

## ORIGINAL ARTICLE

# Social Media Use and Adolescents' Self-Esteem: Heading for a Person-Specific Media Effects Paradigm

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*Eighteen earlier studies have investigated the associations between social media use (SMU) and adolescents' self-esteem, finding weak effects and inconsistent results. A viable hypothesis for these mixed findings is that the effect of SMU differs from adolescent to adolescent. To test this hypothesis, we conducted a preregistered three-week experience sampling study among 387 adolescents (13–15 years, 54% girls). Each adolescent reported on his/her SMU and self-esteem six times per day (126 assessments per participant; 34,930 in total). Using a person-specific,  $N=1$  method of analysis (Dynamic Structural Equation Modeling), we found that the majority of adolescents (88%) experienced no or very small effects of SMU on self-esteem ( $-.10 < \beta < .10$ ), whereas 4% experienced positive ( $.10 \leq \beta \leq .17$ ) and 8% negative effects ( $-.21 \leq \beta \leq -.10$ ). Our results suggest that person-specific effects can no longer be ignored in future media effects theories and research.*

**Keywords:** ESM, ambulatory assessments, differential susceptibility, Instagram, Snapchat, DSEM, idiographic analysis,  $N=1$  analysis

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An important developmental task that adolescents need to accomplish is to acquire self-esteem, the positive and relative stable evaluation of the self. Adolescents' self-esteem is an important predictor of a healthy peer attachment (Gorrese & Ruggieri, 2013), psychological well-being (Kernis, 2005), and success later in life (Orth & Robins, 2014). In the past decade, a growing number of studies have investigated how adolescents' social media use (SMU) may affect their self-esteem. Adolescents typically spend 2–3 hours per day on social media to interact with their peers and

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exchange feedback on their messages and postings (Valkenburg & Piotrowski, 2017). Peer interaction and feedback on the self, both bedrock features of social media, are important predictors of adolescent self-esteem (Harter, 2012). Therefore, understanding the effects of SMU on adolescents' self-esteem is both important and opportune.

To our knowledge, 18 earlier studies have tried to assess the relationship between SMU and adolescents' general self-esteem (e.g., Woods & Scott, 2016) or their domain-specific self-esteem (e.g., social self-concept; Blomfield Neira & Barber, 2014; Košir *et al.*, 2016; Valkenburg *et al.*, 2006). The ages of the adolescents included in these studies ranged from eight to 19 years. Fifteen of these studies are cross-sectional correlational (e.g., Cingel & Olsen, 2018; Meeus *et al.*, 2019), two are longitudinal (Boers *et al.*, 2019; Valkenburg *et al.*, 2017), and one is experimental (Thomaes *et al.*, 2010). Some of these studies have reported positive effects of SMU on self-esteem (e.g., Blomfield Neira & Barber, 2014), others have yielded negative effects (e.g., Woods & Scott, 2016), and yet others have found null effects (e.g., Košir *et al.*, 2016). It is no wonder that the two meta-analyses on the relationship of SMU and self-esteem have identified their pooled relationships as "close to 0" (Huang, 2017, p. 351), "puzzling," and "complicated" (Liu & Baumeister, 2016, p. 85).

While this earlier work has yielded important insights, it leaves two important gaps that may explain these weak effects and inconsistent results. A first gap involves the time frame in which SMU and self-esteem have been assessed in previous studies. Inherent to their design, the cross-correlational studies have measured SMU and self-esteem concurrently, at a single point in time. The two longitudinal studies have assessed both variables at three or four times, with one-year lags, with the aim to establish the potential longer-term effects of SMU on self-esteem (Boers *et al.*, 2019; Valkenburg *et al.*, 2017). However, both developmental (e.g., Harter, 2012) and self-esteem theories (e.g., Rosenberg, 1986) argue that, in addition to such longer-term effects, adolescents' self-esteem can fluctuate on a daily or even hourly basis as a result of their positive or negative experiences. These theories consider the momentary effects of SMU on self-esteem as the building blocks of its longer-term effects. Investigating such momentary effects of SMU on adolescents' self-esteem is the first aim of this study.

A second gap in the literature that may explain the weak and inconsistent results in earlier work is that individual differences in susceptibility to the effects of SMU on self-esteem have hardly been taken into account. Studies that did investigate such differences have mostly focused on gender as a moderating variable, without finding any effect (Kelly *et al.*, 2018; Košir *et al.*, 2016; Meeus *et al.*, 2019; Rodgers *et al.*, 2020). However, these null findings may be due to the high variance in susceptibility to the effects of SMU within both the boy and girl groups. After all, if differential susceptibility leads to positive effects among some girls and boys and to negative effects among others, the moderating effect of gender at the aggregate level would be close to zero. Therefore, the time is ripe to investigate differential susceptibility to the effects of SMU at the more fine-grained level of the individual rather

than by including group-level moderators. Such an investigation would not only benefit media effects theories (e.g., Valkenburg & Peter, 2013), but also self-esteem theories that emphasize that the effects of environmental influences may differ from person to person (e.g., Harter & Whitesell, 2003). Investigating such person-specific susceptibility to the effects of SMU is, therefore, the second aim of this study.

To investigate the momentary effects of SMU on self-esteem (first aim), and to assess heterogeneity in these effects (second aim), we employed an experience sampling (ESM) study among 387 middle adolescents (13–15 years), whom we surveyed six times a day for three weeks (126 measurements per person). We measured SMU by asking adolescents on each measurement moment how much time in the past hour they had spent on the three most popular social media platforms among Dutch adolescents (van Driel *et al.*, 2019): Instagram, WhatsApp, and Snapchat. We focused on middle adolescence because this is the period of most significant fluctuations in self-esteem (Harter, 2012). By employing a novel, person-specific method to analyze our intensive longitudinal data, we were able, for the first time, to assess the effects of SMU at the level of the individual adolescent, and to assess how these effects differ from adolescent to adolescent.

### Social Media Use and Self-Esteem Level

Personality and social psychological research into the antecedents, consequences, and development of self-esteem has mostly focused on two aspects of self-esteem: self-esteem level and self-esteem instability. Most of this research has focused on self-esteem level, that is, whether it is high or low (Crocker & Brummelman, 2018). This also holds for studies into the effects of SMU. For example, all of the 15 correlational studies have investigated whether adolescents who spend more time with social media report a lower (or higher) level of self-esteem compared to their peers who spend less time with social media (e.g., Apaolaza *et al.*, 2013, 12–17 years; Barthorpe *et al.*, 2020, 13–15 years; Bourke, 2013, 12–16 years; Cingel & Olsen, 2018, 12–18 years; Kelly *et al.*, 2018, 14 years; Morin-Major *et al.*, 2016, 12–17 years; O'Dea & Campbell, 2011,  $M_{\text{age}}$  14; Rodgers *et al.*, 2020,  $M_{\text{age}}$  12.8; Thorisdottir *et al.*, 2019, 14–16 years; Valkenburg *et al.*, 2006, 10–19 years; van Eldik *et al.*, 2019, 9–13 years). In statistical terms, these studies have investigated the *between-person* relationship of SMU and self-esteem.

The majority of studies into the between-person relationship of SMU and self-esteem used Rosenberg's (1965) self-esteem scale, which is the most commonly used survey measure to assess general, trait-like levels of self-esteem. These studies asked adolescents at one point in time to evaluate their selves in general or across a certain period in the past (e.g., in the past year). In the current study, we also investigated the between-person relationship between SMU and adolescents' general levels of self-esteem. But unlike earlier studies, we assessed their levels of SMU and self-esteem by averaging the 126 momentary assessments of both variables across a three-week period. Such in situ assessments generally produce data with greater

ecological validity because they are made in the natural flow of daily life, which reduces recall bias (van Roekel *et al.*, 2019). Given the inconsistent results in previous studies, the literature does not allow us to formulate a hypothesis on the between-person association between SMU and self-esteem level. Therefore, we investigated the following research question:

(RQ1) Do adolescents who spend more time with social media report a lower or higher level of self-esteem compared to adolescents who spend less time with social media?

### Social Media Use and Self-Esteem Fluctuations

A second strand of personality and social psychological research has focused on the instability of self-esteem. Self-esteem instability refers to the extent to which self-esteem fluctuates within persons (Kernis, 2005). Whereas research into the level of self-esteem has predominantly tried to establish differences in self-esteem *between* persons, work on self-esteem instability has focused on fluctuations in self-esteem *within* persons. Rosenberg (1986) distinguishes between two types of within-person self-esteem fluctuations: baseline and barometric instability. Baseline instability refers to potential within-person changes in levels of self-esteem that occur slowly and over an extended period of time. It has been shown, for example, that self-esteem decreases in early adolescence after which it may slowly and steadily increase again in later adolescence (Harter & Whitesell, 2003). Barometric fluctuations, in contrast, reflect short-term within-person fluctuations in self-esteem as a result of one's everyday positive and negative experiences. Rosenberg (1986) argued that such barometric fluctuations are particularly evident during adolescence, when adolescents typically experience enhanced uncertainty about their identity (i.e., how to define who they are and will become), intimacy (i.e., how to form and maintain meaningful relationships), and sexuality (e.g., how to cope with sexual desire and define their sexual orientation; Steinberg, 2011).

One of the aims of the current study is to investigate how SMU may induce within-person fluctuations in barometric self-esteem. Two earlier social media effects studies have focused on within-person effects, one longitudinal study (Boers *et al.*, 2019,  $M_{\text{age}} 17.7$ ) and one experiment (Thomaes *et al.*, 2010, 8–12 years). Using Rosenberg's self-esteem scale, Boers *et al.* found negative within-person effects of SMU on baseline self-esteem. However, because the assessments of SMU and self-esteem were one year apart, and because short-term fluctuations can hardly be derived from designs with longer-term measurement intervals (Keijsers & van Roekel, 2018), this study, although important, may not inform a hypothesis on the influences of SMU on barometric self-esteem.

A within-person experiment by Thomaes *et al.* (2010) does confirm self-esteem instability theories in the context of SMU. Thomaes *et al.* based their experiment on Leary and Baumeister's (2000) Sociometer theory. Like Rosenberg's theory of self-esteem, Sociometer theory proposes that self-esteem serves as a sociometer

(cf. barometer) that gauges the degree of approval and disapproval from one's social environment. An important proposition of Sociometer theory is that self-esteem changes are accompanied by changes in affect (mood and emotions). Self-esteem (and affect) goes up when people succeed or when others accept them, and it drops when people fail or when others reject them. The results of Thomaes *et al.* confirmed Sociometer theory: When preadolescents' online social media profiles were approved by others, their self-esteem increased, and when their online profiles were disapproved, their self-esteem dropped.

In Thomaes *et al.*'s study, peer approval was experimentally manipulated so that one group of preadolescents (8-13 years) received positive feedback and an equally sized group received negative feedback on their online profiles. In reality, however, peer approval and disapproval in social media interactions are typically not as neatly balanced. In fact, studies have often reported a positivity bias in social media-based interactions (e.g., [Reinecke & Trepte, 2014](#); [Waterloo \*et al.\*, 2017](#)), meaning that social media users tend to share and receive more positive than negative information. This positivity bias also strongly holds for adolescent social media users. For example, among a national sample of adolescents, only 8% "sometimes" received negative feedback on their posts, whereas 91% "never" or "almost never" received such feedback ([Koutamanis \*et al.\*, 2015](#)). Therefore, on the basis of Sociometer theory, the positivity bias of social media interactions, and the findings of Thomaes *et al.*, we expect an overall positive within-person effect of time spent with social media on adolescents' self-esteem:

(H1) Overall, adolescents' self-esteem will increase as a result of their time spent with social media in the past hour.

### **Heterogeneity in the Effects of Social Media Use on Self-esteem**

Most media effects theories that have been developed during and after the 1970s agree that media effects are conditional, meaning that they do not equally hold for all media users (for a review see [Valkenburg \*et al.\*, 2016](#)). These theories have sparked numerous media effects studies trying to uncover how certain dispositional, environmental, and contextual variables may enhance or reduce the cognitive, affective, and behavioral effects of media. In the past decade, this media effects research has resulted in an upsurge in meta-analyses of media effects, which not only helped integrating the findings in this vastly growing literature, but also pointed at the moderators that may explain differential susceptibility to media effects.

Despite their undeniable value, the effect sizes for both the main and moderating effects of media use that these meta-analyses have yielded typically range between  $r = .10$  and  $r = .20$  ([Valkenburg \*et al.\*, 2016](#)). Although small to medium effect sizes are common in many neighboring disciplines, some media scholars have argued that such small media effects defy common sense because everyday experience offers anecdotal evidence of strong media effects for some individuals ([Valkenburg \*et al.\*,](#)

2016). Moreover, qualitative studies have repeatedly confirmed that media users differ greatly in their responses to (social) media (e.g., Rideout & Fox, 2018). And studies on the emotional reactions to scary media content have reported extreme responses for particular individuals (Cantor, 2009).

There is an apparent discrepancy between the magnitude of conditional media effects sizes reported in quantitative studies and meta-analyses on the one hand and the results of qualitative studies and anecdotal examples on the other. By focusing on group-level moderator effects, meta-analyses (and the studies on which they are based) invariably gloss over more subtle individual differences between people (Pearce & Field, 2016). Diving deeper into these subtle individual differences, however, is only possible with research designs that are able to detect differences in person-specific effects. Such designs require a large number of assessments per person to derive conclusions about processes within single persons, as well as a sufficient number of participants for bottom-up generalization to sub-populations (Voelkle et al., 2012).

An important aim of this study is to capture such person-specific susceptibilities to the effects of SMU by employing a novel method of analysis: Dynamic Structural Equation Modeling (DSEM). DSEM is an advanced modeling technique that is suitable for analyzing intensive longitudinal data, that is, data with 20 to more than 100 repeated measurements that are typically closely spaced in time (McNeish & Hamaker, 2020). DSEM combines the strengths of multilevel analysis and Structural Equation Modeling (SEM) with  $N = 1$  time-series analysis.  $N = 1$  time-series analysis enables researchers to establish the longitudinal (lagged) associations between SMU and self-esteem within single persons. The multilevel part of DSEM provides the opportunity to test whether the person-specific effect sizes of SMU on self-esteem differ between persons. Combining the power of a large number of assessments of single persons with a large sample, DSEM may help us answer the question: For how many adolescents does SMU support their self-esteem, for how many does it hinder their self-esteem, and for how many does it not affect their self-esteem?

Not only media effects theories, but also self-esteem theories give reason to assume person-specific effects of environmental influences on self-esteem. These theories agree that some individuals experience significant boosts (or drops) in self-esteem when they experience minor disapproval (or approval) from their peers, whereas the self-esteem of others may fluctuate only in case of serious self-relevant experiences (Crocker & Brummelman, 2018). For example, a study by Harter and Whitesell (2003) showed that 59% of adolescents were prone to self-esteem fluctuations, whereas 41% were not or less prone to such fluctuations. Based on these insights of self-esteem theories, it is likely that the effects of SMU will also differ from adolescent to adolescent. Due to the positivity bias of social media interactions, we expect that most adolescents will experience *increases* in self-esteem as a result of their SMU in the past hour, whereas a smaller group will experience *decreases* in

self-esteem, and for another smaller group of adolescents their SMU will be *unrelated* to their self-esteem. Therefore, we hypothesize:

(H2) The effect of time spent with social media on self-esteem will vary from adolescent to adolescent.

## Method

### Participants

This preregistered study is part of a larger project on the psychosocial consequences of SMU. The present study uses data from the first three-week experience sampling method (ESM) wave of this project that took place in December 2019. The sample consisted of 387 early and middle adolescents (13- to 15-year-olds; 54% girls;  $M_{\text{age}} = 14.11$ ,  $SD = .69$ ) from a large secondary school in the southern area of The Netherlands. Participants were enrolled in three different levels of education: 44% were in lower prevocational secondary education (VMBO), 31% in intermediate general secondary education (HAVO), and 26% in academic preparatory education (VWO). Of all participants, 96% was born in The Netherlands and self-identified as Dutch, 2% was born in another European country, and 2% in a country outside Europe. The sample was representative of this area in The Netherlands in terms of educational level and ethnic background (Statistics Netherlands, 2020).

### Procedure

The study was approved by the Ethics Review Board of the University of Amsterdam. Before the start of the study parents gave written consent for their child's participation in the study, after they had been extensively informed about the goals of the study. At the end of November 2019, participants took part in a baseline session during school hours. Researchers informed participants of the aims and procedure of the study and assured them that their responses would be treated confidentially. Participants were provided with detailed instructions about the ESM study that started in the week following upon the baseline survey. They were instructed on how to install the ESM software application (Ethica Data) on their phones, and how to answer the different types of ESM questions. At the end of the baseline session, participants completed an initial ESM survey on their use of different social media platforms, which we used to personalize subsequent ESM surveys. In case of questions or problems with the installment of the software, three researchers were present to help out.

**ESM study.** In the three-week ESM study, participants completed six 2-minute surveys per day in response to notifications from their mobile phones. The first and last ESM surveys contained 24 questions, whereas each of the other four ESM surveys consisted of 23 questions. Each ESM survey assessed, among other variables not reported in this study, participants' self-esteem and their SMU. Participants

received questions about their time spent with Instagram, WhatsApp, and Snapchat if they had indicated in the baseline session that they used these platforms more than once per week. In case participants did not use any of these platforms more than once a week, they were surveyed about other platforms that they did use (e.g., YouTube or gaming). If they did not use any other platforms either, they received other questions to ensure that each participant received the same number of questions. In total, 375 (97%) participants received questions about WhatsApp, 345 participants (89%) about Instagram, and 285 (73%) about Snapchat.

**Sampling scheme.** In total, participants received 126 ESM surveys (i.e., 21 days \* 6 assessments a day) at random time points within fixed intervals. The sampling scheme was tailored to the school's schedule and participants' weekday and weekend routines to avoid that participants received notifications during class hours and while sleeping in on the weekends. Five to ten minutes after each ESM notification, participants received an automatic reminder. We have uploaded our entire notification scheme with the response windows on OSF.

**Monitoring plan/incentives.** We regularly messaged adolescents to check whether we could help with any technical issues and to motivate them to fill out as many ESM surveys as possible. Adolescents received a small gadget for participating in the baseline session, and a compensation of €0.30 for each completed ESM survey. In addition, each day we held a lottery, in which four participants who had completed all six ESM surveys the day before could win €25.

**Compliance.** We sent out 48,762 surveys (i.e.,  $387 \times 126$ ) to participants. Due to unforeseen technical problems with the Ethica software, 862 ESM surveys did not reach participants. As a result, 47,900 ESM surveys were received, and 34,930 surveys were completed. This led to a compliance rate of 73%, which is good in comparison with previous ESM studies among adolescents (van Roekel et al., 2019). On average, participants completed 90.26 ESM surveys ( $SD = 23.84$ ).

**A priori power-analyses.** The number of assessments was determined based on the fact that a minimum of 50–100 assessments per participant is recommended to conduct  $N = 1$  time-series analyses (Voelkle et al., 2012). In order to obtain at least 50 assessments per participant, we took a conservative approach and scheduled for a total of 126 assessments. A priori power analyses indicated that a number of 300 participants would suffice to reliably detect small effect sizes with a minimum power of .80 and significance levels of  $p = .05$ .

## Measures

**Time spent with social media.** To obtain an ecologically valid ESM assessment of time spent with social media, we asked participants at each assessment how much time in the past hour they had spent with the three most popular platforms: WhatsApp, Instagram, and Snapchat. For each platform, we selected the most popular activities (van Driel et al., 2019). For Instagram, we asked: How much time in the past hour have you spent. . . (1) sending direct messages on Instagram? (2)



reading direct messages on Instagram? (3) viewing posts/stories of others on Instagram? For WhatsApp, we asked: How much time in the past hour have you spent. . . (4) sending messages on WhatsApp? (5) reading messages on WhatsApp? For Snapchat we asked: How much time in the past hour have you spent. . . (6) viewing snaps of others on Snapchat? (7) viewing stories of others on Snapchat? (8) sending snaps on Snapchat? Response options for each of these activities were measured with a Visual Analog Scale (VAS) that ranged from 0 to 60 minutes with one-minute intervals.

Participants' scores on these activities were summed for each of the three platforms. For some assessments this summation led to time estimations exceeding 60 min. For WhatsApp this pertained to 0.85% of all 34,127 assessments, for Instagram to 2.40% of all 31,718 assessments, and for Snapchat to 3.87% of all 26,533 assessments. As indicated in our preregistration, these scores were recoded to 60 min. In a next step, the indicated times spent with WhatsApp, Instagram, and Snapchat were summed to create a variable "time spent with social media." The summation of the three platforms again led to some estimations exceeding 60 min (i.e., 10.64% of all 34,686 estimations). In accordance with our preregistration, these scores were recoded to 60 min.

**Self-esteem.** Based on Rosenberg's (1965) self-esteem scale, and studies establishing the validity of single-item measures of self-esteem (e.g., Robins *et al.*, 2001), we presented participants with the question: "How satisfied do you feel about yourself right now?" We used a 7-point response scale ranging from 0 (not at all) to 6 (completely), with 3 (a little) as the midpoint.

### Method of Analysis

As preregistered, we employed Dynamic Structural Equation Modeling (DSEM) for intensive longitudinal data in Mplus Version 8.4. Following the recommendations of McNeish and Hamaker (2020), we estimated a two-level autoregressive lag-1 model (AR[1] model) with self-esteem as the outcome. At the within-person level (level 1), we specified SMU in the past hour as the time-varying covariate of self-esteem (to investigate H1), while controlling for the autoregressive effect of self-esteem (i.e., self-esteem predicted by lag-1 self-esteem). At the between-person level (level 2), we included the latent mean level of self-esteem and the latent mean of SMU in the past hour, and the correlation between these mean levels (to investigate RQ1). Finally, we included the between-person variances around the within-person effects of SMU on self-esteem (i.e., random effects to investigate H2).

Before estimating the model, we checked the required assumption of stationarity, that is, whether the mean of the outcome did not systematically change during the study (McNeish & Hamaker, 2020). To do so we compared a two-level fixed effect model with day of study predicting self-esteem with an intercept-only model (i.e., a model without predictors). The assumption of stationarity was confirmed: Day of the study explained only 0.82% of the within-person variance in self-esteem.

**Model specifications.** By default, DSEM uses Bayesian Markov Chain Monte Carlo (MCMC) for model estimation. We followed our preregistered plan of analyses and ran the DSEM model with a minimum of 5,000 iterations. Before interpreting the estimates, we checked whether the model converged following the procedure of Hamaker et al. (2018). Model convergence is considered successful when the Potential Scale Reduction (PSR) values are very close to 1 (Gelman & Rubin, 1992), and the trace plots for each parameter look like fat caterpillars. We interpreted the parameters with the Bayesian credible intervals (CIs), as well as the Bayesian  $p$ -values. The hypotheses are confirmed if the 95% CIs for the effect of SMU on self-esteem (within-level; H1) and for the variance around this effect (between-level; H2) do not contain 0. Further details of the analytical strategy can be found in the preregistration of the study.

## Results

### Correlations and Descriptives

Table 1 presents the means, standard deviations (SDs), ranges, and the within-person, between-person, and intra-class correlations (ICCs) of time spent with social media (SMU) and self-esteem. As the table shows, the average level of self-esteem was high ( $M = 4.09$ ,  $SD = 1.12$ , range = 0–6). Participants spent on average almost 17 minutes (range 0–60 min.) with social media in the hour before each measurement occasion. The between-person association of the mean level of SMU with the mean level of self-esteem was significantly negative ( $r = -.14$ ,  $p = .005$ ). The within-person correlation was close to zero ( $r = -.01$ ,  $p = .028$ ), but significant (due to the high power of the study).

The Intra-Class Correlations (ICCs) were .45 for self-esteem and .48 for SMU, which means that 45% of the variance in self-esteem and 48% of the variance in

**Table 1** Descriptive Statistics and Within-Person, Between-Person, and Intra-Class Correlations of Time Spent with Social Media (SMU) and Self-Esteem

	Descriptive statistics			Correlations		
	Range	$M$	$SD$	Within	Between	Intra-Class
Self-esteem	0–6	4.09	1.12	n/a	n/a	.45
SMU	0–60	16.93 <sup>a</sup>	14.48	-.01 <sup>b</sup>	-.14 <sup>c</sup>	.48

Notes.

<sup>a</sup>Mean scores reflect average number of minutes spent with social media in the past hour.

<sup>b</sup>Within-person association ( $p = .028$ ) between SMU and self-esteem.

<sup>c</sup>between-person association ( $p = .005$ ) between SMU and self-esteem.

SMU was explained by differences between participants (i.e., between-person variance), whereas the larger part of these variances (55% and 52%) was explained by fluctuations within participants (i.e., within-person variance). These ICCs confirm that our sampling scheme of six assessments a day was appropriate for assessing within-person fluctuations in self-esteem and SMU and led to data with sufficient within-person variance for DSEM analyses.

### DSEM Results

In all the steps of the analysis strategy, we followed our preregistered plan. We first ran a DSEM model with a minimum of 5,000 iterations (and a default maximum of 50,000 iterations) and one-hour time intervals ( $TINTERVAL = 1$ ). This model did not converge: The Potential Scale Reduction (PSR) convergence criterion reached 1.354, which is not close enough to 1. As recommended by [McNeish and Hamaker \(2020\)](#), in a next step, we improved the model setup by increasing the time interval from 1 to 2 hours ( $TINTERVAL = 2$ ). This model converged well and before the 5,000 iterations. The PSR for this model was 1.006. Visual inspection of the trace plots confirmed that convergence was successful. Finally, we also ran a model with 10,000 iterations to exclude the possibility that the PSR value of 5,000 iterations was close to 1 by chance ([Schultzberg & Muthén, 2018](#)). This model reached a PSR of 1.002, and its results did not deviate from the model with 5,000 iterations.

### Investigating Research Question and Hypotheses

To answer our research question (RQ1), we investigated the between-person association between SMU and self-esteem. The DSEM analyses revealed a significantly negative association of  $-.147$  between SMU and participants' level of self-esteem, meaning that participants who spent more time with social media across the three weeks had a lower average level of self-esteem compared to participants who spent less time with social media across this period ([Table 2](#)).

Our first hypothesis (H1) predicted an overall positive within-person effect of SMU on self-esteem. This within-person effect represents the average changes in self-esteem (i.e., self-esteem controlled for self-esteem at  $t-1$ ) as a result of SMU in the previous hour. This hypothesis did not receive support. Despite the high power of the study, the within-person effect was nonsignificant ( $\beta = -.009$ ), meaning that, on average, participants' self-esteem did not increase nor decrease as a result of their SMU in the previous hour ([Table 2](#)).

Our second hypothesis (H2), which predicted that the within-person effect of SMU on changes in self-esteem would differ from participant to participant, did receive support ([Table 2](#): random effect = 0.006,  $p = .000$ ). This random effect means that there was significant variance between participants in the extent to which their SMU in the previous hour predicted changes in their self-esteem.

**Table 2** DSEM Results of the Between-Person Associations and Within-Person Effects of Time Spent with Social Media (SMU) and Self-Esteem (S-E)

	<i>b</i>	$\beta$	<i>P</i>	95% CI
Between-Person associations				
SMU & S-E (RQ1)	-.239	-.147	.003	[-.243, -.043]
SMU & $\beta^a$	-.004	-.035	.354	[-.213, .149]
S-E & $\beta^b$	-.026	-.298	.000	[-.447, -.144]
Within-Person effects				
SMU $\rightarrow$ S-E (H1; $\beta$ )	-.008	-.009	.088	[-.024, .005]
S-E ( <i>t</i> -1) $\rightarrow$ S-E ( <i>t</i> )	.222	.221	.000	[.208, .236]
	$\sigma^2$		<i>p</i>	95% CI
Random effect	0.006		.000	[0.004, 0.008] <sup>c</sup>
SMU $\rightarrow$ S-E (H2)				
Other variances				
SMU (between-person)	2.117		.000	[1.840, 2.458]
SMU (within-person)	2.300		.000	[2.267, 2.335]
S-E (between-person)	1.255		.000	[1.088, 1.459]
S-E (within-person, residual)	1.274		.000	[1.254, 1.293]

*Notes:*

<sup>a</sup>The relationship between SMU and  $\beta$  reflects the extent to which the within-person effect of momentary SMU on momentary S-E depends on the average level of adolescents' SMU;

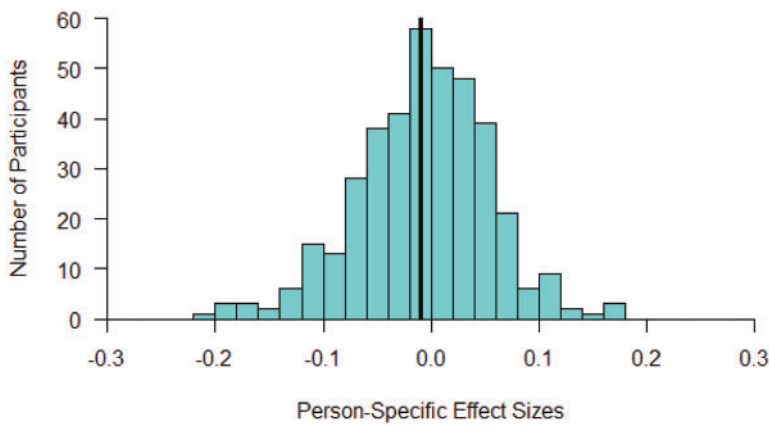
<sup>b</sup>The relationship between S-E and  $\beta$  reflects the extent to which the within-person effect of momentary SMU on momentary S-E depends on adolescents' average level of S-E;

<sup>c</sup>The 95% Credible Interval of the variance around the effect of SMU on S-E indicates that the within-person effect of SMU on S-E differed among participants. *b*'s are unstandardized;  $\beta$ 's are standardized using the STDYX Standardization in Mplus; *p*-values are one-tailed Bayesian *p*-values (McNeish & Hamaker, 2020).

Figure 1 shows the distribution of the person-specific standardized effect sizes for the effect of SMU on changes in self-esteem. These effect sizes ranged from  $\beta = -.21$  to  $\beta = +.17$  across participants. As the bar graph shows, the majority of participants (88%) experienced no or very small positive or negative effects of their SMU (i.e.,  $-.10 < \beta < .10$ ) on changes in self-esteem, whereas a small group of participants (4%) experienced positive ( $.10 \leq \beta \leq .17$ ), and another small group (8%) experienced negative effects ( $-.21 \leq \beta \leq -.10$ ) of SMU on changes in self-esteem. Figure 2 presents the  $N = 1$  time-series plots of three participants, one who experienced a positive, one who experienced a negative, and one who experienced a null-effect of SMU on self-esteem.

**Exploratory Analyses**

In addition to our preregistered hypotheses, we ran four exploratory analyses. In a first step, we investigated potential platform differences. Because earlier studies into

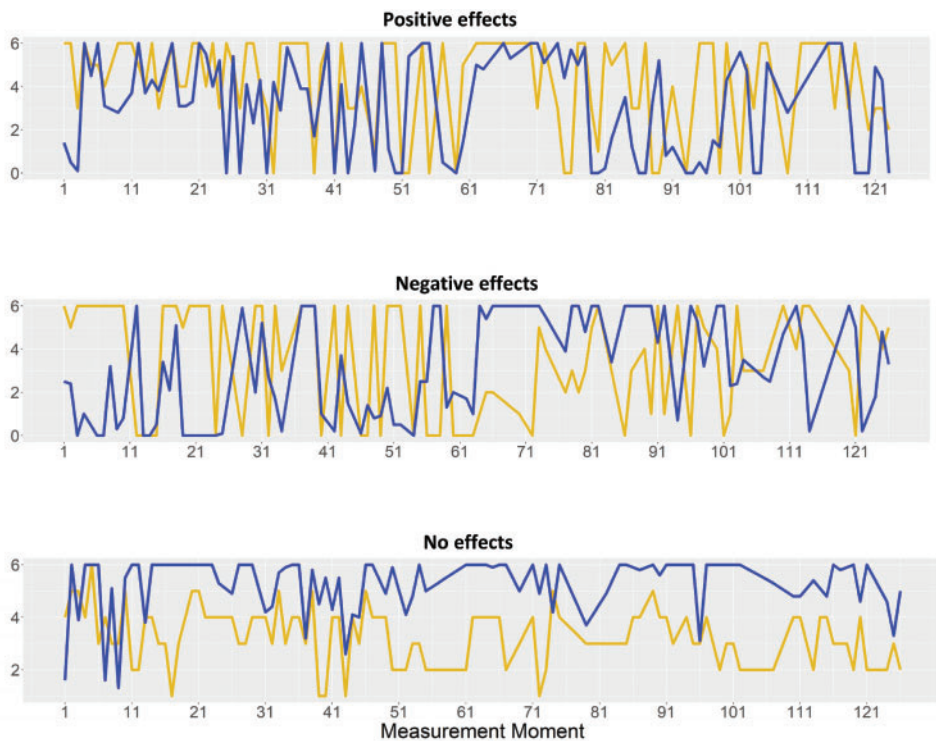


**Figure 1** Range of the Standardized Person-Specific Effects of SMU on in Self-Esteem.  
*Note.* The vertical black line represents the mean of the person-specific effects ( $\beta = -.009$ ).

the relationship between SMU and self-esteem did not investigate differential effects of different platforms, we summed adolescents' use of Instagram, Snapchat, and WhatsApp to create our SMU measure. To explore potential platforms differences, we reran our analyses separately for each of the three platforms. Our results did not show significant differences in the between-person relationships and within-person effects of the use of these platforms on self-esteem (see Supplement 1).

In a second step, we ran a multilevel model without controlling for self-esteem at the previous assessment. Given that DSEM models are rather stringent and that sizeable differences in effect sizes between lagged and non-lagged media effects have been reported (Adachi & Willoughby, 2015), we wanted to get insight into these differences. All other model specifications of the multilevel model were identical to the initial DSEM model. The associations between SMU and self-esteem in the multilevel model ranged from  $\beta = -.34$  to  $\beta = +.33$ . Consistent with the DSEM model, the average within-person association of SMU and self-esteem was close to zero ( $\beta = -.007$ ,  $p = .162$ ,  $CI = [-0.022, 0.007]$  compared to  $\beta = -.009$  in the DSEM model).

In a third step, we explored whether the person-specific within-person effects of SMU on self-esteem (i.e., the  $\beta$ s) differed for adolescents with different mean levels of SMU or different mean levels of self-esteem. As Table 2 shows, the cross-level interaction of participants' mean levels of SMU with the  $\beta$ s was non-significant, indicating that adolescents with higher mean levels of SMU did not experience a more negative (or positive) within-person effect of SMU on their self-esteem than their peers with lower SMU. The cross-level interaction of *self-esteem* and the  $\beta$ s did reveal that the within-person effect of SMU on self-esteem depended on adolescents' mean level of self-esteem: Adolescents with lower average levels of self-esteem had a more positive within-person effect of SMU on self-esteem than adolescents with higher average levels of self-esteem, and vice versa.



**Figure 2** Three  $N = 1$  time-series plots picturing the effects of SMU on self-esteem (S-E). *Note.* The  $x$ -axes represent the measurement moments (range 1–126). The  $y$ -axes represent the co-fluctuations in SMU (blue lines, range 0–60 minutes/10) and S-E (yellow lines, range 0–6). The top plot belongs to a participant who experienced a positive effect of SMU on S-E ( $\beta = .174$ ). The SMU and S-E of this participant regularly co-fluctuated (e.g., around moment 40 and around moment 41). The middle plot is from a participant who experienced a negative effect ( $\beta = -.196$ ): When the SMU of this participant increased, his/her S-E dropped (e.g., around moment 56), and vice versa (e.g., around moment 21). The bottom plot is from a participant who experienced no effects ( $\beta = .013$ ): At some moments, the S-E of this participant increased after his/her SMU increased (e.g., around moment 45), at other moments her/his S-E dropped after his/her SMU went up (e.g., moment 72), resulting in a net effect close to zero.

In a final step, we investigated a between-person hypothesis of one of the anonymous reviewers, who suggested to check whether adolescents with moderate SMU would experience higher trait levels of self-esteem than those with low and high SMU. We investigated this potential inverted U-shaped relationship between SMU and self-esteem by following the two-step hierarchical regression analysis used by Cingel and Olsen (2018). At step 1 of this regression analysis, we found a negative linear relationship between SMU and self-esteem ( $\beta = -.145$ ,  $p = .005$ ;  $R^2 = .021$ , see also Table 1). At step 2, we found no significant curvilinear relationship between

SMU and self-esteem, because the added squared SMU term did not result in a significant change in the explained variance ( $\Delta R^2 = .001$ ,  $\Delta F(1, 380) = .516$ ,  $p = .473$ ).

### Sensitivity Analysis

As preregistered, we conducted a validation check to examine whether participants' answers were trustworthy according to the following criteria: (1) inconsistency of participants' within-person response patterns, (2) outliers, (3) unserious responses (e.g., gross comments) to the open question in the ESM study. Based on these criteria, we considered the responses of eight participants as potentially untrustworthy, because they violated criterion 1 and 2 ( $n = 4$ ) or criterion 1 and 3 ( $n = 4$ ). As a sensitivity analysis, we reran the DSEM analysis without these eight participants. The results of both the between-person and within-person associations did not deviate from those of the full sample.

### Discussion

The two existing meta-analyses on the relationship of SMU and self-esteem assessed the effects of their included empirical studies as weak and their results as mixed (Huang, 2017; Liu & Baumeister, 2016). The between-person associations reported in empirical studies on SMU and self-esteem ranged from  $+ .22$  (Apaolaza *et al.*, 2013) to  $-.28$  (Rodgers *et al.*, 2020). In the current study, the between-person association between SMU and self-esteem fits within this range: We found a negative relationship of  $r = -.15$  between SMU and self-esteem (RQ1), meaning that adolescents who spent more time on social media across a period of three weeks reported a lower level of self-esteem than adolescents who spent less time on social media. This negative relationship pertained to the summed usage of Instagram, Snapchat, and WhatsApp, but did not differ for the usage of each of the separate platforms.

In addition, although we hypothesized a positive overall *within*-person effect of SMU on self-esteem (H1), we found a null effect. However, this overall null effect must be interpreted in light of the supportive results for our second hypothesis (H2), which predicted that the effect of SMU on self-esteem would differ from adolescent to adolescent. We found that the majority of participants (88%) experienced no or very small positive or negative effects of SMU on changes in self-esteem ( $-.10 < \beta < .10$ ), whereas one small group (4%) experienced positive effects ( $.10 \leq \beta \leq .17$ ), and another small group (8%) negative effects of SMU ( $-.21 \leq \beta \leq -.10$ ) on self-esteem.

The person-specific effect sizes reported in the current study pertain to SMU effects on *changes* in self-esteem (i.e., self-esteem controlled for previous levels of self-esteem). As Adachi and Willoughby (2015, p. 117) argue, such effect sizes are often "dramatically" smaller than those for outcomes that are not controlled for their previous levels. Indeed, when we checked this assumption of Adachi &

Willoughby, the associations between SMU and self-esteem not controlled for its previous levels resulted in a considerably wider range of effect sizes ( $\beta = -.34$  to  $\beta = +.33$ ) than those that did control for previous levels ( $\beta = -.21$  to  $\beta = +.17$ ). To account for a potential undervaluation of effect sizes in autoregressive models, Adachi and Willoughby (2015, p. 127) proposed “a more liberal cut-off for small effects in autoregressive models (e.g., small = .05).” In this study, we followed our preregistration and interpreted effect sizes ranging from  $-.10 < \beta < +.10$  as non-existent to very small. However, if we would apply the guideline proposed by Adachi and Willoughby (2015) to our results, the distribution of effect sizes would lead to 21% negative susceptibles, 16% positive susceptibles, and 63% non-susceptibles.

Our results showed that the effects of SMU on self-esteem are unique for each individual adolescent, which may, in turn, explain why the two meta-analyses evaluated the effects of their included studies as weak and their results as inconsistent. First, our results suggest that these effects were *weak* because they were diluted across a heterogeneous sample of adolescents with different susceptibilities to the effects of SMU. This suggestion is supported by comparing our overall within-person effect ( $\beta = -.01$ , ns) with the full range of person-specific effects, which ranged from moderately negative to moderately positive. Second, the effects reported in earlier studies may have been *inconsistent* because these studies may, by chance, have slightly oversampled either “positive susceptibles” or “negative susceptibles.” After all, if a sample is somewhat biased towards positive susceptibles, the results would yield a moderately positive overall effect. Conversely, if a sample is somewhat biased towards negative susceptibles the results would report a moderately negative overall effect.

It may seem reassuring at first sight that the far majority of participants in our study did not experience sizeable negative effects of SMU on their self-esteem. However, as illustrated in the bottom  $N = 1$  time-series plot in Figure 2, for some participants, their non-significant within-person effect may result from strong social media-induced ups and downs in self-esteem, which cancelled each other out across time, resulting in a net null effect. However, as the two upper time-series plots in Figure 2 show, not only the non-susceptibles, but also the positive and negative susceptibles sometimes experienced effects in the opposite direction: The positive susceptibles occasionally experienced negative effects, while the negative susceptibles occasionally experienced positive effects.

Although DSEM models enable researchers to demonstrate how within-person effects of SMU differ *across* persons, they do not (yet) allow us to statistically evaluate the presence of both positive *and* negative effects within one and the same person (Hamaker, 2020, personal communication). A possibility to analyze the combination of positive and negative effects within persons may soon be offered by even more advanced modeling strategies than DSEM, which are currently undergoing a rapid development. Among those promising developments are regime



switching models (Lu *et al.*, 2019), which provide the opportunity to establish the co-occurrence of both positive and negative effects of SMU within single persons.

### Explanatory Hypotheses and Avenues for Future Research

Although our study allowed us to reveal the prevalence of positive susceptibles, negative susceptibles, and non-susceptibles among participants, it did not investigate why and when some adolescents are more susceptible to SMU than others. Our exploratory results did show that adolescents with a lower mean level of self-esteem, experienced a more positive within-person effect of SMU on self-esteem than adolescents with a higher mean level of self-esteem. This latter result may point to a social compensation effect (Kraut *et al.*, 1998), indicating that adolescents who are low in self-esteem may successfully seek out social media to enhance their self-esteem. Our DSEM analysis did not reveal differences in the within-person effects of SMU on self-esteem among adolescents with high and low SMU, suggesting that the positive effects among some adolescents cannot be attributed to modest SMU, whereas the negative effects among other adolescents cannot be attributed to excessive SMU.

An important next step is to further explain why adolescents differ in their susceptibility to SMU. A first explanation may be that adolescents differ in the valence (the positivity or negativity) of their experiences while spending time on social media. It is, for example, possible that the positive susceptibles experience mainly positive content on social media, whereas the negative susceptibles experience mainly negative content. In this study, we focused on time as a predictor of momentary ups and downs in self-esteem. However, most self-esteem theories emphasize that it is the valence rather than the duration of social experiences that results in self-esteem fluctuations. It is assumed that self-esteem goes up when we succeed or when others accept us, and drops when we fail or when others reject us (Leary & Baumeister, 2000). Future research should, therefore, extend our study by investigating to what extent the valence of experiences on social media accounts for differences in susceptibility to the effects of SMU above and beyond adolescents' time spent on social media.

A second explanation as to why adolescents differ in their susceptibility to the effects of SMU may lie in person-specific susceptibilities to the positivity bias in SM. Our first hypothesis was based on the idea that the sharing of positively biased information would elicit reciprocal positive feedback from fellow users, which, in turn, would lead to overall improvements in self-esteem. However, our results suggest that, for some adolescents, this positivity bias may lead to *decreases* in self-esteem, for example, because of their tendency to compare themselves to other social media users who they perceive as more beautiful or successful. This tendency towards social comparison may lead to envy (e.g., Appel *et al.*, 2016) and decreases in self-esteem (Vogel *et al.*, 2014).

Until now, studies investigating the positive feedback hypothesis have mostly focused on the positive effects of feedback on self-esteem (e.g., Valkenburg *et al.*,

2017), whereas studies examining the social comparison hypothesis have mainly focused on the negative effects of social comparison on self-esteem (e.g., Vogel *et al.*, 2014). However, both the positive feedback hypothesis and the social comparison hypothesis are more complex than they may seem at first sight. First, although most adolescents receive positive feedback while using social media, a minority frequently receives negative feedback (Koutamanis *et al.*, 2015), and may experience resulting *decreases* in self-esteem. Likewise, although social comparison may lead to envy, it may also lead to inspiration (e.g., Meier & Schäfer, 2018), and resulting *increases* in self-esteem. Future research should attempt to reconcile these explanatory hypotheses by investigating who is particularly susceptible to positive and/or negative feedback, and who is particularly susceptible to the positive (e.g., inspiration) and/or negative (e.g., envy) effects of social comparison on social media.

Another possible explanation for differences in person-specific effects of SMU on self-esteem may lie in differences in the specific contingencies on which adolescents' self-esteem is based. Self-esteem contingency theory (Crocker & Brummelman, 2018) recognizes that people differ in the areas of life that serve as the basis of their self-esteem (Jordan & Zeigler-Hill, 2013). For example, for some adolescents their physical appearance may serve as the basis of their self-esteem, whereas others may base their self-esteem on peer approval. Different contexts may also activate different self-esteem contingencies (Crocker & Brummelman, 2018). On the soccer field, athletic ability is valued, which may activate the athletic ability contingency in this context. On social media, physical appearance and peer approval may be relevant, so that these contingencies may particularly be triggered in the social media context. It is conceivable that adolescents who base their self-esteem on appearance or peer approval may be more susceptible to the effects of SMU than adolescents who base their self-esteem less on these contingencies, and this is, therefore, another important avenue for future research.

### **Stimulating Positive and Mitigating Negative Effects**

Our results suggest that for the majority of adolescents the momentary effects of SMU are small or negligible. As discussed though, all adolescents—whether they are positive susceptibles, negative susceptibles, or non-susceptibles—may occasionally experience social media-induced drops in self-esteem. Social media have become a fixture in adolescents' social life, and the use of these media may thus result in negative experiences among all adolescents. Therefore, not only the negative susceptibles, but all adolescents need their parents or educators to help them prevent, or cope with, these potentially negative experiences. Parents and educators can play a vital role in enhancing the positive effects of SMU and combatting the negative ones. Helping adolescents prevent or process negative feedback and explaining that the social media world may not be as beautiful as it often appears, are important ingredients of media-specific parenting as well as school-based media literacy programs.

Although this study was designed to contribute to (social) media effects theories and research, our analytical approach may also have social benefits. After all,  $N = 1$  time-series plots could not only be helpful for theory building, but also for person-specific advice to adolescents. These plots give a comprehensive snapshot of each adolescent's experiences and responses across more or less prolonged time periods. Such information could greatly help tailoring prevention and intervention strategies to different adolescents. After all, only if we know which adolescents are more or less susceptible to the negative and positive effects of social media, are we able to adequately target prevention and intervention strategies at these adolescents.

### **Towards a Personalized Media Effects Paradigm**

Insights into person-specific susceptibilities to certain environmental influences is burgeoning in several disciplines. For example, in medicine, personalized medicine is on the rise. In education, personalized learning is booming. And in developmental psychology, differential susceptibility theories are among the most prominent theories to explain heterogeneity in child development. Although  $N = 1$  or idiographic research is now progressively embraced in multiple disciplines, spurred by recent methodological developments, it has a long history behind it. In fact, in the first two decades of the 20th century, scholars such as Piaget, Pavlov, and Thorndike often conducted case-by-case research to develop and test their theories bottom up (i.e., from the individual to the population; [Robinson, 2011](#)). However, in the 1930s, idiographic research soon lost ground to nomothetic approaches, certainly after Francis Galton attached the term nomothetic to the aggregated group-based methodology that is still common in quantitative research ([Robinson, 2011](#)). However, due to technological advancements, it has become feasible to collect masses of intensive longitudinal data from masses of individuals on the uses and effects of social media (e.g., through ESM, tracking). Moreover, rapid developments in data mining and statistical methods now also enable researchers to analyze highly complex  $N = 1$  data, and by doing so, to develop and investigate media effects and other communication theories bottom-up rather than top-down (i.e., from the population to the individual). We hope that this study may be a very first step to a personalized media effects paradigm.

### **Supporting Information**

Additional Supporting Information may be found in the online version of this article.

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