Problematic Use of Social Networking Sites: Antecedents and Consequence from a Dual System Theory Perspective

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Problematic Use of Social Networking Sites: Antecedents and Consequence from a Dual System Theory Perspective

ABSTRACT: Problematic use of social networking sites (SNS) and its adverse consequences has become prevalent; yet, little is known about its conceptualization and etiology. This study draws on dual-system theory to investigate the drivers of problematic use of SNS and its adverse consequences. SEM analyses of time-lagged data collected from 341 Facebook users implicate an imbalance between two systems in the human mind, involving strong cognitive-emotional preoccupation with using the SNS (system 1) and weak cognitive-behavioral control over using the SNS (system 2), as the driver of problematic SNS use behaviors. Problematic use of SNS in turn, diminished users' academic performance. This study contributes to research on the dark side of IS use by conceptualizing problematic IS use and explaining its drivers and consequences. It demonstrates that the dual-system theory is an appropriate theoretical perspective for explaining problematic IS use, superior to planned behavior-based models. It also explains some of the precursors of the dual system and offers practical implications to IT artifact designers and users.

KEYWORDS: Problematic Use; Dual System Theory; Dual Process Theory; Social Networking Sites; Facebook; Dark Side of IS Use; Self-esteem; Stimulus Properties; User Characteristics

Introduction

Notwithstanding the benefits that using social networking sites (SNS) has had for the users, not all of their effects have been positive. SNS use has also led to a range of problematic behaviors in form of impulsive, risky and disadvantageous uses of these systems [72]. As an example, 14% of drivers disclosed that they have been using SNS while driving, a problematic behavior that can slow down drivers' response time up to 38% and represents a more serious source of distraction for drivers than having alcohol in the blood within legal limits (10-30%), texting (37%), and marijuana use (21%) [6]. As another example, American college students spend about one-fifth of their time in class on digital devices toward "non-class purposes" including the use of SNSs, despite their realization of the destructive impacts of such problematic behaviors on their grades [58]. This is critical, considering the increasing prevalence of SNS use among young adults; between 85% and 99% of college students are social media (e.g., Facebook) users [45]. Furthermore, recent studies [e.g., 22] have pointed to the negative effects of interruptions and interferences created by impulsive SNS use (e.g., during face to face conversations) on interpersonal relations and social functioning. Such findings speak to a type of prevalent *problematic use of SNS* with plausible negative consequences for the users [86]; yet, this phenomenon has been left largely unexplored.

A problematic behavior is defined as an impulsive, short-lived behavior that is considered inappropriate, prohibited, or even dangerous in a given environment and context, or for a given state and goal of the individual [5, 13]. Extant literature has described different instances of problematic uses of technology, such as "prohibited use" [12], "dangerous use" (a.k.a., "risky use") [12, 15], "technoference" [59], and "dysfunctional use" [15]. Integrating these perspectives, we define problematic use of an SNS as unplanned, impulsive SNS use instances

that are less advantageous to users, as they can likely lead to negative consequences for the user and are often disapproved by the society [31]. Examples of problematic use of SNS include using SNS while driving, listening to class lectures, attending meetings, or talking face to face with others. While the nature of SNS use can be active or passive [21, 56], in all of these instances, users typically do not plan on engaging in such behaviors and, in retrospect, users and perhaps also the society may judge them as poor choices. This judgment stems from the fact that problematic use behaviors, in turn, may result in damaging ramifications, such as accidents in case of using SNS while driving, or diminished academic performance in case of using SNS during lectures.

While problematic use behaviors have sometimes been fully associated with "behavioral addictions", recent research [e.g., 14] has challenged the clinical and psychological utility of this approach and called for distinctive conceptualizations of problematic behaviors. Problematic use behaviors tend to be momentary, impulsive, and largely irrational. While they can be a symptom or an outcome of a behavioral addiction, not all instances of a problematic use behavior necessarily stem from addictions [5, 37, 67]. It is important to note that problematic behaviors are often problematic even if they are done once. For example, a single instance of SNS use while driving is certainly problematic, but can occur with or without underlying addiction. Furthermore, even repeating the problematic behavior does not necessarily make it an addiction; it can be just a bad habit or a decision-making deficit[1] that does not meet all addiction criteria [78]. For instance, repeatedly using SNS while driving may be harmful, but it may not always meet addiction criteria such as withdrawal and a constant need to increase this activity [75].

1- Decision-making deficit refers to the process of "failed decision-making" leading to irrational decisions that are displayed in form of incoherence in the attitude or negative ramifications for the persons [37]. An example of a decision-making deficit is checking SNS when driving, knowing that it can risk their and others' lives.

Therefore, problematic use of SNS merits a distinctive conceptualization from addiction and habit [15]. Such a distinctive perspective on problematic use of information systems (IS), and specifically SNS, is scarce; yet, it is highly needed as prohibited, risky, and socially objectionable uses of hedonic IS systems are on the rise, such as the recent incidents involving Pokémon Go™ [e.g., 19, 55],. Hence, the objective of this study is to develop and test a theoretical model to explain the etiology (i.e., underlying causes) of problematic use of SNS and its adverse consequences, which can possibly be generalized to other IS contexts.

Problematic use of SNS seems largely irrational; why would some people check SNS while driving considering that they are in fact risking their lives? [6, 80] Or why would a student spend a large portion of class time on Facebook at a risk of failing the class? [58] Such potentially harmful and socially objectionable behavioral choices seem to be similar to other established and often legal problematic behaviors, such as problem gambling, excessive alcohol consumption, excessive sexual behavior, and overeating [42]. Hence, similar to other problematic behaviors, it is reasonable to view problematic use of SNS as a decision-making deficit [37]. To that end, the oft-used planned behavior theoretical lenses for explaining use behaviors may not be able to portray a clear picture of problematic SNS use, given their underlying assumption of rationality. In essence, understanding problematic use of SNS requires a theoretical lens that accounts for less rational and impulsive behaviors. As such, this study expands the focus of IS research from mainly planned behavior models to models that describe irrational, problematic use behaviors [68].

An appropriate and well-established theoretical lens to investigate the etiology of problematic behaviors is *dual-system theories* [e.g., 25] (a.k.a., dual-process models [e.g., 29, 69]). A dual-system theory perspective suggests that problematic behaviors can be attributed to an *imbalance*

between two different types of emotional-cognitive systems in human minds: an impulsive, largely automatic system (system 1) versus an inhibitory, reflective system (system 2). The imbalance involves strong persistent urges (preoccupations, impulsions) generated by system 1, coupled with weak motivations and/or abilities to control or inhibit these preoccupying thoughts or the target behavior exercised by system 2 [8].

Accordingly, in this study, we contend that an imbalance in the abovementioned dual system drives problematic use of SNS. We further explain the merits of the dual system theoretical choice by comparing its power in explaining problematic use of SNS to that of planned behavior-based models. Furthermore, post-hoc analyses elucidate some of the stimulus (SNS) properties and user's psychological characteristics that can influence this imbalance.

Theoretical Foundation

Dual-System Theory of Cognition and Behavior

Numerous behavioral and neuroscience studies have advanced the notion of *dual-system theory* by explaining that human behavior is guided by two structurally and conceptually different *types* of brain systems [29, 69], a view sometimes narrated as "the two minds hypothesis" [34, p. 914]. The findings of cognitive neuroscience studies supplement the findings of behavioral studies [7, 40, 46, 67] by identifying distinct brain areas associated with each of the two systems and their corresponding functionalities in decision making [77]. These studies generally agree on two key principles of the dual-system theory. The first principle explains the distinctive nature of the two systems: one is an impulsive, largely automatic, and reflexive (reactive) cognitive system, and the other is a controlled, inhibitory, and reflective (prudent) cognitive system. The second principle refers to the way the two systems interact and their distinct roles in decision-making. Extant research suggests that decisions to engage in (or avoid) a behavior are guided by a 'tug of

war' between the two aforementioned systems. While system 1 generates impulsions to engage in (or avoid) the behavior, system 2 reflects on the impulsions and the behavior, determines whether they are aligned with the person's long-term goals, and decides whether the behavior should be enacted or inhibited [81].

The dual-system theory has been particularly useful in explaining the etiology of problematic behaviors, such as problem gambling, overeating, problematic drinking, and smoking [see 29 for a review]. Prior research in this domain [e.g., 30, 33] has shown that different problematic behaviors share similar etiology in terms of a deficit in the balance (i.e., an imbalance) between the two cognitive systems – system 1 and system 2, which is manifested in strong impulsions to engage in the problematic behavior *combined with* ineffective inhibitory control abilities [37]. Given conceptual similarities between problematic use of SNS and other established problematic behaviors [84], the dual-system theory is deemed a natural and appropriate theoretical underpinning for explaining the problematic use of SNS [82]. This contention is further supported by findings of cognitive neuroscience studies in the context of Facebook use [77], which showed that system 1 is in operation when people are exposed to stimulant cues from Facebook (e.g., notifications from a user's contacts on Facebook) and system 2 is engaged when users were asked to inhibit responses to Facebook stimuli.

Dual-System Theory in the Context of Problematic Use of SNS

Prior works on dual system theory have, oft-arbitrarily, used a broad range of pertinent cognitive, emotional, and behavioral factors to represent each of the two systems (system 1 and system 2). Examples of such factors are automatic affective reactions vs. self-control [35, 40], habit vs. self-regulation [67], heuristic processing vs. systematic processing [20], and automatic stereotyping vs. suppression [26]. While these factors may be relevant to the context of our study and

notwithstanding their contributions, we choose to take a more systematic approach in capturing the two systems in this study. As such, rather than arbitrarily choosing factors for representing systems 1 and 2, we draw on a model that has been designed and validated as an overarching manifestation of a dual-system model in the context of problematic behaviors. Specifically, we adapt Collins and Lapp [23]'s overarching manifestations of systems 1 and 2 that has been originated and validated in the context of problematic alcohol use. It is deemed relevant for explaining the problematic use of SNS given the arguably similar neural and cognitive etiology of all problematic behaviors [67, 75]. As such, we respectively manifest systems 1 and system 2 in the case of SNS use in terms of *cognitive-emotional preoccupation with using the SNS*, and *cognitive-behavioral control over using the SNS*.

We contend that system 1 is automatically engaged when a preoccupied user is exposed to an external (e.g., a notification from Facebook) or an internal stimulant cue (feelings of loneliness [56]) and generates an urge to use the SNS. System 2, in contrast, reflects on the consequences of this behavioral choice and tries to prevent it if deemed suboptimal, damaging, or socially disapproved. Specifically, system 2 tries to restrain impulsions and associated preoccupying thoughts both behaviorally (i.e., inhibiting the action) and cognitively (i.e., suppressing the thoughts). As such, activation of system 2 not only can directly inhibit the problematic behavior (direct behavioral effect), but also can weaken the effects of system 1 on the problematic behavior (cognitive moderation effect) [23] (Figure 1).

INSERT FIGURE 1 HERE

Cognitive-Emotional Preoccupation with Using an SNS

Cognitive-emotional preoccupation with a behavior, such as using an SNS, refers to obsessions and persistent thoughts about the behavior [32, 44]. Prior studies have shown that preoccupation

with a behavior triggers strong urges to engage in the behavior [23, 40, 69], which then lead to *problematic behaviors* [5]. Cognitive-emotional preoccupation with a stimulus is a result of gradual formation of certain associative clusters in one's long-term memory by co-activation of the stimulus, the cognitive and/or emotional reactions to it, and the behavioral tendencies associated with those reactions [40]. Once such associative clusters are established in one's long-term memory, any internal or external cue related to the stimulus (i.e., stimulant cues, such as a thought of socializing with friends on the SNS or notifications from friends on the SNS) can reactivate the associative clusters. This can result in the emergence of strong urges (i.e., preoccupying thoughts and feelings) toward the behavior(s) associated with the stimulus (e.g., using the SNS) [32]. Hence, cognitive-emotional preoccupation with a behavior is at the heart of impulsions toward that behavior [23]. Impulsions toward a behavior, in turn, positively reinforce people's drives to engage in the behavior and create a difficult-to-resist motivational state, which may result in problematic behaviors [51].

In addition to the *positive behavioral reinforcement* (a.k.a., reward seeking) mechanism, preoccupation may also result in a problematic behavior via a *negative behavioral reinforcement* (a.k.a., pain avoidance) mechanism. Specifically, preoccupation can take over people's thoughts and can provoke anxiety, disruption, and disorientation [1]. In order to alleviate the disruption and distress provoked by preoccupations, people may engage in the problematic behavior advocated by their cognitive-emotional preoccupation [48]. Two examples are checking the door locks ten times before leaving the house in response to preoccupation with the thought of a burglary [1], and repeatedly checking the SNS lest a notification from a friend on SNS was left unnoticed. Extrapolating this to the context of our study, we contend that cognitive-emotional preoccupation with using an SNS is an appropriate manifestation of system 1, which drives the

problematic use of SNSs, presumably through *positive and negative behavioral reinforcement* mechanisms (Figure 2).

Cognitive-Behavioral Control over Using an SNS

Cognitive and behavioral control refers to one's ability to inhibit, interrupt, or change desired and impulsive cognitive and behavioral responses (i.e., thoughts and behaviors) such that the person eventually manages to mitigate or avoid problematic behaviors [43, 71]. Prior dual-system studies [5, 35, 37, 40] have shown that problematic behavior is associated with strong preoccupations with that behavior (system 1) coupled with *an impaired cognitive and behavioral control* that fails to inhibit these behaviors and override the preoccupying thoughts and feelings (system 2). Furthermore, lack of cognitive-behavioral control is at the heart of problematic use of SNS [see 36 for a review], where SNS users lack the motivation and/or the ability to control their SNS use [77]. This is consistent with prior research findings on other problematic behaviors such as criminal acts [43]. Hence, we draw on cognitive-behavioral control[2] as the manifestation of system 2 in our dual-system perspective of problematic use of SNS (Figure 2).

INSERT FIGURE 2 HERE

Hypotheses

Negative Consequences of Problematic Use of SNS: Diminishing Academic Performance

Prior studies have discussed various negative consequences that can emerge from problematic use of SNS [e.g., 80], among which diminished performance is relatively prevalent [73]. Considering that the sample for this study is drawn from university students (see Methodology section), it is reasonable to focus on a performance measure conducive to this context, namely

2- It is noteworthy that cognitive-behavioral control can be conceptualized in two different ways: a general self-control personality trait [40] and a domain-specific control function [54]. In this study, we focus on cognitive-behavioral control as a domain-specific control function in the context of SNS use, because it is relatively more specific to the context of the problematic behavior, as compared with a general self-control personality trait [54].

academic performance. Academic performance is the extent to which students have achieved their learning goals [63] and is often captured by grades (or grade averages) reflecting knowledge of specific topics in relation to learning objectives [27].

We argue that problematic use of SNS can diminish one's academic performance, because it requires attention (e.g., attending to Facebook notifications and posts in class) and can preoccupy and distract students beyond class time [38]. As such, it can prevent students from effectively attending to and working on important educational activities in class or at home and diminish their academic performance [58, 64]. Drawing on cognitive load theory [70], Mayer and Moreno [57] explain that use of multimedia in class can simply overload students' limited working memory, which can reduce deep learning. In the context of our study, one must have enough working memory available for processing course materials (in class or at home) to be able to effectively learn them. When the working memory is overloaded by unrelated stimuli (e.g., using Facebook in class), deeper cognitive processing and effective learning cannot occur. Hence:

H1: *Problematic use of an SNS is negatively associated with students' academic performance.*

Effect of Cognitive-Emotional Preoccupation (system 1) on the Problematic Use of SNSs

System 1 can generate *cognitive and/or emotional preoccupation* with behaviors [32], which can foster the enactment of such behaviors even when they are problematic [40, 69]. As explained earlier, preoccupation with a behavior, such as using an SNS, is formed as a result of developing and strengthening certain associative clusters in one's long-term memory. The associative clusters can result in the emergence of strong impulsions toward the behavior as cognitive and/or emotional reactions to relevant internal stimuli (e.g., negative emotions) as well as external stimuli (e.g., SNS notification) [32]. For example, through repeated rewarding experience with using Facebook, an associative cluster may be formed in users' mind that links the thought of

using Facebook, the rewarding feelings generated by using it – such as the joy in socializing with friends [24], and the behavioral schema that has led to the rewarding feeling. Once established, the associative clusters can be reactivated quickly and sub-consciously by an external stimulant cue such as a notification from Facebook, as well as by internal conditions such as feeling of loneliness or boredom [40, 56, 69]. Turel et al. [77] have shown that people with such established clusters respond significantly faster to Facebook stimuli as compared to neutral stimuli; and that these responses can be very difficult to inhibit.

In essence, cognitive and/or emotional preoccupation with an SNS creates potent drives to use the SNS, which users may find difficult to resist and hence can serve as a basis for unplanned, problematic use of the SNS [69]. When high levels of preoccupation with using an SNS are formed, the thoughts of using the SNS and the emotional gains associated with it (e.g., joy, relief of boredom) become more persistent. As such, a mere thought about the SNS in this case can trigger a strong urge to use it, even in situations where it can be risky, prohibited, or socially objectionable. In addition, preoccupation can be disturbing and annoying, as people find it difficult to concentrate on other tasks in the presence of such preoccupying thoughts and feelings [32, 44]. One way to alleviate the pains of preoccupation is to engage in the behavior at the heart of the preoccupation [48], even when this behavior is problematic. As such, preoccupation can foster problematic behaviors via both positive (reward seeking) and negative (pain avoidance) reinforcement mechanisms. On this basis, we contend the following:

H2: *Cognitive-Emotional Preoccupation with using an SNS is positively associated with the problematic use of the SNS.*

Effects of Cognitive and Behavioral Control (system 2) on the Problematic Use of SNSs

People with stronger cognitive-behavioral control over their behaviors are more adept at regulating their behavioral drives in support of achieving their long-term goals [28]. Effective cognitive-behavioral control hinges on two major ingredients, namely *plans* and *ability* to control and restrict preoccupying thoughts and/or their resulted problematic behaviors [23]. Plans to control a behavior encapsulate how much people are aware of and concerned about their impulsions. They build on the idea that people do not only react to and deal with impulsions at the moment, rather, given the human's capacity for foresight, a considerable amount of control strategies and inhibitory plans, which were taken at an earlier point in time, determine the extent to which preoccupation and problematic behaviors can be controlled [41]. People's plans to control their impulsions and/or override associated problematic behaviors depend on how much conflict they conceive between the plausible consequences of the problematic behavior and their long-term goals, as well as on how motivated (concerned) they are to resist the problematic behavior and its underlying impulsions [41].

Control abilities are associated with the concept of "willpower" [7, 9], defined as "a combination of determination and self-discipline that enables somebody to do something despite the difficulties involved... the mechanism that enables one to endure sacrifices now in order to obtain benefits later" [9, p. 215]. Without the required willpower to restrict the impulsions and/or alter a problematic behavior, the other ingredient (i.e., plans to control) will be fruitless, as if "the person might know what he or she wants and be quite aware of his or her own behavior but not be able to self-perform the necessary actions" [7, p. 673]. Prior research [e.g., 23] has shown that individuals who are concerned about and have the ability to restrict a problematic behavior

develop stronger cognitive-behavioral control over the behavior, which mitigates the extent and frequency of the problematic behavior.

Extrapolating this logic to the context of this study, we contend that problematic use of an SNS and awareness regarding the plausible negative consequences of this problematic behavior, such as not being able to follow up with course materials and wasting time, sow the seeds of concerns within the individual. This can result in planning for and trying to inhibit the problematic use of an SNS. Social cognitive theory [3] lends additional support to this contention by explaining that people are expected to restrict their behaviors when they are deemed problematic. Consequently, cognitive-behavioral control over SNS use can prevent or inhibit the problematic use of the SNS. Hence:

H3: *Cognitive-behavioral control over using an SNS is negatively associated with the problematic use of the SNS.*

We contend that in addition to the direct inhibitory effects on problematic behaviors (H3), cognitive-behavioral control can also have a moderation effect on the impact of cognitive-emotional preoccupation on the problematic behavior. We suggest that higher levels of cognitive-behavioral control weaken the effect of cognitive-emotional preoccupation on the institution of the problematic behavior. Cognitive monitoring theory [16] explains that specific regions in the brain detect the occurrence of conflicts in information processing, such as the conflicts between the preoccupying thoughts driven by system 1 and the goal-directed inhibition triggered by system 2. This conflict then triggers adjustments in the mental weights given to individual's thoughts in favor of goal-directed cognitions, which serve to resolve the conflicts by suppressing the emphasis put on pre-potent impulsions. In essence, when cognitive-behavioral control is high, people are less disturbed and motivated by system 1 impulsions, can override

them to some extent, and the overall effect of system 1 preoccupying thoughts on one's behavioral choices is reduced. As such, the role of cognitive-behavioral control is not limited to directly inhibiting problematic behaviors (e.g., by preventing physical action); it also includes cognitive control responsibilities in the face of cognitive-emotional preoccupation (i.e., cognitively changing attention and priority schemata).

Extrapolating the foregoing argument to the context of this study, one can expect that exercise of cognitive-behavioral control over using the SNS in response to a cognitive-emotional preoccupation with using the SNS results in the emergence of conflict between the two systems. Consequently, an adjustment is triggered in the person's decision-making process to resolve the conflict by suppressing the effects of cognitive-emotional preoccupation with using the SNS on the person's behavioral choice. Prior research [e.g., 35, 54] has provided considerable support for similar moderation effects. For example, it has been shown that cognitive-emotional preoccupation with drinking alcohol predicts problematic drinking behavior only in individuals with low cognitive-behavioral control over their drinking behavior, but not in individuals with high cognitive-behavioral control [54]. Hence:

H4: *Cognitive-behavioral control over using an SNS reduces the strength of the relationship between cognitive-emotional preoccupation with using the SNS and the problematic use of the SNS.*

Methodology

Procedure and Sample

Multi-wave self-reported and objective data were collected over four points in time (t_1 - t_4). The sample was comprised of Facebook users who were undergraduate students at a large North American university and did not need to use Facebook for their coursework. Participants were

given two bonus points in exchange for their time. This sampling choice was made for two reasons. First, university students are more prone than others to develop problematic use of SNS due to their flexible schedules, free time, high use and little external control over their Internet use (e.g., no parental or organizational control). Second, Facebook is the most popular SNS among university students and university students represent a large percentage of Facebook users. Furthermore, the problematic use of Facebook seems to be prevalent and has been associated with a plethora of negative ramifications [76].

The purpose of multi-wave data collection was to avoid the "percept-percept" problem, which refers to the collection of both antecedent and dependent data at the same time that could artificially inflate or deflate correlations among factors [18], and which can be controlled by using a time lag between the collection of the antecedents and dependent data [87].

As such, self-reported data regarding cognitive-emotional preoccupation with using Facebook and cognitive-behavioral control over using Facebook were collected at t_1. Next, self-reported data regarding participants' problematic use of Facebook were collected one week later (t_2). Consistent with past research using student sample and multi-wave data collection [e.g., 50, 90], one-week time lag between t_1 and t_2 was selected because it is not too short, hence allowing ample activity on the SNS, and not too long such that the respondents forget or lose interest in the study [78]. Furthermore, a regular week in the academic semester was selected to represent normal, regular semester behaviors and our study did not involve any experimental treatment. Hence, it is reasonable to expect respondents' behaviors, including their Facebook use, during the data collection period not to be systematically different from their behaviors in other weeks. Lastly, objective data for measuring academic performance (Grade Point Average – GPA) were collected from the university records system at the end of the same semester that was 10 weeks

after t_2 (t_3), as well as one year after t_2 (t_4). Students' IDs were used for mapping GPAs to the self-reported data and were removed after the mapping was completed.

Three hundred and ninety participants were invited to voluntarily complete the online surveys via class email, out of which 341 Facebook users (87% response rate) provided complete responses. Respondents included 52% women, and their average age was 23 (18–60, SD= 4.36). Furthermore, respondents, on average, had 4.2 years of Facebook experience, possessed 348 contacts on their Facebook accounts, and spent 1.5 hours per day on Facebook, for 5.9 days per week. Furthermore, these participants, on average, were active on 2.6 SNSs other than Facebook, such as Instagram (62.8% of users), LinkedIn (49.6% of users), Twitter (35.2% of users), Google+ (32.6% of users), and Snapchat (29.6% of users). Nonetheless, in the survey, they were asked to only focus on their experience with using Facebook.

Measures

Measurement items were adapted from well-established and reliable research instruments (Table 1). *Cognitive-emotional preoccupation with using Facebook* and *cognitive-behavioral control over using Facebook* were measured at t_1 using Collins and Lapp [23]'s measurement inventory developed for problematic drinking, which was adapted to the context of problematic use of Facebook. Consistent with Collins and Lapp [23], cognitive-emotional preoccupation was operationalized as a reflective[3] second-order factor based on three first-order factors, which were adapted to the context of using Facebook: (1) "emotion", which refers to avoiding or alleviating

3 The decision for specifying the second-order factors in our study as reflective was consistent with original specification of these factors by Collins and Lapp [23]. In addition, we deemed this appropriate for two additional reasons. First, the high composite reliability scores for the second-order constructs based on all of their first-order items (0.913 for cognitive-emotional preoccupation and 0.909 for cognitive-behavioral control) point to their reflective specification. Second, the correlations among the first-order factors for cognitive-emotional preoccupation are in the range of (0.56-0.66) and the correlation between the two the first-order factors for cognitive-behavioral control is 0.68 (see Table 2), which are in almost same range as Collins and Lapp [23]'s findings. Such relatively high correlations also deem reflective specification appropriate.

negative emotions as a drive for using Facebook; (2) "cognitive pre-occupation", which captures persistent distracting thoughts about using Facebook; and (3) "govern", which refers to difficulty in controlling one's use of Facebook, reflecting the strength of the impulsions. Similarly, cognitive-behavioral control was operationalized as a reflective second-order factor manifested through two first-order factors, which were adapted to the context of using Facebook: (1) "concern", which captures worries about and plans to reduce using Facebook; and (2) "restrict", which refers to the attempts to limit and inhibit using Facebook.

Problematic use of Facebook was measured based on problematic use frequency measures [80], which were adapted to the context of problematic use of Facebook. Specifically, we asked respondents to report their frequency of using/checking Facebook during the previous week (between t_1 and t_2) in potentially problematic and inappropriate situations that require people's full attention, namely (1) while they were attending classes at school, (2) while they were driving, (3) while they were talking face to face with people, and (4) while they were working[4]. These situations represent problematic behaviors in the sense that they are typically irrational, unplanned, can have negative consequences for the users, are preformed when other tasks require full attention of the user, and are, by and large, socially objectionable.

Academic performance was measured at an aggregate level – semester-based performance (t_3 and t_4) and annual performance (t_4) in the program – rather than at the level of a specific course, assuming that the problematic use of Facebook can diminish academic performance across the board and not necessarily in terms of grades in a specific course. To do so, consistent with prior studies [e.g., 64], we used multiple objective GPA scores, i.e., the averages of grades on specific

4- We acknowledge that some of these situations may be less directly linked to academic performance (e.g., using Facebook while driving), but we retained a broad perspective as a means to achieve higher content validity in our measurement of problematic Facebook use.

subjects in a program of studies. Hence, academic performance was operationalized using three objective measures, namely students' GPAs for the semester in which the survey was administered, students' GPAs for the semester one year after the survey was administered, and students' cumulative GPAs for the duration of studies one year after the survey was administered.

We also adapted Bhattacherjee [10]'s instruments for measuring *perceived usefulness of Facebook* and *satisfaction with using Facebook*. We used these factors as controls and also to compare the performance of our dual-system perspective in explaining the variance in problematic use of Facebook with what is explained by main planned behavior (rationale)-based models of continued IS use, in which usefulness and satisfaction are among the key determinants [e.g., 10] (see Model Comparisons post-hoc analysis).

Demographic variables, such as age and gender were measured for control purposes. Finally, we also measured the respondents' self-esteem (using Rosenberg [65]'s instrument), number of contacts (friends) on Facebook, extent of Facebook use experience, number of hours of Facebook use per day, number of days of Facebook use per week, and the list of other SNSs being used by them for descriptive and post-hoc analyses purposes.

INSERT TABLE 1 HERE

Furthermore, to ensure the validity of all measurement items, a series of initial assessments, including face validly checks (n=15) and pilot testing (n=60) were performed, details of which are explained in Appendix A.

Data Analysis and Results

Preliminary Analyses

A series of preliminary data analyses ensured the absence of artifacts that could compromise the quality of analyses: (1) low reliability of factors, (2) low validity of factors, (3) serious deviations from normality assumption, (4) multicollinearity among the factors, and (5) common method variance (CMV) bias. To that end, the descriptive statistics, kurtosis and skewness indices, average variance extracted (AVE) scores, reliability scores, and inter-factor correlations were calculated for the factors, as outlined in Table 2. Furthermore, a confirmatory factor analysis (CFA) model using AMOS version 23 was estimated to ensure the goodness-of-fit of the measurement model (see Appendix B for details).

INSERT TABLE 2 HERE

Hypotheses Testing

The results of SEM analyses show that the proposed research model (Figure 2) exhibits good fit to the data (RMSEA = 0.056, with 95% confidence interval of (0.050 – 0.061); SRMR = 0.079; CFI = 0.94; IFI = 0.94; and TLI = 0.93). Estimated path coefficients and their significance levels show that all four hypotheses were supported (Figure 3). As predicted in H1, problematic use of Facebook negatively affected students' academic performance (-0.18, $p < 0.01$). Consistent with H2, the results demonstrated that system 1, manifested in cognitive-emotional preoccupation with using Facebook, had a significant positive effect on problematic use of Facebook (0.91, $p < 0.001$). Moreover, consistent with H3, system 2, manifested in cognitive-behavioral control over using Facebook, had a negative direct effect on problematic use of Facebook (-0.55, $p < 0.05$). In addition, in line with H4, cognitive-behavioral control negatively moderated the effect of cognitive-emotional preoccupation on problematic use of Facebook (-0.29, $p < 0.001$). Together,

dual-system mechanisms explained more than 39% of the variance in problematic use of Facebook, which in turn explained almost 8% of the variance in students' academic performance[5].

We controlled for the effects of four factors in our model, namely age, gender, perceived usefulness of Facebook, and satisfaction with using Facebook. Age showed a negative association with problematic use of Facebook (-0.18, $p < 0.01$) as well as academic performance (-0.13, $p < 0.05$). Furthermore, perceived usefulness of Facebook showed a positive association with academic performance (0.21, $p < 0.01$).

INSERT FIGURE 3 HERE

Post-hoc Analyses

Post-hoc Analysis (1): A Deeper Look into the Moderation Effect of Cognitive-Behavioral Control

The Interaction software package [66] was used as a means to delve further into the moderation effect of cognitive-behavioral control (H4). The plot and path coefficients presented in Figure 4 demonstrate that the effect of cognitive-emotional preoccupation with using Facebook on problematic Facebook use is largely positive and significant, but is diminished as the level of cognitive-behavioral control over using Facebook increases. Furthermore, when cognitive-behavioral control is at least two standard deviations above the mean, the effect of cognitive-emotional preoccupation on problematic Facebook use is non-significant. Hence, for people with

5 The same model was also tested using only one item for measuring the *problematic use of Facebook in class*, which was more conceptually aligned with academic performance as the dependent variable. While the fit of the model was slightly improved, the results of hypothesis testing remained the same. Explained variance for problematic use of Facebook in class was 29.6%, the path coefficient from problematic use to academic performance was -0.16 ($p < 0.05$), and the explained variance for academic performance was 6.5%. Hence, we lost explanatory power in problematic SNS use (from 39.3% reduced to 29.6%) and in academic performance (from 7.4% reduced to 6.5%). Essentially, this suggests that problematic SNS use is a rather stable behavior that can emerge and affect different contexts (e.g., when driving, working, attending class, or talking to others).

strong control over their Facebook use, cognitive-emotional preoccupation does not affect problematic Facebook use, which is consistent with the dual-system theory perspective and Collins and Lapp [23]'s findings about problematic drinking.

INSERT FIGURE 4 HERE

Post-hoc Analysis (2): A Deeper Look into the Effect of Imbalance between Systems 1 and 2 on the Problematic Use of Facebook

The results of the SEM analysis imply that the *imbalance* between system 1 and system 2 drives the problematic behavior. In this post-hoc analysis, we shed more light on this issue by directly testing the role of the imbalance. To do so, the imbalance between cognitive-emotional preoccupations (CEP) and cognitive-behavioral control (CBC) was calculated as the difference between the standardized scores of the two factors (imbalance = CEP – CBC). Next, we conducted two analyses: (1) a pair-wise comparison (ANCOVA) of imbalance levels between two subgroups in our sample representing low and high extent of problematic use of Facebook using an average (2.74) split, and (2) a hierarchical regression of the problematic use of Facebook on the imbalance scores. The results of both analyses showed that the imbalance significantly and positively ($p < 0.001$) explains the extent of problematic use of Facebook (see Appendix D for details). In other words, as the imbalance grows larger, the extent of problematic use of Facebook increases as well, which is consistent with the dual-system perspective on the etiology of problematic behaviors.

Post-hoc Analysis (3): Alternative Model Comparisons

To better illustrate the relevance and power of the proposed research model in explaining problematic use of Facebook, we estimated and compared three alternative models (alternative models 1 to 3 depicted in Appendix C). The purpose of the additional analyses is to compare the

ability of IS-continuance models based on the planned behavior (rationality-based) perspective and our proposed dual-system theory model to explain variance in problematic use behaviors. The alternative model 1 represented a planned behavior model of problematic use of Facebook and included the typical rational drivers of continued system use (perceived usefulness and satisfaction [e.g., 10]). The alternative model 2 included the two main dual-system perspective factors (i.e., cognitive-emotional preoccupation with and cognitive-behavioral control over using Facebook) and their interaction term as antecedents of problematic use of Facebook. The alternative model 3 included all factors in alternative models 1 and 2 with problematic use of Facebook as the dependent factor. In other words, alternative model 3 combined the planned behavior and dual-system perspectives (see Appendix C). The results of the SEM analyses of the three alternative models are provided in Table 3.

INSERT TABLE 3 HERE

Table 3 shows that alternative model 1 explains 11% of variance in problematic use of Facebook, while alternative models 2 and 3, respectively explain 38% and 40% of variance in the problematic use of Facebook. Adding perceived usefulness and satisfaction to the proposed dual-system model increased R^2 by merely 2%, which points to their weak explanatory power for problematic SNS use, as also indicated by their non-significant path estimates. Hence, the findings demonstrate that the dual-system theory is substantially more effective in explaining problematic use of Facebook, as compared to planned behavior-based models of IS use. These findings are conceivable considering the *incongruity* between the underlying rationality and planned-behavior assumptions in rationality-based IS use models and the irrationality and spontaneity underlying problematic behaviors, such as problematic use of Facebook. These

findings reaffirm our choice of dual-system theory as an appropriate theoretical lens for investigating the etiology of problematic use of SNS.

Post-hoc Analysis (4): A Glance into Precursors of Dual System Factors

Considering the central role of systems 1 and 2 in provocation and inhibition of problematic use of SNS, it would be illuminating to discuss the factors that can affect their stimulation (a.k.a., precursors [39]). This post-hoc analysis explains the results of an investigation of the effects of two such factors, namely *user's number of Facebook friends*, a stimulus property arguably affecting cognitive-emotional preoccupations with Facebook, and *user's self-esteem*, a user characteristic arguably affecting cognitive-behavioral control over using Facebook (see Appendix E for more theoretical detail).

The post-hoc analysis results supported our contentions (see Appendix E). Specifically, they demonstrated a significantly positive relation between user's number of Facebook friends and cognitive-emotional preoccupation (0.13, $p < 0.01$) and a significant inverted U relation between user's self-esteem and cognitive-behavioral control (-0.23, $p < 0.001$).

Discussion

Why do some people use SNS while driving, attending a class, working (when they are supposed to do other things), and meeting other people face to face (when such a behavior is deemed rude and may adversely affect their social interaction)? All of these, unfortunately increasingly frequent, instances of SNS use have several things in common. First, these behaviors are largely unplanned. Most people, for example, will not rationally plan to check their Facebook page when they start driving. Similarly, students typically do not come to class with an intention to spend much of their lecture time on Facebook. Second, these behaviors usually result in negative consequences. They are typically inconsistent with one's primary goals in life (e.g., succeeding

in school), and are typically deemed inappropriate and problematic. However, people still frequently engage in them. For example, 24% of young-adults use SNSs and emails while driving [80]. In our sample, 76% of respondents reported using Facebook in class, 40% reported using it while driving, 63% reported its use while talking face-to-face with others, and 65% reported using it at work instead of working. This points to the largely irrational basis of these behaviors and, as demonstrated in this study, they are better explained by a theoretical lens, such as the dual-system theory, that can reasonably reveal their underlying etiology.

Drawing on the dual system theory, this study showed that problematic SNS use, like many other problematic behaviors, is instigated by strong cognitive-emotional preoccupation with the behavior coupled with weak domain-specific control abilities. The findings showed that behaviors, such as using Facebook while driving or attending a class, are strongly associated with an imbalance of two cognitive systems – system 1 and system 2. While system 1, manifested in cognitive-emotional preoccupation with using Facebook, created a motivational state of desire, system 2, manifested in cognitive-behavioral control over using Facebook, tried to inhibit the desire and prevent the execution of the motivational state. The tug-of-war between the two systems explained more than 39% of the variance in problematic use of Facebook, which in turn explained almost 8% of variance in students' academic performance.

Implications for Research

First, this study expands and informs the emerging body of research on the dark side of IS use [73], which thus far, has mostly overlooked the conceptualization, drivers, and consequences of problematic IS use. Specifically, this study theoretically and empirically explains the etiology of problematic use of IS and demonstrates its potential adverse consequences, at least in the area of academic performance. By borrowing theories that explain the etiology of other, more

established problematic behaviors (e.g., problematic drinking, problem gambling, overeating), this study managed to explain substantial variance in problematic SNS use (39.3%). As such, our findings point to possible etiological similarities between the problematic use of IS and other problematic behaviors. Furthermore, our findings support the idea that problematic SNS use is rooted in an imbalance between system 1 and system 2 cognitive processes: strong persistent urges (preoccupations, impulsions) generated by system 1 and weak motivations and/or abilities to control or inhibit these preoccupying thoughts or the behavior exercised by system 2.

Second, this study contributed to the bodies of literature on IS use and dual-system theory. Specifically, the findings showed that not only the dual-system theory is an appropriate lens for explaining problematic IS use, but also that its key factors, namely emotional-cognitive preoccupation and cognitive-behavioral control, are more appropriate than planned behavior-based factors, such as perceived usefulness and satisfaction, for explaining the problematic use of IS. As such, when IS use seems to be enacted without proper reflection and planning (i.e., it is less rational), the dual-system perspective may be a more fitting theory than the planned behavior-based perspective for explaining such behaviors. Simply put, in situations where not all use instances are well planned and rational, dual-system theory can point to the relevant factors that can better explain such spontaneous and problematic behaviors, as compared to planned-behavior models. This is an important extension of the IS use literature that has mainly relied on rationality assumptions [10].

Third, in addition to showing the importance of the dual-system perspective in explaining problematic use of IS, we also examined the nuances of the proposed moderation effect. Results of the post-hoc analysis showed that the effect of cognitive-emotional preoccupation with using Facebook on problematic use of Facebook varies based on one's level of cognitive-behavioral

control over using Facebook. This effect becomes non-significant for users with control abilities at least two standard deviations above the mean. These findings again point to similarities between IS use and other behaviors that are generally healthy (e.g., moderate alcohol consumption, eating), but have the potential to become problematic, if they are enacted spontaneously, in improper situations, and without proper control.

Finally, as explained in the post-hoc analyses, our findings show the importance of stimulus properties (number of friends on Facebook) and user characteristics (self-esteem) in influencing dual system factors, and ultimately the imbalance between the two systems. These findings contribute to dual systems research on the dark side of IS use by showing the importance of IT artifact properties as well as user characteristics that can influence the problematic use of IS. Specifically, our findings demonstrated a direct positive effect of number of friends on Facebook on the preoccupation with Facebook and an inverted U relation between self-esteem and inhibition capacities. These results can also explain the mixed findings in prior studies regarding the effect of self-esteem on self-regulation abilities [49].

Implications for Practice

Our findings also offer a range of practical implications for IT artifact designers, users, and educational institutions for controlling problematic IS use. First, our findings show that problematic use of IS has a strong association with an imbalance between system 1 and system 2 processes. Reflecting on the conceptualization and measurement of these factors, IT artifact designers can help users reduce their problematic use by making it easier to monitor and govern their use. They may do so by providing, for example, easy to observe usage statistics and warnings to users or intermediary facilities to limit the amount of time on the system, which can serve to increase awareness of the need to inhibit one's behavior and ultimately allow stronger

self-regulatory efforts [4] (providing that users are willing to use such intermediary systems). A case in point is a functionality incorporated in some of the videogame consoles, such as Xbox, that provides a "family timer" to limit the amount of time a family can use the console per day or per week [89]. Other examples are applications that provide usage statistics and warnings to Facebook users [e.g., 88] and/or prevent automatic use of Facebook by asking users for the purpose of the visit before it passes them to their Facebook pages (e.g., Focustimeapp.com). This approach can not only reduce the preoccupations with the systems, but also increase the concern and restrict dimensions of system 2, and ultimately help in facilitating cognitive-behavioral control over using the service.

That being said, it might be naive to assume that IT artifact designers are the only responsible parties for the formation and control of users' problematic behaviors; the users should also assume responsibility. In fact, users should also learn to better control their impulsions by understanding the nature of their problematic behavior and its risks, as well as avoiding the stimuli that can activate or strengthen their preoccupations. An example is switching off the notifications within the SNS to avoid stimulant cues, such as SNS notifications, that can instigate their system 1 toward using the SNS. In severe cases, when loss of control is established, users (at least those who are aware of the problematic behavior) can revert to psychological therapy aimed at correcting problematic behaviors, such as cognitive behavioral therapy [17].

With pressures to increase graduation rates and student success [2], the findings imply that educational institutions should also focus on helping students control their problematic IS use behaviors in classroom settings and possibly beyond. First, these institutions can create awareness of this problem through on-campus workshops explaining what is at risk, why students should be aware of and avoid problematic uses of IS, and how they can be prevented

[79]. This can follow the model of the National Institute on Alcohol Abuse and Alcoholism [61] that recommends workshops involving lectures and role-playing for reducing alcohol abuse on campus. Second, they can reduce problematic use of largely non-academic systems such as Facebook or video games by restricting the access to them in class. Although students can plausibly bypass these attempts using their own private devices (e.g., smartphones with data plans), even small reductions in problematic IS use behavior may help students improve their academic performance.

Future Research

This study can precede future studies in several different ways. First, the possible escalation in the prevalence of problematic use of IS [83], the scarcity of research on this issue [67], and the broad range of possible adverse consequences beyond the ones captured in this study [e.g., 47] warrant more research on this problem, its etiology, and consequences. A case in point is the effect of age on problematic use behaviors. As a control variable in our model, age is significantly and negatively associated with both problematic use of SNS and academic performance, which merits deeper theorization in future research. Another example is the role of students' cognitive, emotional, and behavioral engagement facets with school [64] in driving problematic IS use.

A second point that is worthy of further attention is the role of planning in the problematic use of IS. For example, although using Facebook while driving seems like a very impulsive and unplanned behavior, using Facebook in the middle of a face-to-face conversation might be less impulsive under certain circumstances (e.g., users may plan to seek additional conversation topics while talking face to face with people). As such, future research can shed more light on this issue and decompose the planned and unplanned aspects of problematic use behaviors.

Third, we measured a snapshot of problematic SNS use. This was based on an assumption of relative stability of the problematic behavior over time, which has been corroborated by our data. We measured problematic SNS use during one week in a semester and even this snapshot measurement was sufficient for identifying an effect on students' academic performance at a later time. Similarly, Meerkerk, et al. [60] have found a correlation of 0.83 between their measurements of compulsive use of Internet (a problematic behavior) at t_1 and one year later at t_2, which further supports the validity of our assumption that problematic behaviors are generally stable over time. Nonetheless, a deeper assessment of the stability of problematic use of SNS and generally problematic IS use represents an important avenue for future research, which can be addressed with longitudinal research designs.

Fourth, this study was done in a single context (SNS) and focused on the use of a single SNS, namely Facebook. While Facebook use is deemed to be prone to problematic behaviors [76-78, 80], it still remains to be seen how the dual-system perspective performs in explaining other types of problematic uses (e.g., work related) in other IS use settings (e.g., using a less hedonic IS). For instance, our model can possibly explain security misbehaviors, problematic video gaming, problematic online pornography usage, or texting while driving. Its application in such contexts should be examined in future research. Our findings should also be corroborated in different cultural settings, in different educational institutions (e.g., high schools), and with other adverse outcomes (e.g., car accidents), for increased generalizability.

Fifth, consistent with past research [e.g., 78], we allowed one-week gap between t_1 and t_2 to avoid “percept-percept” problem in the data [18]. Nonetheless, future research may extend the generalizability of our findings by testing different time lags between different waves of data collection.

Sixth, while this study focused on theory-driven, systematic, and overarching manifestations of system 1 and system 2 and a single adverse outcome of problematic use, namely academic performance, other relevant manifestations of systems 1 and 2[6] and their outcomes (e.g., physical and psychological well-being and the social relationship quality) should be examined in future research.

Seventh, given the importance of cognitive-emotional preoccupation and cognitive behavioral control in driving problematic use behaviors, it is also important to have a better understanding of their antecedents and moderators. While we tested two such antecedents, namely number of friends on Facebook (as a stimulus property), and users' self-esteem (as a personal characteristic), future research may consider other stimulus properties (e.g., type of social networking platform) and user's characteristics (e.g., personality and awareness) as plausible antecedents and/or moderators of the effects of cognitive-emotional preoccupation and cognitive behavioral control on problematic IS use behaviors [40]. Furthermore, given the largely hedonic nature of the target behavior in this study, future research may also focus on the "hedonic" antecedents that may excite system 1, such as enjoyment with the SNS.

Eighth, our findings corroborated that the dual-system perspective is a valid theoretical stance for explaining the etiology of problematic use of IS. In that sense, problematic use of IS is similar to some of the more established problematic behaviors such as alcohol consumption. This implies that it might be reasonable for IS researchers to further borrow from the established literature on problematic behaviors [e.g., 11] in an attempt to better understand problematic use of IS. Hence, we suggest that future research relies on the similarities observed between problematic use of IS

6- Some examples of such manifestations are automatic affective reactions vs. self-control [40], habit vs. self-regulation [67], stimulus bound system and higher order system [e.g., 74], heuristic processing vs. systematic processing [20], reflexive system and reflective system [e.g., 53], automatic stereotyping vs. suppression [26], and impulsive system and reflective system [e.g., 40].

and other more established problematic behaviors to further explore how other theories focusing on such behaviors [e.g., 52] can inform the study of problematic IS use. One example is theories helping with the design of the IT artifact [e.g., 88, 89] as they can play a role in facilitating increased control on problematic IS use.

Conclusion

This study advances a view based on dual-system theory to explain the problematic use of SNS, and possibly other IS. Our findings show that the problematic use of SNS is associated with a deficiency in the balance between two systems in the human mind, one that governs preoccupation and desire and the other that governs concern and inhibition. Consequently, when cognitive-emotional preoccupation is strong and cognitive-behavioral control is weak, people are more likely to engage in problematic use behaviors, which can ultimately result in adverse consequences for them. Our findings not only support this theory, but also show that the proposed dual-system view is superior to planned behavior-based models in explaining the problematic use of IS. The dual system view can therefore supplement planned behavior-based views in examining IS use behaviors. Therefore, this study can serve as a basis for future research on this important, yet underexplored, IS use phenomenon.

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Figures and Tables

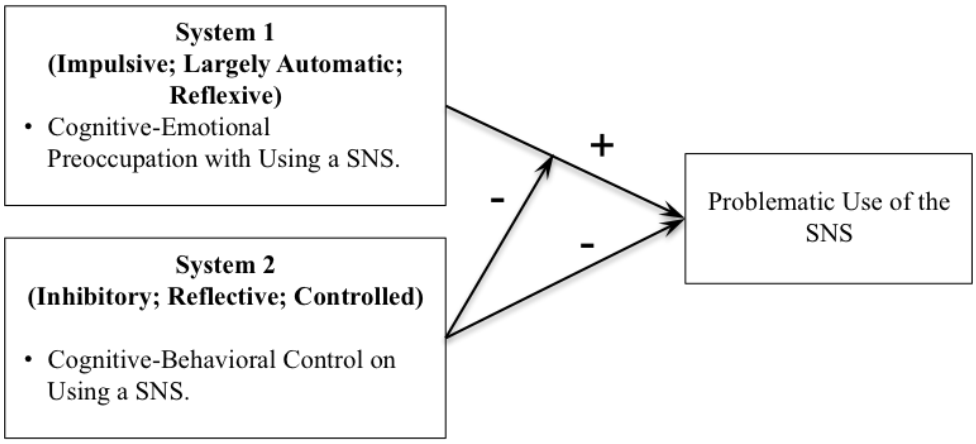


Figure 1. Problematic Use of an SNS from a Dual-System Perspective

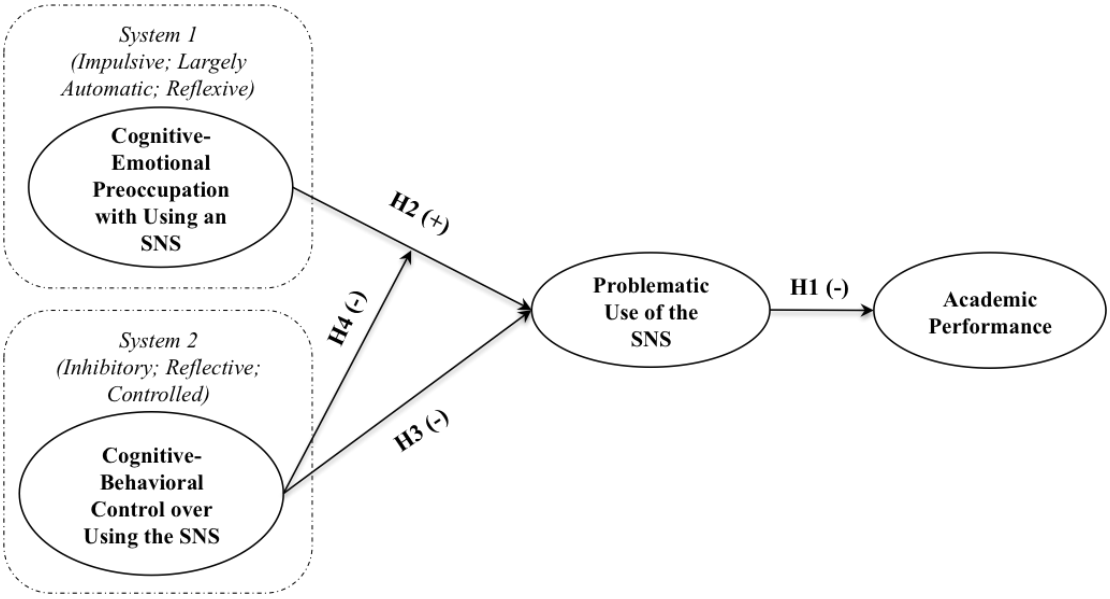
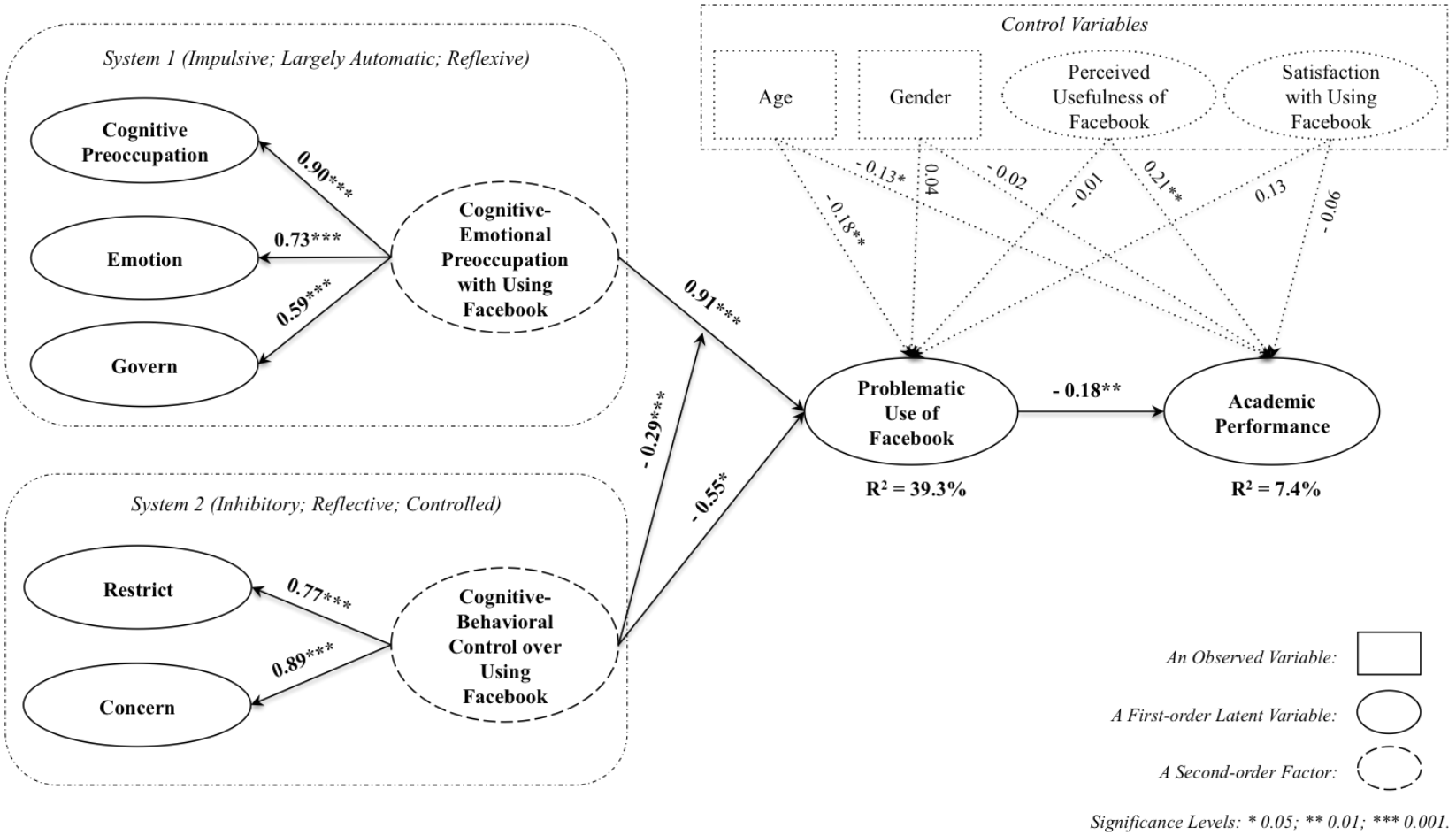


Figure 2. Research Model



N = 341;
Chi-square (430) = 884.06;
CFI = 0.94; IFI = 0.94; TLI = 0.93; SRMR = 0.079; RMSEA = 0.056 (95% Confidence Interval: 0.050 – 0.061).

Figure 3. Results of Hypotheses Testing using Covariance-based SEM

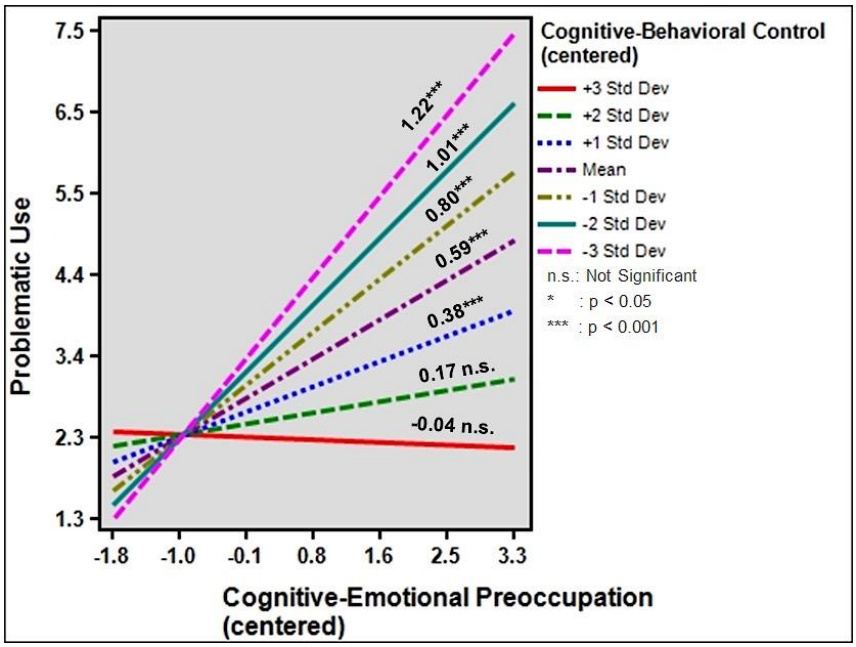


Figure 4. Interaction Effect Plot for H4

Table 1. Measurement Instrument

Factor & Reference	**Time**	**Measurement Items**
Emotion [23]	t_1	Reflecting on your experience with using Facebook, HOW OFTEN... (1=never, 7=Always) - When you feel anxious, you crave to use Facebook? - When you feel lonely, you feel an urge to use Facebook? - Do you ever feel so nervous that you really need to use Facebook?
Cognitive Preoccupation [23]	t_1	Reflecting on your experience with using Facebook, HOW OFTEN... (1=never, 7=Always) - Do you find yourself unable to stop thinking about using Facebook? - Is it hard to distract yourself from thinking about Facebook? - Do thoughts about using Facebook intrude into your daily activities?
Govern [23]	t_1	Reflecting on your experience with using Facebook: (Very little=1, Very High =7) - How much effort does it take for you to keep your Facebook use under control? - How much difficulty do you have controlling your Facebook use? Reflecting on your Facebook use, how often.... (1=never, 7=Always) - Do you find that once you start using Facebook it is difficult for you to stop?
Concern [23]	t_1	Reflecting on your experience with using Facebook, HOW OFTEN... (1=never, 7=Always) - Does the sight of Facebook make you think about limiting your use of it? - Does seeing news about Facebook stimulate concerns about the need to limit your Facebook use? - Does seeing other people using Facebook remind you of your efforts to control your use of Facebook?

Factor & Reference	Time	Measurement Items
Restrict [23]	t_1	Reflecting on your experience with using Facebook, HOW OFTEN... (1=never, 7=Always) - Do you ever cut back on using Facebook in an attempt to change your Facebook use habits? - Do you attempt to cut down using Facebook? - Do feelings of guilt about too much use of Facebook help you to control your Facebook use?
Problematic Use of Facebook [85]	t_2	Over the PREVIOUS WEEK, how often did you use Facebook... (1=very rarely/never, 7=very often) - While in class (not for school purposes)? - While driving (even just checking)? - While talking face to face with people? - While at work (not for work purposes)?
Academic Performance [62]	t_3 and t_4	(Objective measures taken from university systems) - Student's GPA for the semester in which the survey was administered (t3). - Student's GPA for the semester one year after the survey was administered (t4) - Student's Cumulative GPA one year after the survey was administered (t4).
Perceived Usefulness of Facebook [10]	t_1	Reflecting on your experience with using Facebook, please indicate HOW MUCH you agree with the following statements: (Strongly Disagree=1, Strongly Agree =7) - Using Facebook improves my academic performance. - Using Facebook improves my academic productivity. - Using Facebook improves my academic effectiveness.
Satisfaction with using Facebook [10]	t_1	Reflecting on your experience with using Facebook, please indicate HOW DO YOU FEEL about your overall experience of Facebook use: - 1: Very Dissatisfied – 7: Very Satisfied. - 1: Very Displeased – 7: Very Pleased - 1: Very Frustrated – 7: Very Contended. - 1: Absolutely Terrible – 7: Absolutely Delighted.
Self-esteem [65]	t_1	Below is a list of statements dealing with your general feelings about yourself. Please indicate how strongly you agree or disagree with each statement (Strongly Disagree=1, Strongly Agree =5). - I feel that I am a person of worth, at least on an equal plane with others. - I feel that I have a number of good qualities. - All in all, I am inclined to feel that I am a failure. - I am able to do things as well as most other people. - I feel I do not have much to be proud of. - I take a positive attitude toward myself. - On the whole, I am satisfied with myself. - I wish I could have more respect for myself. - I certainly feel useless at times. - At times I think I am no good at all.

Table 2. Descriptive Statistics, Reliabilities, Square Roots of AVEs (in bold on diagonal), and Correlations

	Mean (SD)	**CR (Alpha)**	**Kurtosis (Skew)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
(1) Govern	3.1 (1.4)	0.88 (0.87)	-0.50 (0.31)	**0.84**												
(2) Restrict	3.0 (1.4)	0.97 (0.90)	-0.51 (0.37)	0.55	**0.86**											
(3) Emotion	2.9 (1.4)	0.88 (0.88)	-0.22 (0.50)	0.56	0.50	**0.84**										
(4) Concern	2.7 (1.4)	0.89 (0.88)	-0.60 (0.43)	0.58	0.68	0.59	**0.85**									
(5) Cognitive Preoccupation	2.4 (1.3)	0.88 (0.88)	0.14 (0.86)	0.66	0.59	0.61	0.69	**0.84**								
(6) Problematic Use of Facebook	2.7 (1.3)	0.76 (0.75)	-0.60 (0.54)	0.34	0.16	0.32	0.25	0.33	**0.72**							
(7) Academic Performance	2.8 (0.4)	0.92 (0.90)	0.88 (0.26)	-0.01	-0.02	0.02	0.01	-0.07	-0.14	**0.89**						
(8) Age (C)	23 (4.4)	NA	NA	-0.12	-0.08	-0.05	-0.08	-0.02	-0.20	-0.07	NA					
(9) Gender(C)	0.52 (0.5)	NA	NA	0.08	0.11	0.09	0.13	0.06	0.05	-0.05	-0.05	NA				
(10) Perceived Usefulness (C)	4.7 (1.3)	0.89 (0.89)	0.07 (-0.49)	0.03	-0.16	0.05	-0.10	-0.06	0.09	0.12	0.01	-0.13	**0.85**			
(11) Satisfaction (C)	5.2 (1.2)	0.94 (0.94)	0.08 (-0.43)	0.03	-0.11	0.05	-0.08	0.03	0.19	-0.03	-0.01	0.02	0.5	**0.9**		
(12) Number of Friends (P)	348 (490)	NA	5.73* (44.3)*	0.17	0.04	0.10	0.11	0.13	0.12	-0.08	-0.16	0.02	0.11	0.18	NA	
(13) Self-esteem (P)	3.9 (0.8)	0.91 (0.90)	-0.49 (-0.13)	-0.18	-0.22	-0.24	-0.22	-0.25	-0.05	0.05	0.02	-0.14	0.16	0.26	0.11	**0.71**

SD: Standard Deviation; CR: Composite Reliability; Alpha: Cronbach's Alpha; Skew: Skewness; (C): Control; (P): Exclusively Used in the Post-hoc Analyses.
* Due to serious deviation from normality, the log-transformed scores of this factor were used in the post-hoc analysis. Log transformation changed kurtosis to 1.9 and skewness to -1.06.

Table 3. Results of Model Comparisons

Factors	Alternative Model 1 (Planned Behavior)	Alternative Model 2 (Dual-System Perspective)	Alternative Model 3 (Combined Perspective)
Perceived Usefulness of Facebook	-0.01	NA	-0.01
Satisfaction with Using Facebook	0.26***	NA	0.13
Cognitive-Emotional Preoccupation with Using Facebook (CEP)	NA	0.98***	0.94***
Cognitive-Behavioral Control on Using Facebook (CBC)	NA	-0.61*	-0.57*
CEP × CBC	NA	-0.30***	-0.29***
Gender	0.03	0.05	0.04
Age	-0.20***	-0.17**	-0.18**
Variance Explained (R2)	11%	38%	40%
R2 Change	11%	27%	2%
Adjusted R2	10%	38%	40%
Chi-square	130.76	496	737
Degree of freedom (df)	57	193	348
RMSEA	0.062	0.068	0.057
(95% Confidence Interval)	(0.048, 0.076)	(0.061, 0.075)	(0.052, 0.063)
SRMR	0.044	0.098	0.079
CFI	0.97	0.93	0.94
IFI	0.97	0.93	0.94
TLI	0.96	0.92	0.93

* p<0.05; ** p<0.01; *** p<0.001; NA: Not Applicable.

Problematic Use of Social Networking Sites: Antecedents and Consequence from a Dual System Theory Perspective

Appendix A – Preliminary Assessment

In order to ensure the validity of all measurement items, a series of initial assessments were performed. First, the measures were presented to a group of 15 Facebook users (students and faculty) and based on their feedback, minor adjustments were applied. Next, a pilot study was performed using the refined measurement items with a separate sample of 60 undergraduate students who were Facebook users. These participants were not part of the sample in the main data collection rounds. The purpose of the pilot study was to ensure the reliability and validity of the measurement items as well as the procedures, before commencing with data collection for

research model validation. Participants in the pilot study were asked to complete an online survey based on the measurement items outlined in Table 1 in the main manuscript and using the same procedures we used for data collection described in the main manuscript (i.e., collecting data at multiple time points).

Descriptive statistics, reliability scores, and inter-factor correlations for the factors were calculated. As demonstrated in Table A1, all factors were internally consistent with Cronbach's α and Fornell and Larcker [7]'s composite reliability scores above 0.7 [18]. Moreover, the results demonstrated strong convergent and discriminant validity with square root of AVE scores over 0.7 and exceeding the corresponding correlations with other factors [22]. Furthermore, the results indicated that data distributions were acceptable with kurtosis and skewness indices with the range of -0.75 to 1.1 [13, 17]. In addition, variance inflation factor (VIF) indices of less than 2 indicated that multicollinearity was not an issue in these data [17]. Overall, it was concluded that the measurement instruments were sufficiently valid and reliable. This increased our confidence that the measures and procedures can be used in the main study (the cross loadings based on the main sample are provided in Table A2).

Table A4. Descriptive Statistics, Reliabilities, and Correlations for Pilot Sample

	Mean (SD)	CR (Alpha)	**Kurtosis (Skewness)**	1	2	3	4	5	6	7	8
(1) Govern	3.2 (1.3)	0.88 (0.87)	0.27 (0.64)	**0.84**							
(2) Restrict	3.4 (1.5)	0.97 (0.90)	-0.29 (0.26)	0.60	**0.86**						
(3) Emotion	3.2 (1.4)	0.88 (0.88)	-0.55 (0.10)	0.71	0.54	**0.84**					
(4) Concern	3.0 (1.5)	0.89 (0.88)	-0.23 (0.52)	0.63	0.68	0.59	**0.85**				
(5) Cognitive Preoccupation	2.4 (1.2)	0.88 (0.88)	1.1 (1.1)	0.73	0.62	0.69	0.69	**0.84**			
(6) Problematic Use of Facebook	3.0 (1.4)	0.76 (0.75)	-0.75 (0.51)	0.47	0.23	0.52	0.41	0.47	**0.72**		
(7) Academic Performance	2.7 (0.4)	0.92 (0.90)	0.04 (0.83)	-0.13	0.049	-0.022	0.105	-0.061	-0.175	**0.89**	

(8) Self-esteem	3.3 (0.3)	0.91 (0.90)	0.11 (-0.64)	0.24	0.21	0.26	0.22	0.23	0.01	0.01	**0.70**

Note 1: Square Root of Average Variance Extracted (AVE) scores are on the diagonal (bold and shaded).
Note 2: CR: Composite Reliability; Alpha: Cronbach Alpha.

Table A5. Cross Loadings of Measures and Factors for the Main Sample

	CogPre t_1	Emotion t_1	Govern t_1	Restrict t_1	Concern t_1	Self-Esteem t_1	Problematic Use t_2	GPA t_3 - t_4	PU t_1	SAT t_1
CogPre1	**0.904**	0.532	0.585	0.517	0.612	-0.247	0.284	-0.092	-0.084	0.037
CogPre2	**0.914**	0.530	0.568	0.545	0.597	-0.214	0.312	-0.019	-0.061	0.051
CogPre3	**0.878**	0.589	0.626	0.557	0.621	-0.241	0.277	-0.045	-0.012	0.007
Emtn1	0.565	**0.919**	0.520	0.510	0.545	-0.240	0.284	0.029	0.034	0.053
Emtn2	0.486	**0.877**	0.495	0.404	0.468	-0.173	0.277	0.041	0.093	0.071
Emtn3	0.586	**0.892**	0.482	0.444	0.579	-0.242	0.301	0.011	0.002	0.022
Gvrn1	0.576	0.497	**0.922**	0.465	0.524	-0.148	0.309	0.021	0.032	0.052
Gvrn2	0.563	0.482	**0.905**	0.456	0.484	-0.205	0.288	-0.003	0.028	-0.018
Gvrn3	0.611	0.502	**0.838**	0.559	0.527	-0.158	0.319	-0.029	0.018	0.073
Rstrct1	0.489	0.435	0.538	**0.906**	0.601	-0.202	0.121	0.013	-0.142	-0.089
Rstrct2	0.486	0.390	0.471	**0.911**	0.587	-0.181	0.124	-0.057	-0.196	-0.100
Rstrct3	0.627	0.527	0.510	**0.907**	0.652	-0.256	0.170	-0.007	-0.090	-0.092
Cncrn1	0.622	0.579	0.539	0.654	**0.892**	-0.233	0.201	-0.003	-0.060	-0.085
Cncrn2	0.598	0.531	0.519	0.593	**0.941**	-0.227	0.289	0.054	-0.098	-0.018
Cncrn3	0.631	0.506	0.512	0.613	**0.867**	-0.177	0.183	-0.020	-0.100	-0.088
SlfEst1	-0.227	-0.142	-0.097	-0.152	-0.188	**0.706**	-0.031	0.048	0.266	0.267
SlfEst2	-0.206	-0.157	-0.095	-0.198	-0.198	**0.764**	-0.050	0.083	0.281	0.255
SlfEst3	-0.188	-0.141	-0.126	-0.141	-0.135	**0.679**	-0.035	0.051	0.137	0.250
SlfEst4	-0.204	-0.180	-0.129	-0.201	-0.222	**0.712**	-0.079	0.112	0.237	0.154
SlfEst5	-0.160	-0.119	-0.123	-0.132	-0.122	**0.579**	0.020	0.068	0.034	0.217
SlfEst6	-0.091	-0.173	-0.037	-0.146	-0.137	**0.724**	-0.031	-0.029	0.177	0.269
SlfEst7	-0.145	-0.202	-0.087	-0.137	-0.132	**0.586**	0.020	-0.020	0.124	0.233
SlfEst8	-0.214	-0.225	-0.218	-0.217	-0.188	**0.674**	-0.046	-0.006	0.054	0.092
SlfEst9	-0.189	-0.198	-0.142	-0.150	-0.146	**0.774**	-0.050	0.025	-0.048	0.092
SlfEst10	-0.187	-0.205	-0.200	-0.169	-0.146	**0.812**	-0.075	-0.008	0.059	0.160
ProbUse1	0.255	0.244	0.278	0.083	0.190	-0.102	**0.768**	-0.132	0.167	0.219
ProbUse2	0.237	0.218	0.209	0.141	0.160	-0.068	**0.707**	-0.106	-0.018	0.075
ProbUse3	0.270	0.292	0.305	0.167	0.256	-0.059	**0.765**	-0.086	0.051	0.148
ProbUse4	0.218	0.212	0.235	0.093	0.164	-0.023	**0.780**	-0.135	0.091	0.200
GPA1	-0.002	0.074	0.068	0.008	0.064	0.064	-0.128	**0.948**	0.154	0.019
GPA2	-0.027	0.051	0.003	0.010	0.023	0.011	-0.153	**0.937**	0.113	-0.032
GPA3	-0.126	-0.042	-0.078	-0.067	-0.032	0.083	-0.139	**0.890**	0.083	-0.070
PU1	-0.075	0.005	0.013	-0.162	-0.102	0.141	0.062	0.104	**0.853**	0.397
PU2	-0.037	0.046	0.008	-0.133	-0.087	0.182	0.116	0.086	**0.928**	0.454
PU3	-0.059	0.062	0.057	-0.126	-0.078	0.196	0.099	0.153	**0.924**	0.407

Sat1	0.096	0.097	0.084	-0.061	0.003	0.242	0.246	-0.048	0.450	**0.939**
Sat2	0.021	0.036	0.009	-0.128	-0.082	0.208	0.195	-0.034	0.443	**0.930**
Sat3	-0.028	0.000	0.015	-0.105	-0.108	0.203	0.171	-0.003	0.429	**0.916**
Sat4	0.019	0.044	0.032	-0.094	-0.067	0.186	0.184	-0.021	0.388	**0.892**

Appendix B – Preliminary Analyses

A series of preliminary data analyses ensured the absence of artifacts that could compromise the quality of analyses: (1) low reliability of factors [18], (2) low validity of factors [22], (3) serious deviations from normality assumption [17], (4) multicollinearity among the factors [17], and (5) common method variance (CMV) bias [22]. To that end, the descriptive statistics, kurtosis and skewness indices, average variance extracted (AVE) scores, reliability scores, and inter-factor correlations were calculated for the factors, as outlined in Table 2. Furthermore, a confirmatory factor analysis (CFA) model using AMOS version 23 was estimated to ensure the goodness-of-fit of the measurement model.

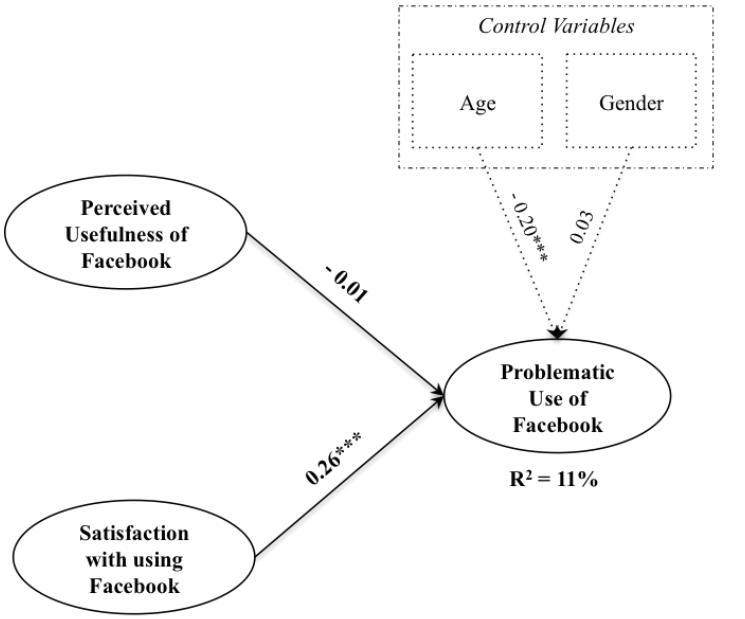
The results of these analyses demonstrated that all factors were internally consistent with Cronbach's α and Fornell and Larcker [7]'s composite reliability scores well above 0.7 [18]. Moreover, the results also demonstrated strong convergent and discriminant validity with (1) square root of AVE scores over 0.7 that exceeded the corresponding correlations with other factors [22]; and (2) all items had larger loadings on their corresponding factors compared to their cross-loadings with the other factors, by the difference magnitude of larger than 0.2 [22] (See Appendix A for details). Furthermore, the kurtosis and skewness indices were between ±2, which ensured no serious deviations from normality [17]. Moreover, variance inflation factor (VIF) indices of less than 2.21 indicated that multicollinearity was not an issue in these data [17]. Furthermore, the CFA estimation showed that the measurement model fits the data well (RMSEA = 0.053 with 95% confidence interval of (0.047 – 0.059); SRMR = 0.049; CFI = 0.95; IFI = 0.95; and TLI = 0.95).

Lastly, we took precautions to ensure that the results are not biased by common method variance (CMV). Specifically, we collected data over four different points in time [14] and used a mix of

self-reported instruments and objective data [21] for estimating our research model. These steps are expected to reduce CMV risks.

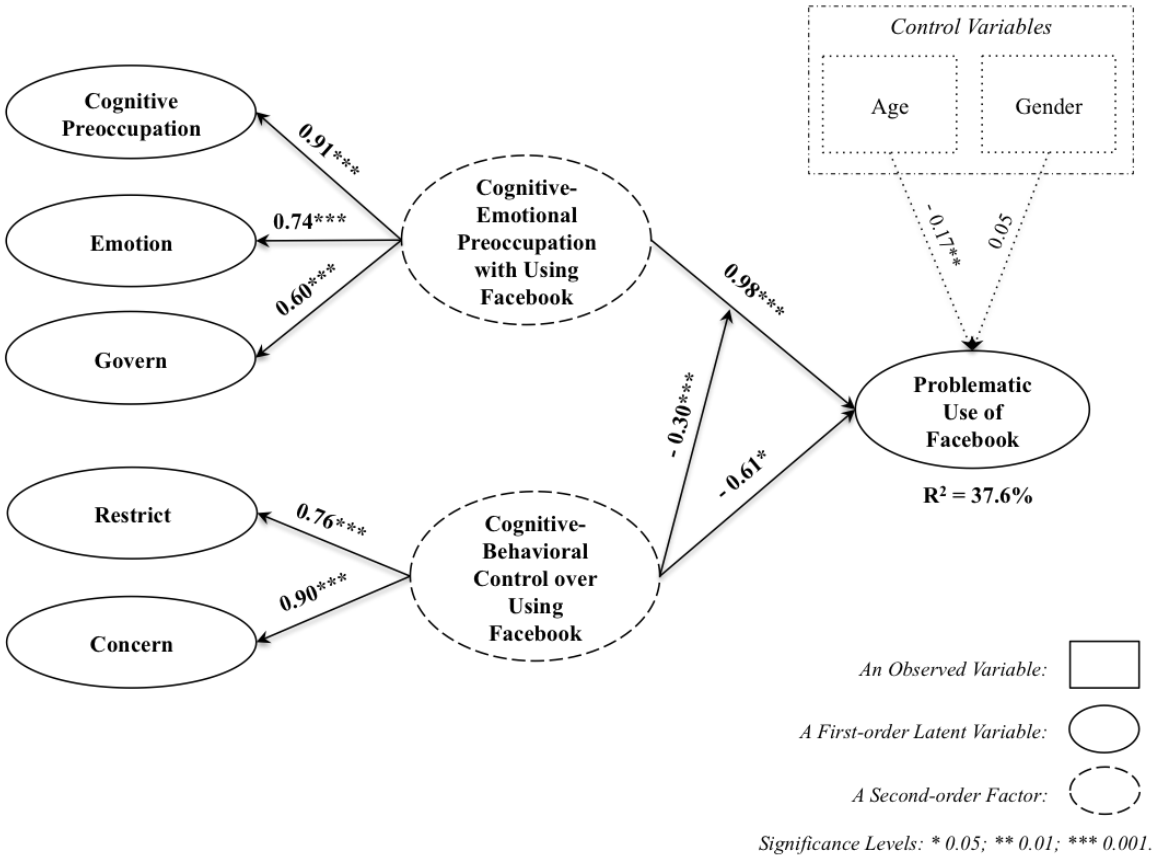
In addition to the precautionary steps, we also tested for potential CMV distortions. Specifically, we used two different methods to minimize the drawbacks of each of the single CMV assessment method [16, 20]. First, Harman's single factor test was performed by subjecting the measurement items to a principal component analysis (PCA) with no rotation. This method produced several components that cumulatively explained 71.1% of the variance, and the largest component captured 39.1% of the variance. Therefore, CMV did not seem to be an issue in this study, based on this method. Second, a common latent factor [16, 20] that captures the communal variance of all model indicators was added to a confirmatory factor analysis (CFA) model which included all of the model's factors. The CFA model was then estimated with and without this common latent factor and the differences in loadings were found to be negligible (0.00–0.08) and below the 0.2 cutoff. Taken together, both methods indicated that a bias as a result of CMV is unlikely to be pertinent in these data.

Appendix C – Alternative Models 1 to 3



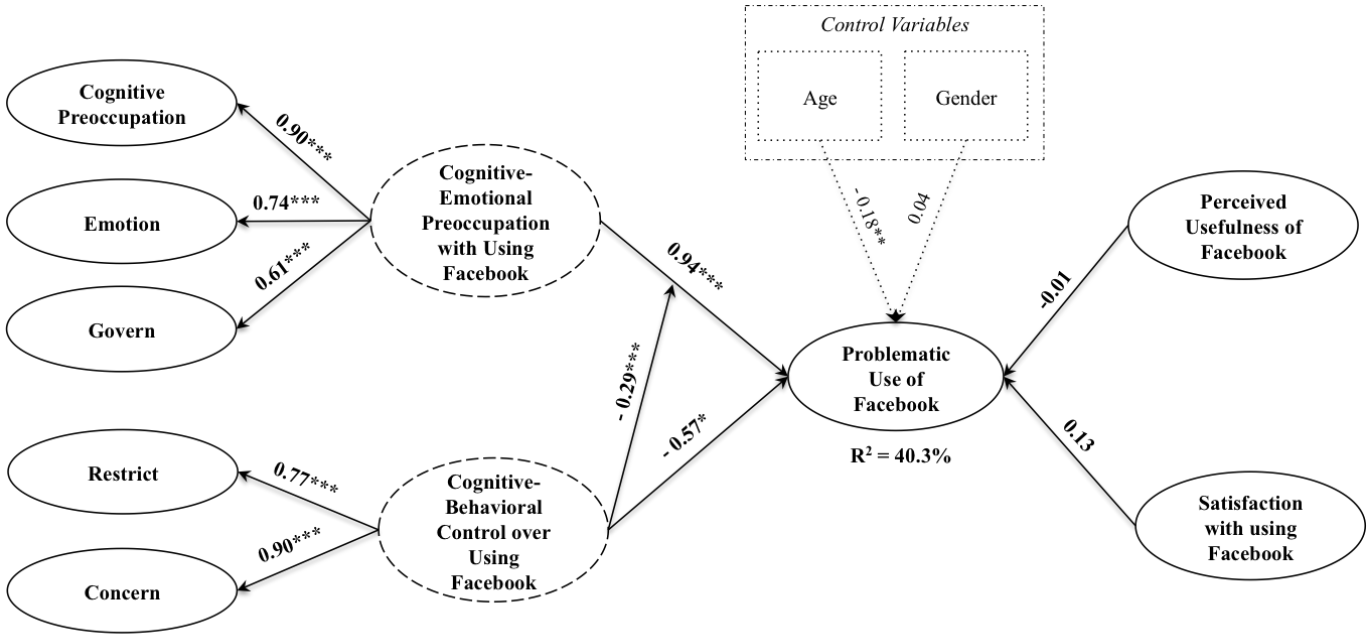
N = 341;
Chi-square (57) = 131;
CFI = 0.97; IFI = 0.97; TLI = 0.96; SRMR = 0.044; RMSEA = 0.062 (95% Confidence Interval: 0.048 – 0.076).

Figure C1. Alternative Model 1



N = 341;
Chi-square (193) = 496;
CFI = 0.93; IFI = 0.93; TLI = 0.92; SRMR = 0.098; RMSEA = 0.068 (95% Confidence Interval: 0.061 – 0.075).

Figure C2. Alternative Model 2



N = 341;
Chi-square (348) = 737;
CFI = 0.94; IFI = 0.94; TLI = 0.93; SRMR = 0.079; RMSEA = 0.057 (95% Confidence Interval: 0.052 – 0.063).

Figure C3. Alternative Model 3

Appendix D – Effect of Imbalance between Systems 1 and 2 on the Problematic Use of Facebook

The results of the SEM analysis imply that the *imbalance* between system 1 and system 2 drives the problematic use of Facebook. In this post-hoc analysis, we shed more light on this issue by directly testing the role of the imbalance between cognitive-emotional preoccupations and cognitive-behavioral control, rather than these two factors, in driving problematic use of Facebook. To do so, we conducted two analyses.

First, we split the sample into two subgroups based on low and high extent of problematic use of Facebook using an average (2.74) split. The imbalance between cognitive-emotional preoccupations (CEP) and cognitive-behavioral control (CBC) was calculated as the difference between the standardized scores of the two factors (i.e., imbalance = CEP – CBC). Next, using the same control variables in the SEM analysis as covariates (i.e., age, gender, perceived usefulness, and satisfaction), an analysis of covariance (ANCOVA) was conducted to investigate differences in the imbalance score between the two subgroups. The results showed that, in line with theories of problematic behavior as applies to information systems [24, 25], the imbalance between cognitive-emotional preoccupations and cognitive-behavioral control is significantly ($p < 0.05$) lower among the subgroup with low problematic use (-0.085) as compared to the subgroup with high problematic use (0.09).

Second, a hierarchical regression, using Enter method and with the same set of control variables, regressed the problematic use of Facebook on the imbalance scores. Similar to the results of the ANCOVA analysis, the results showed that the imbalance significantly and positively explains the extent of problematic use of Facebook ($\beta_{\text{imbalance}} = 0.201$, ΔR^2

= 0.038, $p < 0.001$). In other words, as the imbalance or gap between cognitive-emotional preoccupations and cognitive-behavioral control grows larger, the extent of problematic use of Facebook increases, which is consistent with the dual-system perspective on the etiology of problematic behaviors [23].

Appendix E –Examination of Two Precursors of Systems 1 and 2

Prior research on the dual system [e.g., 8] has pointed to external stimuli and personal characteristics as potential precursors of system 1 and system 2. Although a comprehensive study of precursors of systems 1 and 2 is beyond the scope of this study, a glance into such factors can be illuminating for future research in this area. To that end, we examined post-hoc the effects of a stimulus property, namely users' number of Facebook friends, and a personal characteristic, namely self-esteem, respectively as precursors of users' cognitive-emotional preoccupations with using Facebook and cognitive-behavioral control over using Facebook.

Prior research [e.g., 9, 10, 11] has discussed the importance of stimulus properties and their salience for the individuals in activating the impulsions toward a problematic behavior. In the problematic eating (i.e., overeating) domain, for example, it has been found that dieters are significantly more likely to engage in problematic eating behavior after pre-exposure to a tempting food stimuli, including sight, smell, and taste of tempting-foods [6, 9]. In the context of Facebook use, this relation has been explained in light of "variable rewards" theory [15]; impulsive responses to Facebook stimuli (images) have also been demonstrated [23].

Users check their Facebook, looking for hedonic rewards in form of pleasures in socializing with friends or receiving "likes" or "comments" on their posts and photos. When the human brain is expecting a reward, it surges the levels of dopamine, which is the neurotransmitter that drives us to seek, want, and explore [15, 19]. A simple notification from Facebook provides the stimulant cue for a reward (a message, a "like", or a "comment" from a friend). However, the potential reward is not predictable (it is

variable) and the curiosity as a result of the variability of the reward is a perfect trigger to inundate the brain with dopamine that is geared towards wanting and seeking [15]. As such, it generates strong impulsions toward checking Facebook in sought for the reward, which in some cases (e.g., while driving, attending a class) can, in turn, result in a problematic use behavior.

An important Facebook feature that influences the variability of the hedonic reward is the number of friends the user possesses on Facebook. The larger the number of friends is, the more variable the reward can be. This is because when the network is larger, the variability of the reward (likelihood of receiving “likes” or “comments”) is larger: some friends will provide more content and feedback, such as "likes", and others will provide fewer content and feedback. Cues related to Facebook (e.g., notifications) are also more likely to appear when one’s network is large [23]. In addition, it is reasonable to assume that the information users receive will vary more when their network is large as oppose to when it is small and narrowly focused on limited number of topics, locations, and people [5]. Hence, a larger network should increase the the number of Facebook cues a person is exposed to and reward variability. As such, *one can expect that the number of friends on Facebook should be positively associated with cognitive-emotional preoccupations with using Facebook.*

Self-esteem, as a potential precursor of users’ cognitive-behavioral control over using Facebook, captures a person’s “confidence in one's own worth or abilities”. Self-esteem is known to influence one’s self-regulation and control over the behaviors. In fact, Baumeister [2] explains that decreases in self-esteem are generally accompanied by negative affect such as anxiety, emotional distress, and depression, which tax self-control

abilities. A threat to one's self-esteem, such as engaging in a problematic behavior, presents the person with a choice between either accepting the bad evaluation, which results in lowering one's self-appraisal or maintaining self-esteem by inhibiting the threat (the problematic behavior or the impulsions toward it). While, people with higher levels of self-esteem (more confidence in their worth and abilities) are generally reluctant to revise the evaluations of their self-esteem downward and try to inhibit the threat, people with lower self-esteem are likely to choose the response that offer an immediate escape from the negative affect and the threat. Hence, they focus on short-term hedonic rewards of the problematic behavior, while ignoring long-term risks and negative consequences associated with them, which can result in lower levels of self-regulations and control over the problematic behaviors [3, 4, 12]. Therefore, we expect lower levels of self-esteem to be associated with lower cognitive-behavioral control over the problematic use of Facebook.

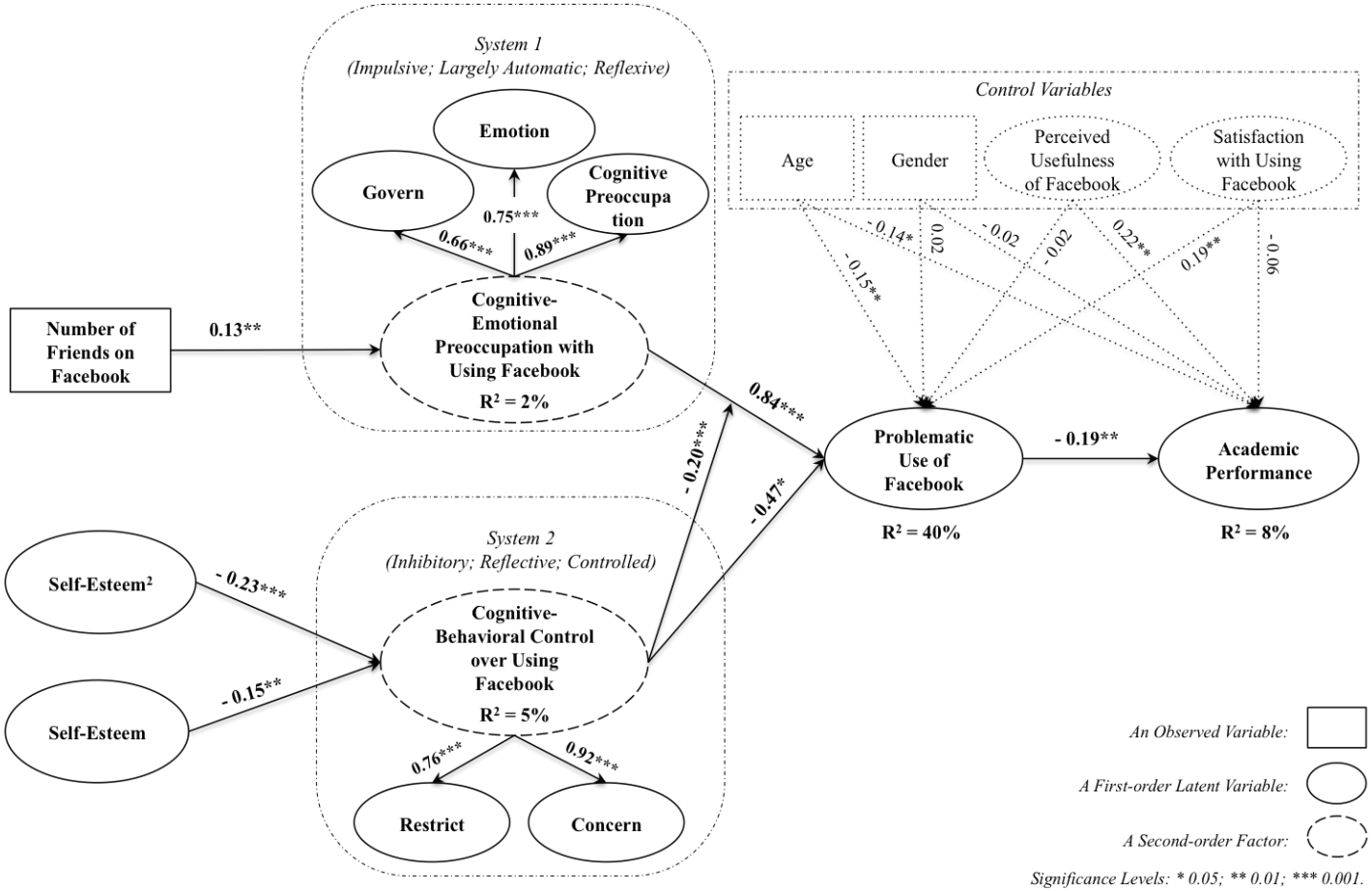
While higher levels of self-esteem are generally considered as a positive antecedent of self-regulation [2], research on self-esteem and self-regulation [e.g., 1] has warned against too much self-esteem. Too much self-esteem is associated with unrealistically high confidence in one’s abilities. This “over-confidence” tends to cause people to overestimate their ability and what they can accomplish, which can lead to lack of adequate focus and energy invested in regulating and controlling the problematic behaviors. As such, we expect too much self-esteem to be associated with lower cognitive-behavioral control over the problematic use of Facebook. Therefore, all things considered, we contend that there is likely a quadratic, inverted U relationship between user’s level of self-esteem and the cognitive-behavioral control over using Facebook.

The results of SEM analysis as depicted in Figure E1 supported our theoretical contentions by showing a significantly positive relation between users' number of Facebook friends[7] and cognitive-emotional preoccupation (0.13, $p < 0.01$) and a significant inverted U (quadratic) relation (see Figure E2) between users' self-esteem and their cognitive-behavioral control (-0.23, $p < 0.001$).

In order to shed more light on the inverted U relation between self-esteem and cognitive-behavioral control, a hierarchical regression analysis, using Enter method, was performed. In the first step, average self-esteem values were inserted, followed by the squared values of average self-esteem in the second step. Consistent with the results of the aforementioned SEM analysis, the results of the hierarchical regression showed significant inverted U relation between self-esteem and cognitive-behavioral control ($\beta_{\text{squared self-esteem}} = -0.192$, $\Delta R^2 = 0.021$, $p < 0.01$).

Furthermore, we also calculated the direct, indirect and total effects of number of Facebook friends (log scores), self-esteem (squared scores), cognitive-emotional preoccupations with using Facebook, and cognitive-behavioral control over using Facebook on problematic use of Facebook, and academic performance (see Tables E1 and E2). The significant total effects of these variables demonstrate their importance in the etiology of problematic use of Facebook and its adverse effects on academic performance.

7- Due to deviations from the normality assumption, the number of Facebook friends was log-transformed before using it in the post-hoc SEM analysis.



N = 341;
Chi-square (517) = 1061.07;
CFI = 0.93; IFI = 0.93; TLI = 0.92; SRMR = 0.079; RMSEA = 0.056 (95% Confidence Interval: 0.051 – 0.060).

Figure E1. Research Model Extended with Two Antecedents of Systems 1 and 2

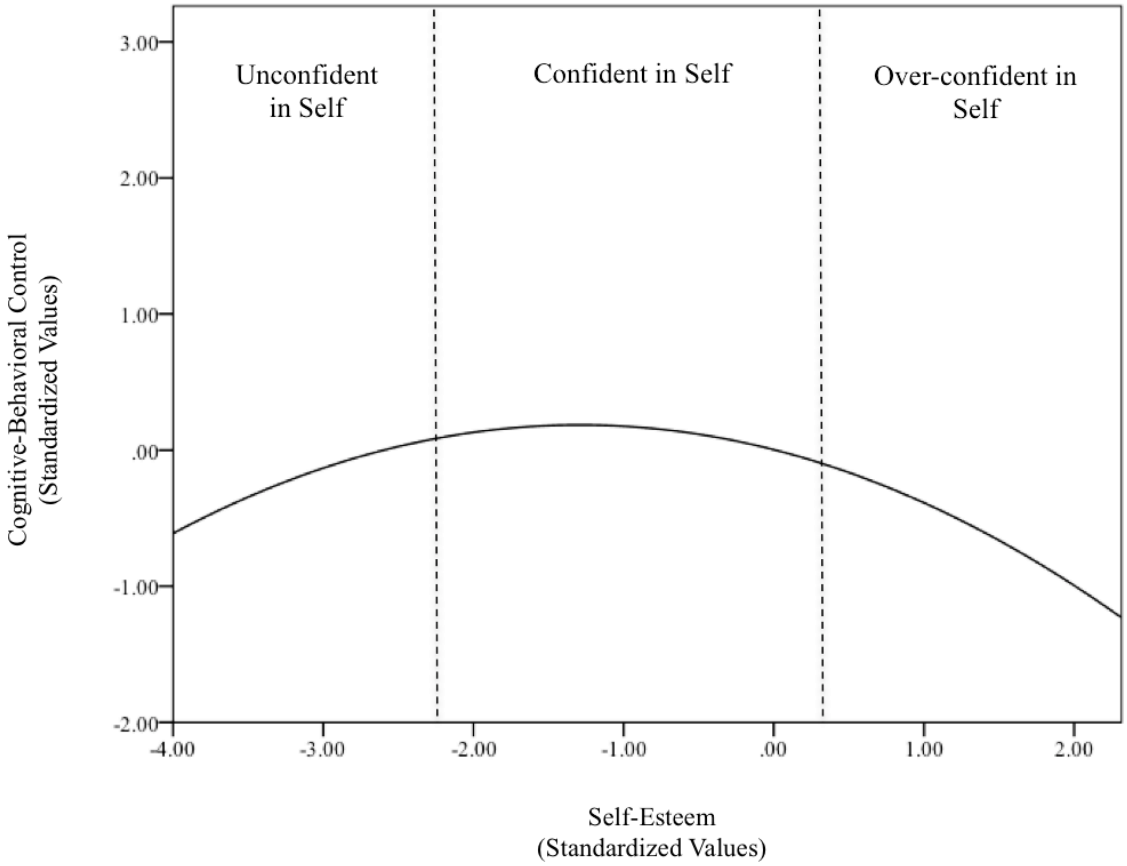


Figure E2. Inverted U Relation Between Self-Esteem and Cognitive-Behavioral Control

Table E1. Total Effects on Problematic Use of Facebook

Variable	Standardized Indirect Effect	Standardized Direct Effect	Standardized Total Effect
Number of Friends on Facebook (log values)	0.11 (0.04, 0.194); p = 0.005		0.11 (0.04, 0.194); p = 0.005
Self-Esteem (squared*)	0.11 (0.018, 0.401); p = 0.033		0.11 (0.018, 0.401); p = 0.033
Cognitive-Emotional Preoccupation with Using Facebook		0.84 (0.506, 1.385) p = 0.002	0.84 (0.506, 1.385) p = 0.002
Cognitive-Behavioral Control over Using Facebook		-0.47 (-1.04, -0.117); p = 0.027	-0.47 (-1.04, -0.117); p = 0.027

Note:
** An inverted U relation.*

Table E2. Total Effects on Academic Performance (GPA)

Variable	Standardized Indirect Effect	Standardized Direct Effect	Standardized Total Effect
Number of Friends on Facebook (log values)	-0.02 (-0.05, -0.006); p = 0.006		-0.02 (-0.05, -0.006); p = 0.006
Self-Esteem (squared*)	-0.02 (-0.10, -0.003); p = 0.025		-0.02 (-0.10, -0.003); p = 0.025
Cognitive-Emotional Preoccupation with Using Facebook	-0.16 (-0.34, -0.059); p = 0.005		-0.16 (-0.34, -0.059); p = 0.005
Cognitive-Behavioral Control over Using Facebook	0.09 (0.019, 0.264); p = 0.018		0.09 (0.019, 0.264); p = 0.018
Problematic Use of Facebook		-0.19 (-0.30, -0.072); p = 0.005	-0.19 (-0.30, -0.072); p = 0.005

Note:
** An inverted U relation.*

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