUGU-Group users stated, *"I often checked how others had selected activities. It made me try to use NUGU for other activities"* (P5) and *"I wondered how the top rankers limited their use. I tried to follow their behavior through referencing the activities they selected"* (P32).

Second, the NUGU-Group users tended to set a limiting goal with a longer time than the NUGU-Alone users ($\chi^2 = 139.72$, $p < .001$, $df = 3$). For the NUGU-Group, 66.1% of their goals set were more than 30 minutes as opposed to 47.0% for the NUGU-Alone users. The NUGU-Group users stated that they became familiar with long use limiting and understood its usefulness through learning from the others that attempted goals with a longer time. One user stated, *"At*

first, I preferred a short time for a goal because I thought I would need my smartphone soon. But, after knowing that setting a longer time helps me concentrate on studying more, I often started to set a goal for two hours" (P15). In contrast, many NUGU-Alone users regarded limiting for longer times as a difficult task. They stated, *"I liked to set 10 minutes to deal with urgent messages"* (P45).

Motivating limiting behaviors with social support

The NUGU usage logs show a significant difference in the number of setting limiting goals between the groups (NUGU-Group: 5.6 goals per day *vs.* NUGU-Alone: 1.3 goals per day, $p < .001$, $d = 1.87$). In order to better understand this, our next question focused on the effectiveness of NUGU's features for motivating users. Almost every NUGU-Group user answered that the social comparison of usage limiting durations from the scoreboard was the strongest motivator. Some noted its helpfulness for evaluating their own actions, by saying, *"I was surprised by others' limiting efforts and I became motivated to catch them"* (P34). In contrast, many NUGU-Alone users were less satisfied with the app because they felt that it did not help them take actions to limit their usage. One participant asked for recommended usage amount, by saying *"I want to be alarmed when I use it too much. Then, I may start to set goals"* (P40).

In particular, the degree of motivation by the competition appeared to differ depending on the social interactions among the group members. We found several interesting interactions among the group members. For example, one group offered a small reward that members buy some snacks for the top ranker, and another group's members called the top ranker by a funny nickname, 'king of limiting'; the top ranker was proud of the nickname and was motivated to keep the position. Also, most group members reported that they often talked about NUGU and their current rankings whenever they met. Furthermore, we also found that the family group had direct and strong interactions to motivate others. One of the family members stated, *"In the first stage, my younger brother told me that my limiting efforts were less than the others, so I started to do more"* (P3).

Interestingly, it appears that such interactions between group members were somewhat related to their interpersonal relationships. More frequent and stronger interactions were reported by close friends and family members, and their performances tended to be better. However, we found that the group of acquaintances, who only had social interactions once per week, exhibited relatively low performance. One group member explained, *"The members in other groups appeared to have frequent interactions. I think I could do more if I were in that situation."* (P10). Furthermore, one of the friend group members reported that she really wanted to push members who did not limit the usage actively because she worried about her team ranking. However, she could not point out their problem in the end because she thought that the relationship with them was not sufficiently close.

According to the interviews, the main function of self-monitoring was primarily to enable users to understand their problematic usage behavior rather than to motivate them to take action. The participants expressed, *"I learned that I spent too much time using my phone in the early hours of the day"* (P31). In addition, some participants mentioned the app's usefulness for tracking the outcomes of their use limiting efforts saying, *"I wanted to check whether my usage time is really reduced or not. I wanted to manage my time"* (P21). However, the users also noted the limitations of self-monitoring in maintaining their motivation. Once they became familiar with their usage and perceived their problems, they tended to neglect the self-monitoring screen. Furthermore, taking action was different to perceiving their problems. One NUGU-Alone user, who answered that the self-monitoring was useful, stated, *"I often forgot to limit my use. Maybe a push notification could be helpful for me"* (P39).

Achieving and abandoning goals

Our analysis demonstrates that the participants succeeded in completing goals at a high rate (success rate: 76.5%). We did not find significant differences in the rates of NUGU-Group (76.2%) and NUGU-Alone (77.5%) A slightly higher success rate in NUGU-Alone resulted from tendency to select goals with a short time. As a result of the interviews, the proposed design elements for helping users achieve their limiting goals contributed to the high success rate. In particular, the participants described four helpful elements: the goal-mode screen, the give-up button with a reconsideration popup, the remaining time for the goal achievement, and the incentive point system.

First, the goal-mode screen encouraged users not to play with their smartphone; one said, *"I liked the functions that lock the screen and turn it to the silent mode. These helped me not play with my smartphone"* (P6). Second, the give-up button with the confirmation popup allowed users to reconsider their choice to give up. One stated, *"The popup made me hesitate on giving up"* (P8). Finally, the remaining time and incentive points helped users manage their current goal and encouraged them to think *"I could think like that 'ah. . . I can succeed in my goal if I just bear with it. Then, I can get more points and the bonus points'"* (P33).

Furthermore, we investigated when the participants gave up and why they did. Their answers were primarily related to the need to use apps related to their productivity (e.g., dictionaries) and their need to do something urgently (e.g., call someone, search for information). Some participants stated, *"Sometimes, I gave up because I needed to write a memo"* (P34). Furthermore, almost half of the give up actions occurred within the first 10 minutes (47.5%). This is related to the opportunity cost. One participant stated, *"If I did not give up within the first 30 minutes, I thought I could succeed in the goal for two hours easily because I didn't want to lose the bonus points"* (P29). The results imply that it is necessary to support users, particularly in the first stage or first ten minutes, in order to help them succeed with their goal.

DISCUSSION

NUGU design aimed to assist in improving self-regulation of limiting smartphone usage through visualizing usage/limiting behaviors, sharing usage/limiting information, encouraging

user participation with social competition, and helping limiting use by locking apps and muting notifications. This work contributed to the body of knowledge in the related fields of CSCW, HCI, and Ubicomp as follows. Our design can be considered as the first example of socially translucent system design for systematically supporting temporary non-use [17, 25]. A socially translucent system makes user activities visible to support awareness, thereby encouraging accountable user behavior according to the social norms [6]. In NUGU, one of the key design choices was how to represent use limiting (or temporary non-use) activities for awareness support. Instead of sharing detailed information, for privacy reasons, NUGU shared an individual' summary statistics among group members (e.g., aggregated limiting time and activity counts), and a group's summary statistics among different groups. Our results confirmed that this level of disclosure was sufficient for achieving desirable outcomes while preserving user/group privacy. Our work also contributed to the scholarship of non-use [3, 9, 17, 25, 29] as we detailed the needs of temporary non-use of smartphones and demonstrated a tool for supporting temporary non-use. Furthermore, NUGU design leveraged the key features of persuasive systems design, namely self-monitoring and social support [23]. When designing systems for assisting in limiting smartphone use, we showed that social support was more critical than self-monitoring. Existing usage intervention mechanisms for mitigating smartphone overuse [15, 20] can be significantly extended through implementing social learning and competition features.

Then, we discussed several practical design implications based on our findings and the limitation of this work. NUGU allows users to share usage/limiting information, but it does not provide other social interaction mechanisms. In our experiment, we found that a group with high cohesion (e.g., a family group) is more likely to have frequent on/offline social interactions, which helped them to encourage one another for continued participation. Likewise, we expect that enabling social interactions through NUGU, such as exchanging short messages and emoticons, might further encourage user participation, thereby successfully self-regulating usage behavior.

We designed NUGU to allow users to start missions through specifying the limiting time and activity to do while limiting. While performing a limiting mission, users cannot execute any apps unless they decide to give up. The participants generally liked this design choice. However, some users stated that fine-grained limiting control (i.e., app-level usage) needs to be supported. For example, they mentioned that some apps related to the productivity, as notes and dictionaries, should not be disabled. There is a trade-off between fine-grained limiting control and support for usage limiting. Because smartphone usage is often contextual (e.g., using dictionaries while studying), the designers (or a group of users) can specify a list of allowable apps for a given context/activity.

Users can benefit from contextual alarms for limiting smartphone use. In NUGU, users should decide when to limit their use. We demonstrated that users' willingness for limiting could be improved through social support. However, due to high accessibility of smartphones, users must pay attention to their smartphone usage throughout the day, which is a challenging task. For example, one group-based intervention participant commented, *"The most difficult thing is to recognize that I should decide to limit use for a given context. I know it is good for me if I do not use a smartphone when I get up. However, I often found myself using it when I woke up. I need some kind of an alarm for usage limiting to better manage my habitual usage"* (P9). One solution is to allow users to schedule reminders for limiting smartphone use, e.g., while taking regular classes or having weekly meetings. In addition, an intervention app can recommend users to limit smartphone use, if it can automatically identify problematic usage (based on the previous usage history) [16, 27].

The validity of our experiment may be limited because the number of participants was small ($n = 62$) and the experiment was conducted over a short time of three weeks. A longitudinal, large-scale experiment should be performed in order to improve the validity of this work. Due to the design constraints of social support, we could not use randomized participant assignment; the statistical analysis partly affirmed the internal validity in that between these groups, and we did not find significant differences in the pre-intervention period results regarding the demographics, usage patterns (time, frequency), and measurement scales (SAS, self-efficacy). Our work closely followed the guidelines [11] through conducting a tailored evaluation on the social support. Besides the quantitative data comparison, we also performed qualitative data analysis in order to present how and why participants used our software and to draw practical design implications.

CONCLUSION

We designed and implemented NUGU (No Use is Good Use), which is a group-based intervention app to support self-regulation on smartphone use. Our three-week user study ($n = 62$) demonstrated that compared with its non-social counterpart, NUGU-Group users' usage decreased significantly, and their perceived level of managing interruptions was improved significantly. We are transitioning into a society of ubiquitous technologies, ranging from smartphones and quantified-self gadgets to the Internet of things, that promise to make our lives easier and more convenient. However, such technologies sometimes cause diverse side effects, such as technology overuse and abuse. We believe that it will become increasingly important for designers and researchers to investigate how to help people be in harmony with these new ubiquitous technologies through managing the side effects beyond simply focusing on technology diffusion.

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