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A dynamic longitudinal examination of social media use, needs, and gratifications among college students

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ABSTRACT

This study extends the U&G theoretical perspective to account for the situated, adaptive, and dynamic nature of mediated cognition and behavior. It specifies dynamic uses and gratifications of social media (compared to other media) in the everyday lives of college students using experience sampling data across 4 weeks. The study tests and quantifies reciprocal causal relationships between needs, social media use, and gratifications, as well as their self-sustaining endogenous (i.e., feedback) effects. Social media use is significantly driven by all four categories of needs examined (emotional, cognitive, social, and habitual), but only gratifies some of them. Ungratified needs accumulate over time and drive subsequent social media use. Interpersonal social environments also affect social media use. In particular, solitude and interpersonal support increase social media use, and moderate the effects of needs on social media use.

1. Introduction

Social media (SM) have become increasingly pervasive in American society. As of 2011, two thirds (65%) of adult internet users engage in activities on social networking sites, compared to less than one third (29%) 3 years ago, and less than one tenth (8%) 6 years ago (Madden & Zickuhr, 2011). For young adults between 18 and 29 years old, social media use is even more common—as of 2010, it was at 72% (Lenhart, Purcell, Smith, & Zickuhr, 2010). Media campaigns, including health and political campaigns, try to identify effective ways to reach, engage, and influence SM users (e.g., Abroms & Lefebvre, 2009; Cooke & Buckley, 2008). Some basic questions to be answered include: What needs drive individuals' SM use? Are they fulfilled? How are the fluctuations in the needs and their fulfillment—or lack thereof—changing users' behavior over time? Uses and gratifications (U&G) research has started to examine what motivates SM use (e.g., Dunne, Lawlor, & Rowley, 2010; Leung, 2009).

The current study aims to extend the U&G theoretical perspective to account for the situated, adaptive, and dynamic nature of cognition and behavior (Wang, Busemeyer, & Lang, 2006; Wang, Lang, & Busemeyer, 2011; Ward, 2002). By this theoretical extension, SM use can be better understood in two important ways. First, dynamic reciprocal causal effects between SM use, needs, and gratifications over time can be tested and quantified. Second, SM use is situated in the context of daily life. The conceptual model and the dynamic analysis in this study test the influences on SM use not only from preceding media use (i.e., in the context of time), but also from individuals' interpersonal social environments.

SM are websites and software that serve a primary function of allowing users to "connect, communicate, and interact with each other" (Correa, Hinsley, & Gil de Zúñiga, 2010, p. 248), often by posting, sharing, or co-producing information (Kushin & Yamamoto, 2010). Our conceptualization of SM therefore includes several overlapping domains: social networking sites (e.g., Facebook, LinkedIn), tools for communication with others (e.g., email, instant messaging), and sites for the sharing of information, which generally can be commented on or altered by others (e.g., blogs, YouTube). To identify the characteristics of SM use, this study compares SM, wherein social interaction is a fundamental component, to all other media (OM), such as television and radio, which are not typically perceived as inherently and primarily social.

2. Use, needs, and gratifications of social media

Over the past few decades, when new forms of media have emerged, the classic theoretical perspective of U&G has often been used to examine "new" media use behavioral patterns and their underlying motivation (Katz, Blumler, & Gurevitch, 1973; Rubin, 2009). Historically, as an alternative to the earlier view of media effects that focuses on what media can do to passive audiences, the U&G perspective has led to a new understanding of audiences as active media users who choose media based upon a variety of

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needs. Since both the production and consumption of SM are fundamentally user-driven, a user-oriented theoretical approach is warranted (Shao, 2009).

Needs are "the combined product of psychological dispositions, sociological factors, and environmental conditions" (Katz, Haas, & Gurevitch, 1973, pp. 516–517) that motivate media use. Gratifications are the perceived fulfillment of a need through an activity, such as media use (Palmgreen, 1984). Naturally, by the definition of SM, social needs are perceived to be the largest force propelling individuals to SM. Research has shown that SM provides unprecedented convenience and efficiency for creating, maintaining, and strengthening social relationships. Many features of SM facilitate self-disclosure and social interactions, such as the removal of geographic boundaries and the rich interaction opportunities afforded by networks of "friends" and information (e.g., Ellison, Steinfield, & Lampe, 2007; Lai & Turban, 2008). SM enables wide and quick distribution of self-disclosed information, and research has shown that appropriate self-disclosure fertilizes and strengthens interpersonal relationships (Altman & Taylor, 1973; Whitty, 2008). In addition, compared to offline interactions, the mediated nature of SM interactions offers users a more controllable environment to strategically present themselves in their interactions (Dunne et al., 2010; Walther, Slovacek, & Tidwell, 2001).

Other needs besides social ones motivate SM use as well. Across the daily mediated and non-mediated activities of college students, four general categories of needs have been identified (Wang & Tchernev, 2012). They are: (1) emotional needs, which are needs "related to strengthening aesthetic, pleasurable, and emotional experience" (Katz et al., 1973, p. 166); (2) cognitive needs, which are "related to strengthening information, knowledge, and understanding" (p. 166); (3) social needs, which are "needs related to strengthening contact with family, friends, and the world" (p. 167); and (4) habitual needs, which are ritualized and help bring structure to one's day (Katz et al., 1973), such as checking Facebook and email after meals.

Research on SM often identifies categories of needs driving SM use similar to the four just mentioned. In a telephone survey with a probability sample of 798 internet users aged 14–70, Leung (2009) identified that in addition to social needs, another three needs—recognition, cognition, and entertainment—also correlate with the time spent on online content generation activities, such as updating personal Web pages, blogging, posting videos on YouTube and contributing information to Wikipedia. This is consistent with research findings on specific types of SM. For example, based upon interviews with 23 bloggers in California, Nardi Schiano, Gumbrecht, and Swartz (2004) found several major needs that motivate people to blog. They range from emotional (e.g., expressing emotions), cognitive (e.g., providing opinions, articulating ideas through writing), to social (e.g., forming and maintaining community forums). Using web-based surveys of 151 Wikipedia contributors, Nov (2007) also found that multiple distinct needs correlate with weekly time spent on contributions, including emotional (e.g., "Writing/editing in Wikipedia is fun") and cognitive (e.g., "Writing/editing in Wikipedia allows me to gain a new perspective on things") needs. Similarly, an assortment of cognitive, emotional and social needs is found in Facebook users (Park, Kee, & Valenzuela, 2009). Although rarely directly examined in SM use research yet, habitual needs are suggested to influence daily SM use as well (LaRose & Eastin, 2004; Wang & Tchernev, 2012).

3. The dynamic reciprocal effects of media uses, needs, and gratifications

Dynamic relationships of mutual influence abound in the world around us. The Dynamic Motivational Activation model (DMA, Wang et al., 2006, 2011; Wang & Tchernev, 2012) proposes that motivated media choices and use can change a user's motivation in real time, which further influences subsequent media choices and use. This *reciprocal causality*, or mutual influence, between motivation (e.g., needs) and media use differs from typical conceptualizations of media effects which often proceed as a one-way causal process from media stimuli or media use behaviors to their effects on emotion, cognition, or behavior. The DMA's reciprocal causality perspective, however, resonates with the reinforcing spirals model proposed by Slater (2007), which posits that media use is affected by individuals' beliefs and attitudes, which in turn, are reinforced by the media use. Also, this perspective is consistent with the conceptual distinction between *gratifications sought*, which drive media use behavior, and *gratifications obtained*, which are the outcomes of the behavior, in U&G research (e.g., Palmgreen, 1984). Based upon the reciprocal causality perspective, needs drive media use, which may fulfill all, part, or none of the needs; the changed needs lead users to adjust their subsequent media choice and use behavior (Wang & Tchernev, 2012; Wang et al., 2006). Formal dynamic analyses of real time data have been employed to explore mutual influences between media use, needs, and gratifications. For example, in a laboratory experiment (Wang et al., 2006), participants were able to change channels at will while watching television. Their sequential channel choices and viewing durations were predicted by the dynamically changing motivational utilities of each channel (i.e., gratifications provided by the channel), which were continuously updated in real time by the channel selection and viewing experience. Similar reciprocal causal relationships between media use, needs, and gratifications are also found in longitudinal research of daily media multitasking activities (Wang & Tchernev, 2012).

Although not yet formally examined, reciprocal relations between SM uses and effects are suggested by empirical evidence. For example, an examination of server log data of 140,000 newcomers to Facebook (Burke, Marlow, & Lento, 2009) found that new users monitor their friends' actions on Facebook, and adaptively change their behavior on Facebook. Those who saw their peers posting many photos on Facebook posted more photos more often than those whose peers posted fewer photos. The findings suggest that Facebook use produces social learning effects, which further influence subsequent Facebook use. Similarly, research suggests that reading others' posts motivates individuals to generate and share content that represents their ideal images of self (Dunne et al., 2010; Shao, 2009). That is, SM use may change underlying motivations, which then change subsequent SM use.

In addition to reciprocal causality, the DMA also proposes that motivational, cognitive, and behavioral responses to media are not only determined by media stimuli (i.e., *exogenous effects* from outside the human motivational/cognitive/behavioral system), but are also determined by the *self-causing* or self-generating property of the system (i.e., *endogenous effects* from within the motivational/cognitive/behavioral system). The endogenous effects of a system are often called *feedback effects*, and they are the hallmark of complex dynamic systems (Buzsàki, 2006). They accumulate the system's earlier responses and integrate them into the current response to external stimuli (Wang et al., 2006, 2011; Ward, 2002). In other words, the endogenous effects of the motivational/cognitive/behavioral system integrate and accumulate exogenous influences from media to produce the observed "media (use) effects" on the system over time (Wang & Tchernev, 2012; Wang et al., 2011). It is in this sense that a complex system is said to be self-causing, self-generating, or self-sustaining (Buzsàki, 2006). Therefore, an accurate understanding of a motivational/cognitive/behavioral system's responses to exogenous influences, such as the "effects" of SM, cannot be achieved without accounting for the system's endogenous influence from itself. Formal dynamic models have

been used to tease apart exogenous effects from media and endogenous feedback effects from motivational/cognitive/behavioral systems, in both media information processing studies (Wang, Morey, & Srivastava, 2012; Wang et al., 2011) and daily media use research (Wang & Tchernev, 2012). Indeed, supporting the DMA, these studies found significant feedback effects of the motivational, cognitive, and behavioral systems. The estimated feedback effects in these DMA studies directly test and quantify the self-causing nature of motivation, cognition, and behavior during media processing and use.

In summary, based upon the U&G and DMA theoretical frameworks, we propose a conceptual model of dynamic uses and gratifications of SM as depicted by Fig. 1. It incorporates the theoretical understanding of reciprocal causality between media use, needs, and gratifications, and the self-causality of motivation, cognition and behavior. Specifically, a set of hypotheses and research questions are proposed as detailed next and noted in Fig. 1.

As reviewed above, a person's SM use at the present time should be determined by his/her previous SM use (*Hypothesis 1a*) and his/her needs at the present time (*Hypothesis 1b*). Our conceptualization of previous SM use behavior will focus on the time window of the preceding 24 h. Our media use data were observed three times a day, so the previous three time points of SM use will be used as predictors of SM use at the present time. In time series models, the three lagged time points are referred to as autoregressive "lag 1," "lag 2," and "lag 3" feedback effects. The lag 3 term is of particular interest because it represents a possible relationship between current SM use and yesterday's SM use at the same time of day, and thus should help us detect any daily patterns of the behavior.

It is worth noting that the three feedback terms do not just mean that the current SM use is only affected by behavior within the last 24 h (i.e., prior three time points). Because each of the SM feedback terms itself is a function of behavior at preceding time points which, in turn, are determined by earlier time points, the proposed lag 1, lag 2, and lag 3 feedback effects of the SM use behavior system are far-reaching, nonlinear, and complicated (see Wang et al., 2011 for simulation examples that exemplify this idea). In addition, we will explore whether preceding OM use—specifically lag 1, lag 2, and lag 3 OM use—affect SM use at the present time point (*Research Question 1*). To compare SM vs. OM use side by side, a corresponding research question and hypotheses are examined for OM use (*Hypothesis 2a*, *2b*; *Research Question 2*).

Similarly, needs are expected to be determined by prior needs (*Hypothesis 3a*), which again, are tested using autoregressive lag 1, lag 2, and lag 3 feedback effects of the needs in the same category. More specifically, because of the endogenous continuity of needs (Wang & Lang, 2012; Wang et al., 2011), the feedback are expected to be positive. In addition, as reviewed earlier, needs are expected to be reduced by the gratifications obtained from preceding activities—SM and OM use (*Hypothesis 3b*). Specifically, we will focus on the gratification from the most recent time point, which should carry the most influence.

Gratifications may be affected by their own feedback effects across time as well (*Hypothesis 4a*). However, as a pleasurable emotional *response to* the fulfillment of needs, they should primarily be determined by the existence and strengths of the needs, and by needs-fulfilling media use. Therefore, it is predicted that gratifications are determined by: needs in the same category (*Hypothesis 4b*), SM use and its interaction with the needs (*Hypothesis 4c*), and OM use and its interaction with the needs (*Hypothesis 4d*).

Finally, not only reciprocal causality and self-causality should predict the dynamics of SM use over time, but so should the environment—particularly the social environment—in which SM use takes place. In this study, we examine two factors of the social environment: solitude, which is a state of an individual, and perceived interpersonal support, which is a trait of individuals. Social contexts, such as being alone (i.e., solitude) or with others, have been shown to affect individuals' media choices (Gross, 2004; Larson, 1995) and the motivations underlying those media choices (Boal-Palheiros & Hargreaves, 2001). Therefore, solitude at a given time is predicted to affect SM and OM use at that time, and to moderate the effects of needs on media use (*Hypothesis 5*). A related chronic measure of interpersonal context is interpersonal support. Described as "the

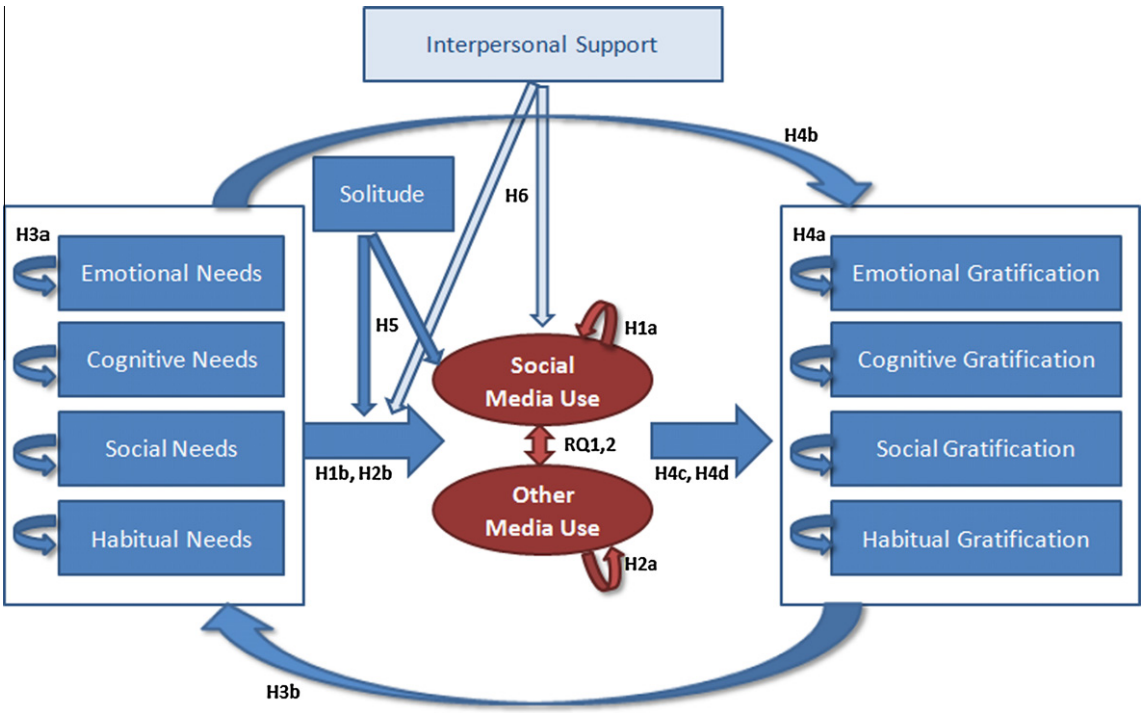

Fig. 1. The conceptual model of reciprocal dynamic influences of social media use, other media use, needs, and gratifications.

various resources provided by one's interpersonal ties," interpersonal support includes a sense of tangible aid, self-esteem, and feelings of belonging and attainment (Cohen & Hoberman, 1983, p.100). Research in patient support has suggested that low non-mediated social support contributes to more active participation in online support activities (Turner, Grube, & Meyers, 2001). This study proposes that perceived interpersonal support affects media use and moderates how needs drive media use (*Hypothesis 6*).

4. Method

4.1. Participants and procedures

Undergraduate students ($N = 28$) at a large Midwestern university participated in the study for monetary compensation. On average, they were 21.43 ($SD = 1.37$) years old. Seventeen participants (60.7%) were female, and the majority (71.43%) were Caucasian. Using the experience sampling method (Kubey, Larson, & Csikszentmihalyi, 1996), participants submitted reports at regular time intervals throughout the day: around lunchtime, in the early evening, and right before they went to bed. Each interval lasted around 5–6 h if we assume 8 h of sleep in a day. Participants' reports detailed activities they had engaged in over the past several hours, including SM use, OM use, and non-media activities. Each person's experience was sampled for 28 consecutive days, resulting in 84 reports per person.

To ensure efficiency, each participant was trained to use a coding scheme and a set of abbreviations developed in a pilot study (described below) to report their data. To avoid contaminating media use behavior, each participant was provided with a cellphone-like device to send their reports. The device was pre-configured and could only be used to send text reports to the research data storage. The device flashed at the beginning of each time interval to remind the participants to submit their reports on time. The participants were trained to use the device and the coding scheme for several hours, and all of them successfully passed multiple testing trials with 100% accuracy. In addition, the participants were given 2 days to grow accustomed to integrating the reporting procedure into their daily lives before data collection began.

4.2. Measures

To develop the coding scheme, a pilot study was conducted using a college student sample ($N = 78$) with similar demographic characteristics to those in the final study. In the pilot study, students provided detailed, open-ended descriptions of their hourly activities over 5 days. These descriptions were content-analyzed to develop coding categories and measures as described below.

SM use included blogs, email, Facebook, IM, LinkedIn, MySpace, online discussion forums, Skype, Twitter, Wikis, YouTube, and other social media. *OM use* included media use aside from social media, such as television, radio, magazines, newspapers, and computer use that was not related to social media. In addition, the participants reported non-mediated activities, such as classroom learning, shopping, and hanging out with friends. For each activity, the participants recorded its duration (in minutes), along with the following information:

Solitude. Whether he or she was physically alone during the activity.

Needs and gratifications. What needs were sought and how much they were gratified. The categories were emotional needs (fun/entertainment, to relax/kill time), cognitive needs (information, studying/work), social needs (personal, professional), and habitual needs (habits/background noise). More than one category could be reported for each activity. For each category of needs reported, the participant rated its strength using a scale of 1 (a teeny tiny need)–10 (an extremely strong need), and to what extent it was gratified by the activity: "1-not at all satisfied," "2-partially satisfied," "3-completely satisfied," or "4-beyond expectations."

After finishing the 4 weeks of reporting, the participants completed demographic information and the college student Interpersonal Support Evaluation Scale (ISES, Cohen & Hoberman, 1983; Cohen, Mermelstein, Kamarck, & Hoberman, 1985). The ISES includes 48 statements, with choices of "probably true" and "probably false." Higher scores indicate higher perceived interpersonal support, and the highest possible score is 48. Among the participants, ISES scores (Cronbach's $\alpha = .78$) ranged from 26 to 48, with an average of 39.21 ($SD = 6.18$).

4.3. Data reduction, time series data set, and dynamic panel models

For each reporting interval of each person, the total duration of SM activities was computed and then divided by the total duration of all activities during that interval. This proportion of time spent on SM was used to indicate SM use for that interval, and ranged from 0 to 1 ($M = .09$, $SD = .19$), that is, from 0% to 100% of the total time reported. The same method was used to compute OM use and time spent in solitude during each interval for each person. OM use ranged from 0 to 1 ($M = .55$, $SD = .36$). Solitude also ranged from 0 to 1 ($M = .48$, $SD = .39$). The four categories of needs and gratifications during each interval for each person were computed by averaging their needs and gratifications levels reported during that interval. Thus, for each individual, time series of 84-observations were created for SM use, OM use, solitude, the four categories of needs and their corresponding gratifications.

There are variations over time within each individual's data as well as variations across individuals. Dynamic panel models are used to simultaneously examine both levels of variation while accounting for unobserved individual heterogeneity (Baltagi, 2008). Unobserved individual heterogeneity refers to all the indi-

Table 1
The selected models of social media and other media use behavior.

	$SM_{i,t}$ *M* (SE)	$OM_{i,t}$ *M* (SE)
Intercept	−.55(.16)*	−.08 (.30)
$SM_{i,t-1}$	−.02(.02)	
$SM_{i,t-2}$	−.04(.02)*	
$SM_{i,t-3}$	.09(.02)*	
$OM_{i,t-1}$		.007(.02)
$OM_{i,t-2}$		−.02(.02)
$OM_{i,t-3}$		.06(.02)*
Emotional $need_{i,t}$	.04(.01)*	.09(.03)*
Cognitive $need_{i,t}$	.06(.01)*	.005(.03)
Social $need_{i,t}$	.10(.02)*	.10(.04)*
Habitual $need_{i,t}$	.06(.02)*	−.004 (.04)
$Solitude_{i,t}$	.10(.03)*	.20(.05)*
$Solitude_{i,t}$ × emotional $need_{i,t}$	−.01(.005)†	−.01(.01)
$Solitude_{i,t}$ × cognitive $need_{i,t}$	.0005(.005)	.02(.01)*
$Solitude_{i,t}$ × social $need_{i,t}$	−.003(.007)	−.03(.01)*
$Solitude_{i,t}$ × habitual $need_{i,t}$	−.01 (.006)†	−.01(.01)
Interpersonal $support_i$	.01(.004)*	.01(.01)
Interpersonal $support_i$ × emotional $need_{i,t}$	−.001(.0003)*	−.002(.001)*
Interpersonal $Support_i$ × cognitive $need_{i,t}$	−.001(.0003)*	−.001(.001)
Interpersonal $support_i$ × social $need_{i,t}$	−.002(.0005)*	−.002(.001)*
Interpersonal $support_i$ × habitual $need_{i,t}$	−.002(.0004)*	.00001(.001)
$Gender_i$	−.05(.04)	.04(.08)
$Race_i$	.03(.01)*	−.02(.03)
Wald χ^2	115.63*	221.39*

* $p < .05$.
† $p < .10$.

Table 2
The selected models of needs.

	Emotional needs$_{i,t}$ *M* (SE)	Cognitive needs$_{i,t}$ *M* (SE)	Social needs$_{i,t}$ *M* (SE)	Habitual needs$_{i,t}$ *M* (SE)
Intercept	2.08(.10)*	1.65(.08)*	.64(.04)*	.76(.04)*
Need$_{i,t-1}$	.10(.05)*	.21(.04)*	.09(.04)*	.09(.04)*
Need$_{i,t-2}$	−.02(.02)	.01(.02)	.03(.017)†	.04(.02)*
Need$_{i,t-3}$	.14(.02)*	.08(.02)*	.11(.02)*	.12(.02)*
Gratification$_{i,t-1}$	−.13(.12)	−.27(.11)*	−.07(.12)	−.19(.10)†
Wald χ^2	59.34*	78.93*	49.23*	43.81*

* $p < .05$.
† $p < .10$.

Table 3
The selected models of gratifications.

	Emotional gratification$_{i,t}$ *M* (SE)	Cognitive gratification$_{i,t}$ *M* (SE)	Social gratification$_{i,t}$ *M* (SE)	Habitual gratification$_{i,t}$ *M* (SE)
Intercept	.02(.03)	.16(.03)*	.08(.01)*	.06(.02)*
Gratification$_{i,t-1}$	.01(.01)	.01(.01)	−.01(.01)	−.01(.01)
Gratification$_{i,t-2}$	−.01(.01)	−.02(.01)*	−.02(.01)*	−.03(.01)*
Gratification$_{i,t-3}$	.03(.01)*	.01(.01)	−.003(.01)	−.02(.01)†
Need$_{i,t}$	.39(.01)*	.30(.01)*	.36(.01)*	.34(.01)*
SM$_{i,t}$	.18(.07)*	−.03(.07)	−.01(.04)	.02(.04)
OM$_{i,t}$	.18(.04)*	−.06(.03)†	−.01(.02)	.03(.02)
SM$_{i,t}$ × need$_{i,t}$	−.02(.02)	.04(.02)*	−.01(.02)	.02(.02)
OM$_{i,t}$ × need$_{i,t}$	−.001(.01)	−.01(.01)	.04(.01)*	.08(.01)*
Wald χ^2	10094.01*	5750.74*	9472.45*	7568.50*

* $p < .05$.
† $p < .10$.

vidual differences which were not measured in the data set—in other words, the uniqueness of each individual beyond what was (or even can be) measured numerically.

To test our hypotheses and explore the research questions, a set of competing nested models were compared for SM use, OM use, needs, and gratifications (detailed in the next section). The generalized method of moments (GMM) was used to fit the models using the xtdpdsys command in Stata/SE 11.0 software (Arellano & Bover, 1995; Blundell & Bond, 1998). Based upon the Wald χ^2 test (Busemeyer & Deiderich, 2010; Engle, 1984), the preferred models were selected for SM use, OM use, needs, and gratifications. They passed the Sargan test for over-identifying restrictions (Arellano & Bond, 1991). They are summarized in Tables 1–3.

5. Results

5.1. The dynamics of SM and OM use

To test the hypotheses and questions on SM use, a set of competing models were compared. The full model predicts the SM use of an individual i at a time point t (i.e., SM$_{i,t}$) using: (1) the autoregressive lag 1, lag 2, and lag 3 feedback effects of SM use (i.e., SM$_{i,t-1}$, SM$_{i,t-2}$, and SM$_{i,t-3}$), (2) the autoregressive lag 1, lag 2, and lag 3 feedback effects of OM use (i.e., OM$_{i,t-1}$, OM$_{i,t-2}$, and OM$_{i,t-3}$), (3) the four categories of needs at time t, (4) their interactions with solitude at time t, and (5) their interactions with the interpersonal support of the individual i. Gender and race are entered as control variables. To explore *Research Question 1*, the full model is compared with a nested model without the lagged effects of OM use as specified in (2) above. Based upon the Wald χ^2 test, the nested model is preferred. This indicates that SM use is quite independent from prior and current OM use. Then to test *Hypothesis 1a*, the preferred model is compared to its nested model excluding feedback effects of SM use as described in (1). Supporting *Hypothesis 1a*, feedback effects of SM use, as shown by the Wald χ^2 test, significantly increase the fit of the model. Next, this preferred model is further compared to three nested models which respectively exclude the effects of needs, solitude, and interpersonal support, as specified in (3)–(5). Wald χ^2 tests show that the model including all of these factors describes the data better, and thus, it is the final selected model. Similar model comparison procedures were carried out for OM use. The final models and coefficients are summarized in Table 1. Coefficients in dynamic panel models can be interpreted in a similar fashion to those in linear regression models, but they provide a "snapshot" of the estimated effects of the variables *per time unit*. They are discussed next.

5.1.1. The effects of system feedback, needs, solitude, and interpersonal support on SM and OM use

As predicted by *Hypotheses 1a* and *2a*, SM and OM use show a significant positive lag 3 feedback effect, indicating daily persistency of the behaviors. Also, SM use shows a significant lag 2 feedback effect, suggesting a more complex continuity pattern than OM use. Supporting *Hypotheses 1b*, *2b*, and *5–6*, needs at a given moment generally increase both types of media use, which are further moderated by solitude at the moment and individual's interpersonal support. These are illustrated in Figs. 2 and 3.

As shown in the left panels of Fig. 2, an increase in any of the four categories of needs increases SM use, and in particular, social needs (the 3rd row) have the largest effects. On average, during a 5–6 h data reporting time period, when social needs increase by one unit (on the 1–10 scale), an additional portion of .1 (i.e., 10%) of the reported time will be spent on SM. Solitude increases SM use, and also moderates the increasing effect of emotional and habitual needs (the 1st and last rows, respectively) on SM in that the increasing rate is slightly smaller when the solitude level is higher. In comparison, as shown in the right panels, only emotional and social needs significantly increase OM use, and they do so with similar effect

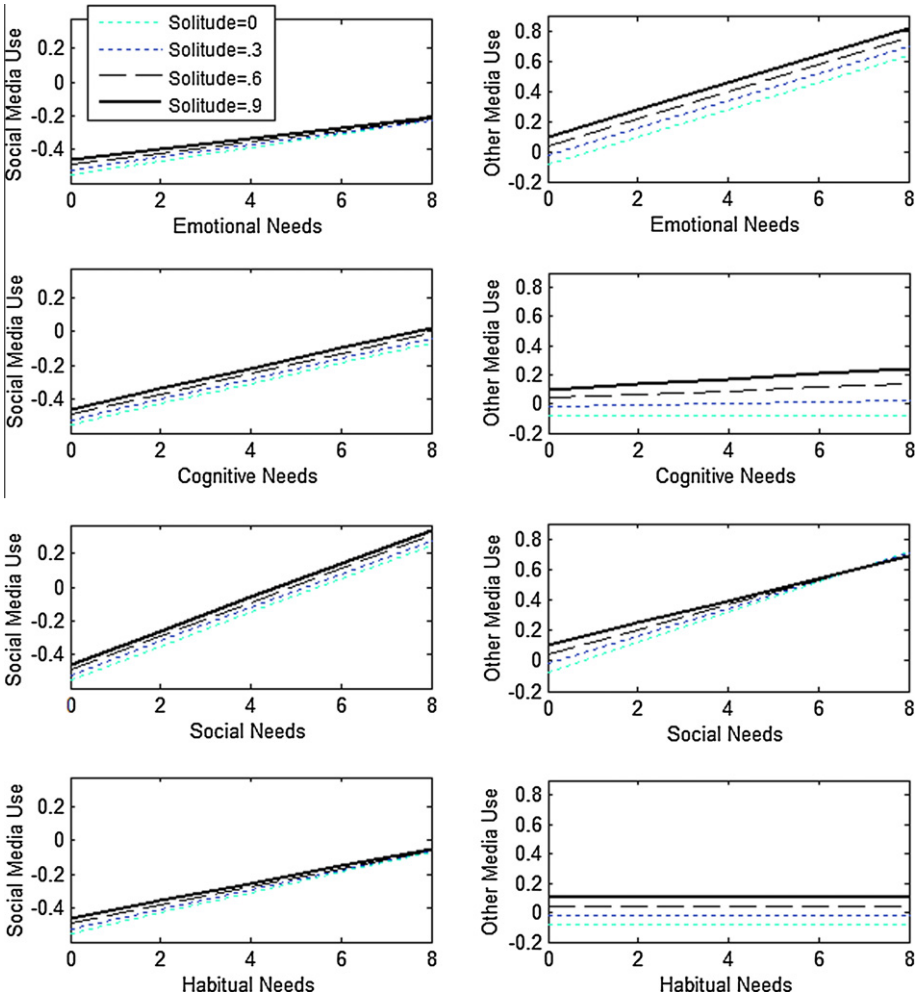

Fig. 2. The effects of needs (on scales of 0–10) and solitude (portion of time) on social media and other media use behavior (portion of time), estimated per time point.

sizes. Solitude increases OM use and also moderates the effects of cognitive and social needs (the 2nd and 3rd rows, respectively).

As shown in Fig. 3, interpersonal support has a larger and more complicated impact on SM than on OM use. It moderates the effects of all needs on SM. As seen in the left panels, those with higher perceived interpersonal support generally use SM more, but this pattern reverses when social or habitual needs are high (>5 on the 1–10 scale; see the 3rd and last rows). Generally, an increase in needs increases SM use, but the pattern reverses when emotional and habitual needs increase among those with higher perceived interpersonal support (see the 1st and last rows). In comparison, perceived interpersonal support only moderates the effects of emotional and social needs on OM use: increasing needs increases OM use, and the increase is greater for those with lower interpersonal support.

5.1.2. The dynamics of SM and OM usage accumulated across time

As reviewed earlier, our dynamic panel models disentangle and estimate the exogenous effects (i.e., needs and solitude) on SM and OM use from the behavior systems' endogenous feedback effects, and therefore, the exogenous and endogenous effects are not confounded. In addition, these effects are estimated *per time unit* as summarized above (see Table 1 and Figs. 2 and 3). The significant feedback effects of SM and OM use support the conceptualization of SM and OM use as dynamic systems with self-causing and self-sustaining continuity. These feedback effects integrate exogenous influences to generate the systems' behaviors across time. They determine how quickly, how strongly, and how enduringly a system responds to the exogenous influences (Luenberger, 1979; Wang et al., 2011, 2012).

As Figs. 2 and 3 systematically illustrate, a combination of needs, solitude, and interpersonal support can produce various changes or effects in SM and OM use. For example, as shown in the third left panel of Fig. 3, when interpersonal support is low (=26), an increase of social needs from 0 to 8 increases SM use by almost .4 unit (i.e., 40% of the time reported during this time interval), but when interpersonal support is high (=45), the increase is only .09 (i.e., 9%). However, as shown next, when we look at the system on a larger time scale, the longer-term integrated effects can be different.

Fig. 4 illustrates how the system feedback effects accumulate and integrate exogenous effects on SM and OM. The exogenous effects, stemming from various combinations of needs, solitude, and interpersonal support (as already systematically shown in Figs. 2 and 3), are fed into a dynamic model along with the significant feedback coefficients of SM and OM use (as summarized in Table 1). The exogenous effects are controlled as a step input (i.e., being turned on from zero to a fixed magnitude for a certain duration), which is helpful for examining the accumulation and evolution of dynamic effects. The step input duration is set to be 84-time-point intervals, as in our empirical data. After each step input, a short zero setting (i.e., no input) is used to allow the system to return to its baseline before the next exogenous influence is turned on. Five step inputs were used to systematically examine their integrated effects when accumulated by the system feedback. The five

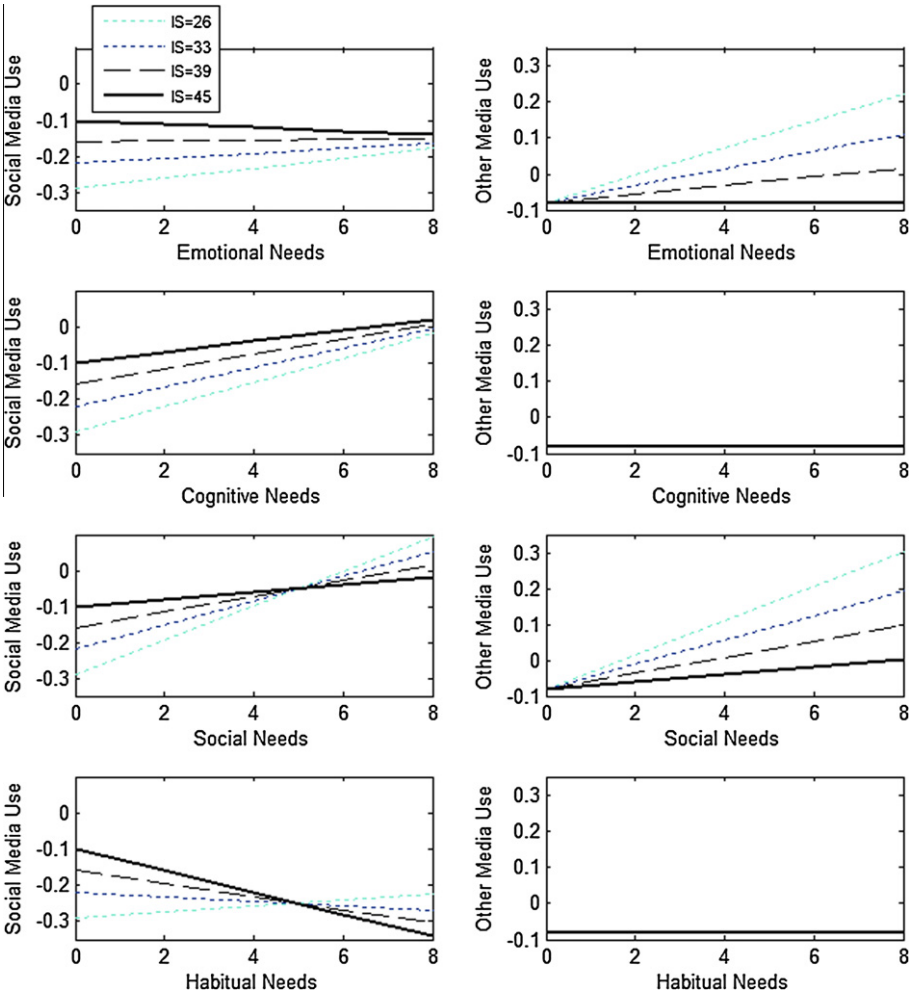

Fig. 3. The effects of needs (on scales of 0–10) and interpersonal support (IS, on a scale of 0–48) on social media and other media use behavior (portion of time), estimated per time point.

step inputs of exogenous effects on SM and OM use are: −.3, −.1, 0, .1, and .3, which respectively mean decreasing SM/OM use by 30%, 10%, and 0% of the time reported in the time interval, and increasing SM/OM use by 10% and 30%. It is worth noting that the purpose of Fig. 4 is to show the integrating and accumulating effects of the system feedback on the exogenous effects. It does not matter what specific external factors cause the exogenous effects those relationships were systematically examined in Figs. 2 and 3.

As shown in Fig. 4, the integrated effects are similar for SM and OM use. A decrease or increase in the exogenous inputs produces slightly larger changes in the same direction across time. This slight increase in effect sizes, although less dramatic than some other dynamic system analysis results (e.g., Wang et al., 2011), illustrates the accumulation effect of the system feedback. In addition, the appearance of exogenous influences (i.e., at time points 10, 110, 210, 310, and 410) as well as their disappearance (i.e., at time points 94, 194, 294, 394, and 494) does not instantaneously start or stop SM or OM use. Instead, because media use depends on its own past (as quantified by the feedback coefficients), it takes time to react to the exogenous influences, resulting in a gradual change to reach equilibrium over a few time points.

5.2. The dynamics of needs

For each category of needs, a full model is compared with its nested models. The full model uses (1) lag 1, lag 2, and lag 3 feedback effects of the needs and (2) gratifications from preceding activities to predict the needs at the time point. To test *Hypotheses 3a* and *3b*, the full model is compared with nested models excluding the effects of feedback or gratifications. Based upon Wald χ^2 tests, the full model is preferred and thus both hypotheses are supported. The estimated model coefficients are summarized in Table 2.

5.2.1. The effects of system feedback and lagged gratifications on needs

Supporting *Hypothesis 3a*, each category of needs has significant positive feedback effects. The lag 1 feedback effects range from .09 to .21, suggesting persistence of the needs across time. Around 10–20% of needs from the previous time point are carried over to the next, which in turn, are further integrated into subsequent time points. In addition, the lag 3 feedback effects of needs, ranging from .08 to .14, suggest a daily pattern of needs. Additionally, habitual and social needs have a small lag 2 feedback effect. Partially supporting *Hypothesis 3b*, lagged gratifications show a significant or marginally significant negative (i.e., reducing) effect on cognitive and habitual needs, but not on emotional and social needs. Increasing cognitive gratifications by 1 unit (on the 1–4 scale) will reduce cognitive needs at the next time point by .27 unit (on the 1–10 scale); increasing habitual gratifications by 1 unit will reduce the needs by .19 unit.

5.2.2. The dynamics of needs across time

On a larger scale across many days, to illustrate how the feedback effects of needs accumulate and moderate the impact of previous gratifications to change the needs over time, we simulated

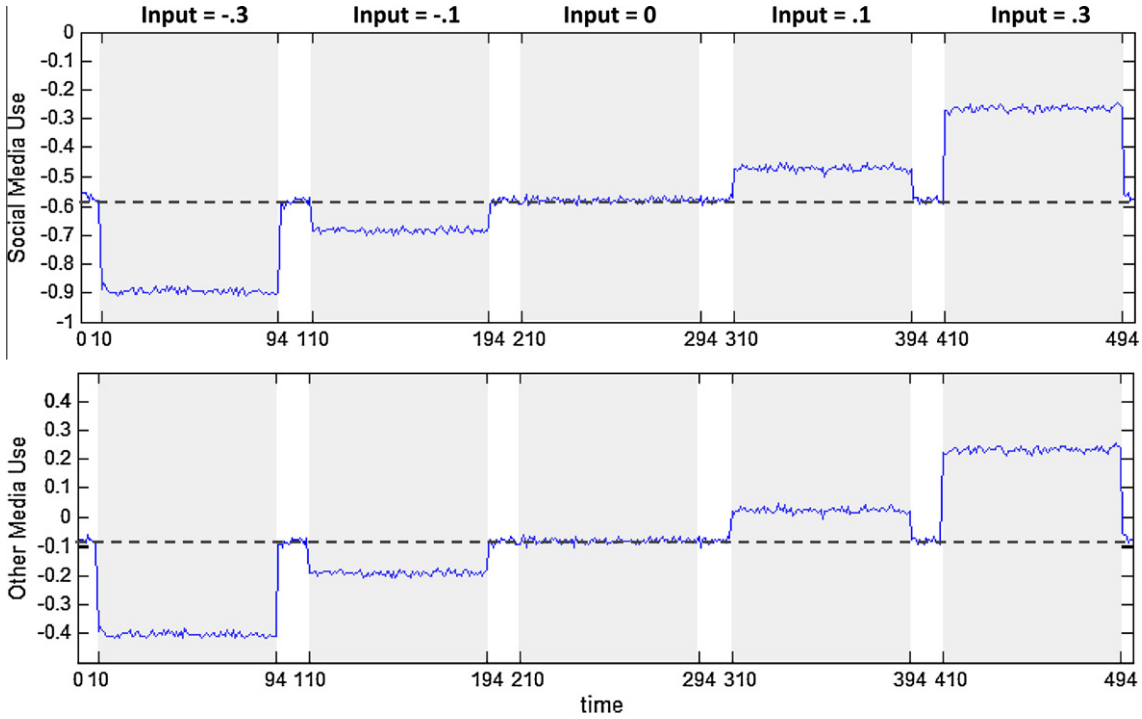

Fig. 4. Dynamics exogenous effects (of needs, solitude, and interpersonal support) on social media and other media use behavior across time as integrated and accumulated by endogenous system feedback of the behavior itself.

their integrated effects using the coefficients in Table 2 (see Fig. 5). Within the range of the actual data, five inputs of gratifications are selected: 0 (baseline), 1 (not satisfied), 2 (partially satisfied), 3 (completely satisfied), and 4 (beyond expectations). Again, the inputs are step inputs. The four panels, from the top to the bottom, respectively depict emotional, cognitive, social, and habitual needs. Similar to the dynamic effects illustrations of SM and OM use, Fig. 5 shows integrated effects that are slightly greater than the effects estimated per time unit (see Table 2). Also the reduction in needs does not occur instantaneously upon gratification. Both patterns illustrate the dynamic, history-dependant nature of needs as tested by the system feedback terms.

5.3. The dynamics of gratifications

To test the hypotheses for gratifications, a procedure similar to that for needs is used: a full model is compared with its nested models for each category of gratifications. The full model includes (1) lag 1, lag 2, and lag 3 feedback effects of the gratifications, (2) needs in the same category, (3) SM use and its interaction with the needs, and (4) OM use and its interaction with the needs. To test *Hypotheses 4a–d*, the full model is compared with nested models excluding each of the blocks of variables (1)–(4) respectively. Based upon Wald χ^2 tests, the full model shows the best fit for all four categories of gratifications (see Table 3).

5.3.1. The effects of system feedback, needs, and SM and OM use on gratifications

Supporting *Hypothesis 4a*, all four categories of gratifications showed small (ranging from −.03 to .03) lag 2 or lag 3 feedback effects. Also, as predicted by *Hypothesis 4b*, all four categories showed positive main effects of needs (ranging from .30 to.39), which suggests that a one unit increase in needs (on the 1–10 scale) will increase gratifications in the same category by .30–.39 unit (on the 1–4 scale). Supporting *Hypothesis 4c* and *4d*, significant effects of SM and OM use on gratifications were identified. However, they are heterogeneous, as described next.

5.3.2. The dynamics of gratifications across time

To systematically illustrate how gratifications respond to changes in needs and media use across time, a set of exogenous inputs, combining different amounts of SM and OM use (as shown on the top of Fig. 6), are fed into the dynamic systems of gratifications along with their significant feedback terms and high (=10) vs. low (=3) needs. As shown in Fig. 6 the condition of SM = .5 and OM = 0, SM use significantly increases emotional and cognitive gratifications, especially when the needs are high. In comparison, as shown in the condition of SM = .0 and OM = .5, OM use affects all four categories of gratifications. It (1) increases emotional gratifications and (2) increases social and habitual gratifications, especially when the needs are high; but it (3) slightly decreases cognitive gratifications. Also, as previously demonstrated for media use and needs, the endogenous feedback effects of gratifications accumulate the effects from media use. Once again, it takes a few time points for gratifications to reach their equilibrium state after a change in media use.

6. Discussion

This study extends U&G theory to account for the dynamic changes of media uses and gratifications in the theoretical framework of dynamic motivational activation. It specifies dynamic uses and gratifications of SM and OM in the everyday lives of college students. First, the study tests and quantifies reciprocal causal relationships between needs, SM and OM use, and gratifications, as well as their self-sustaining feedback effects. Specifying these effects helps more accurately estimate the influences of endogenous and exogenous effects on SM and OM use across time. Second, based upon real life experience sampling, this study was designed to examine SM use in the context of various other activities in daily life. In particular, the dynamics of OM use are compared to the

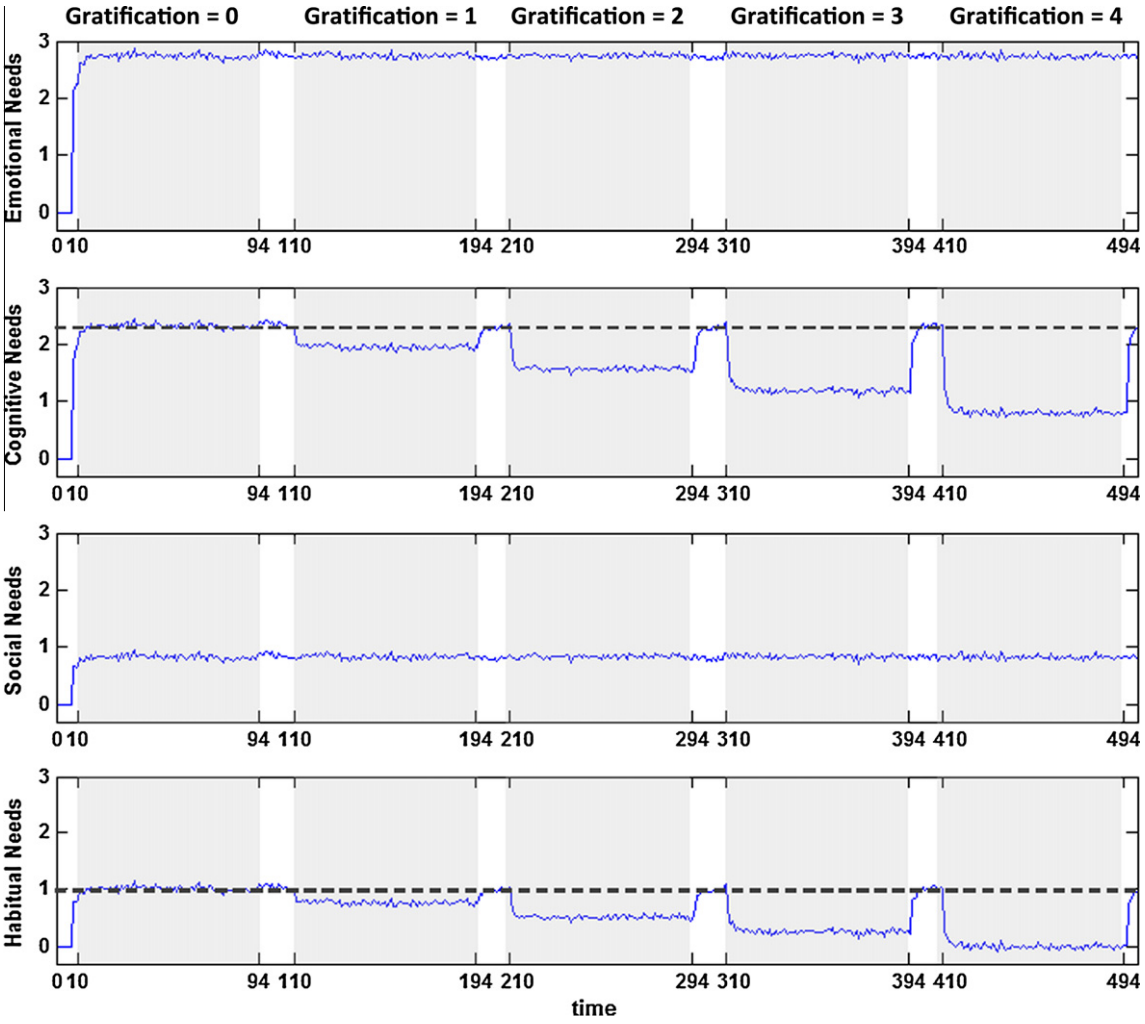

Fig. 5. Needs as a function of system feedback effects and lagged gratification influences across time.

dynamics of SM use side by side to identify their similarities and differences. An interesting finding emerging from this comparison is the different roles that social needs and gratifications play in SM vs. OM use. In addition, the dynamic panel models employed in this study afford simultaneous examination of how the individual differences in interpersonal support and momentary state differences in solitude affect the dynamics of SM and OM use.

6.1. Dynamics of uses and gratifications of SM and OM

Our data identified that OM use is primarily driven by emotional and social needs at that moment in time. In comparison, SM use is significantly driven by all four categories of needs. Interestingly, social needs have the largest effects on motivating both SM and OM use. This is consistent with previous findings (Dunne et al., 2010). Surprisingly, however, SM use only significantly gratifies emotional and cognitive needs, but not social and habitual needs. In comparison, OM use gratifies all needs examined excepted for cognitive needs which it slightly decreases.

Is SM socially gratifying? Our data suggest that the participants perceived social needs as the largest reason for them to use SM, but they did not report being socially gratified. Similar findings actually have been observed previously. For example, Lai and Turban (2008) presumed that SM lead to friendships and gratifications, but did not find evidence to support those ideas. Instead, they found that SM increases work productivity. Similarly, Nov (2007) found that Wikipedia contributors perceive their contributions as a way to gratify their emotional and cognitive needs, but not social needs. On the contrary, however, some other research suggests SM use improves social relationships and social capital (e.g., Steinfield, Ellison, & Lampe, 2008). One possible reason for the seemingly conflicting findings is the differences in conceptualizing and measuring social gratifications across studies. In our study, social gratifications are rather immediate responses to activities reported at the end of each time session, while research that found positive connections between SM use and social relationships or social capital focuses on the long-term accumulation of social relations and resources. Most likely, the long-term social benefits of being connected via SM are not easily recognized after short interactions and participation via SM. Indeed, some short-term SM experiences may even be socially aversive and taxing because of peer pressure and "playground politics" (Dunne et al., 2010). Another possible explanation is that this study employs a broad definition of SM, while specific types of SM may vary in their influence on social gratifications. For example, Wikipedia might be quite different from Facebook in this aspect. Follow-up research is needed to compare specific types of SM in daily uses and gratifications.

It is worth noting that the ungratified social and habitual needs of SM use can accumulate through their own endogenous effects over time, and motivate future SM use. In other words, these needs drive SM use, but are not gratified by SM use, and grow larger to stimulate heavier SM use in the future. In this sense, SM use grad-

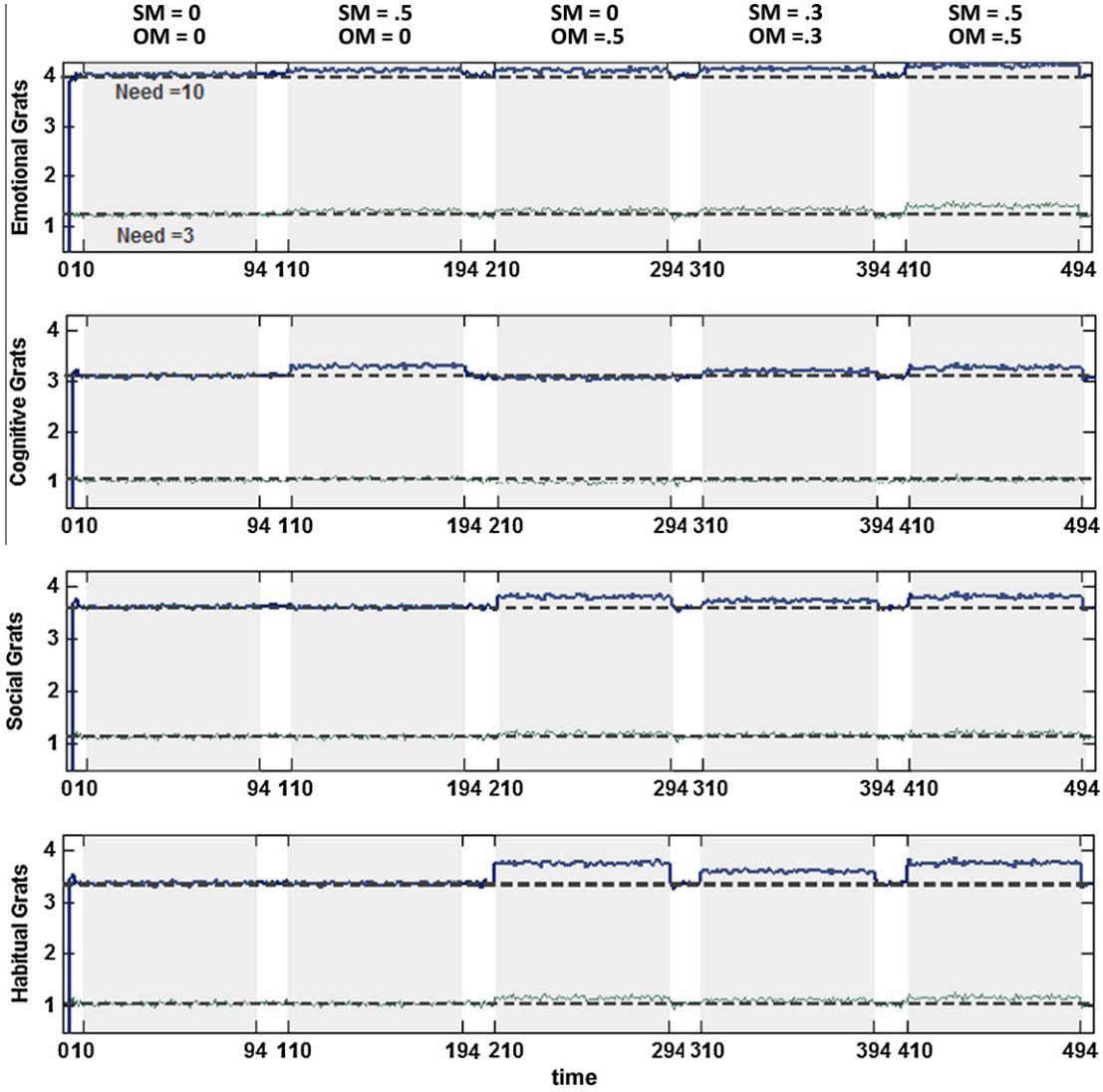

Fig. 6. Gratifications as a function of system feedback effects, needs, SM, and OM use across time.

ually cultivates greater social and habitual needs to use SM. This may help explain the increasing popularity of SM.

In addition to ungratified needs, unsought gratifications also exemplify the complex relationship between needs and gratifications across time. We found that OM use is not explicitly driven by habitual needs, but it gratifies those needs. The resulting lower habitual needs can further influence successive media use. Previous research has documented similar effects (Dunne et al., 2010; Wang & Tchernev, 2012).

6.2. Solitude, perceived interpersonal support, and media use

Solitude increases mediated activities, including both SM and OM use. This is consistent with previous findings (e.g., Larson & Csikszentmihalyi, 1978; Morahan-Martin & Schumacher, 2003). However, it is interesting to note that in general, the effects of solitude are larger on OM use. Possibly, during voluntary solitude when an individual actively selects to be alone, the individual may be more likely to select media activities that he or she has full control of, such as reading books and listening to music, instead of engaging in SM which require participation or even synchronized interaction. Future research can measure voluntary vs. non-voluntary solitude to differentiate their influences on needs and media choices. In addition, solitude moderates the motivating processes for SM and OM use in different ways: it moderates the increasing effects of emotional and habitual needs on SM use, but cognitive and social needs on OM use.

In contrast, perceived interpersonal support has larger effects on SM than on OM use. It moderates the impact of all four categories of needs on SM use but only the impacts of emotional and social needs on OM use. Its effects on SM and OM use are quite divergent: compared to people perceiving high interpersonal support, those perceiving low support are less likely to use SM and more likely to use OM. Further, as needs increase, the differences in SM use between those with high vs. low perceived interpersonal support shrink or even reverse, but the differences in OM use grow larger. These findings suggest that people perceiving higher interpersonal support seek SM over OM to gratify their needs, especially for emotional and social needs. Replications and continuing investigation of this media choice divergence can be helpful for media campaigns. For example, campaigns promoting emotional health or social engagement probably should still utilize OM to target people with low interpersonal social support, but employ SM vehicles to deliver messages to those with high social support.

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