Utrecht University

The Influence of Social Media use on Adolescents' School Performance, and the Role of Sleep Problems and Attention Problems

Leonie Schiphorst, 6014267
Supervisor: Regina van den Eijnden
Name second assessor: Catrin Finkenauer
Faculty: Social Sciences
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Abstract

The last years, researchers have paid more attention to the negative effects of social media use, as there are concerns that social media use (SMU) would negatively affect adolescents' school performances. The present longitudinal study tested whether the use of social media actually affects adolescents' school results, and further investigated whether this relationship can be explained by an increase in attention problems and/or sleep problems. A total of 1038 adolescents (*M* age: 14.5, 48.3% male) completed the questionnaire of the Digital Youth Project twice, with an interval of one year. In line with expectations, the findings indicate that social media use has a negative effect on the subsequent adolescents' school results. Although social media use seems to increase attention problems, and attention problems are associated with lowered school performance, there is little evidence that attention problems would mediate the impact of social media use on adolescents' school performances. Moreover, no evidence was found that the effect of social media use on school grades would be due to an increase in sleep problems. Future research should further investigate the mechanisms through which social media use influences school performances, in order to develop effective prevention and intervention programs.

Keywords: social media, adolescents, school performance, attention problems, sleep problems

Samenvatting

De laatste jaren hebben onderzoekers meer aandacht besteed aan de negatieve effecten van het gebruik van sociale media, omdat de bezorgdheid bestaat dat sociale mediagebruik de schoolprestaties van adolescenten negatief zou beïnvloeden. De huidige longitudinale studie onderzocht of het gebruik van sociale media daadwerkelijk de schoolresultaten van adolescenten beïnvloedt, en onderzocht of deze relatie kan worden verklaard door een toename in aandachtsproblemen en/of slaapproblemen. In totaal hebben 1038 adolescenten (*M*-leeftijd: 14,5, 48,3% man) de vragenlijst van het Digital Youth Project tweemaal ingevuld, met een interval van één jaar. In lijn met de verwachtingen, blijkt uit de bevindingen dat het gebruik van sociale media een jaar later een negatief effect heeft op de schoolresultaten van adolescenten. Hoewel het gebruik van sociale media de aandachtsproblemen lijkt te vergroten, en aandachtsproblemen geassocieerd zijn met verminderde schoolprestaties, is er weinig bewijs dat aandachtsproblemen de impact van het gebruik van sociale media op de schoolprestaties van adolescenten zouden mediëren. Bovendien werd er geen bewijs gevonden dat het effect van het gebruik van sociale media op schoolcijfers toe te schrijven is aan een toename van slaapproblemen. Toekomstig onderzoek zou de mechanismen waarmee het gebruik van sociale media de schoolprestaties beïnvloedt verder kunnen onderzoeken, zodat effectieve preventie- en interventieprogramma's kunnen worden ontwikkeld.

Trefwoorden: sociale media, adolescenten, schoolprestaties, aandachtsproblemen, slaapproblemen

The Influence of Social Media use on Adolescents' School Performance, and the Role of Sleep Problems and Attention Problems

Since the internet became portable, young people started to devote more time to social media (Roberts & Foehr, 2008). Especially among adolescents, the use of social media such as Instagram and Snapchat has increased over the last few years (Anderson & Jiang, 2018; Kloosterman & Van Beuningen, 2015). In 2018, 98.6 percent of Dutch adolescents between 12 and 18 owned a smartphone, and 96.9 percent used social media daily (CBS, 2018).

Despite a growing body of work emphasizing the benefits of SMU to adolescents (Ellison et al., 2007; McLoughlin & Lee, 2010; So, 2016), such as the opportunity to stay involved with peers and the engagement in online social activities (Kuss & Griffiths, 2011; Ryan & Xenos, 2011), also growing attention has been paid to the negative effects of SMU. Scholars have raised concerns that SMU may lead to negative outcomes such as poor school performances (Bailin et al., 2014; Englander et al., 2010; Roberts & Foehr, 2008), which is concerning since it determines how adolescents' lives will eventually evolve (Huang, 2014). Although some existing longitudinal studies test the effect of SMU on adolescents' school performances, these studies have not tested the possible underlying mechanisms. The aim of this longitudinal study, therefore, was to test whether SMU affects adolescents' school performances, as well as possible underlying mechanisms.

SMU frequency and school performance

Several studies demonstrate time spent on social network sites and instant messaging applications correlates with lower learning outcomes (Andersson et al., 2014; Huang & Leung, 2009; Kirschner & Karpinski, 2010; Tang & Hew, 2017). In addition, two reviews report that SMU is correlated with a lower grade point average (GPA) (Hew, 2011; Liu et al., 2017). Moreover, students also report they believe that their SMU contributes to lower academic achievement (Junco & Cotten, 2011; Kloosterman & Van Beuningen, 2015). To our knowledge, the only longitudinal study showed that SMU has a small negative effect on the GPA of adolescents aged 12 to 15 (Van den Eijnden et al., 2018). However, there are also contradictory findings showing no negative relationship between SMU and academic performance (Junco, 2013; Leung, 2015; Pasek & Hargittai, 2009). In sum, most findings indicate a negative relationship between SMU and school performance. Therefore, SMU is hypothesized to have a negative impact on adolescents' school performances (Hypothesis 1). The present study will extend the study by Van den Eijnden et al. (2018), by testing the longitudinal effect of SMU on adolescents' school performances within a somewhat older

sample of adolescents (11 to 17 years), but particularly by investigating two possible underlying mechanisms, namely increased sleep problems and attention problems.

The role of sleep problems

The first underlying mechanism that may explain lowered school performances could be an increase in sleep problems resulting from SMU. Several reviews and cross-sectional studies have found a negative association between SMU and several aspects of sleep quality (Bailin et al., 2014; Bartel et al., 2015; George & Odgers, 2015; Hale & Guan, 2015; Li et al., 2015; Chassiakos et al., 2016; Touitou et al., 2016; Scott & Woods, 2018; Woods & Scott, 2016). It has been found that 86 percent of adolescents sleep with their smartphone on or near their bed (Lenhart et al., 2010), and many adolescents leave their mobile phone on at night to remain accessible (Van den Bulck, 2007). Royant-Parola et al. (2017) found that having a smartphone in the bedrooms is associated with reduced sleep among adolescents. Furthermore, a correlation has been found between SMU and sleep disturbance including night time-specific behaviors such as waking up to check messages or incoming notifications (Levenson et al., 2016; Royant-Parola et al., 2017; Rosen et al., 2016). This late- and overnight mobile phone use is related to less total sleep and lower sleep quality (Calamaro et al., 2009; Van den Bulck, 2004; Wolniczak et al., 2013). This is in line with the longitudinal study by Schweizer et al. (2016), showing that owners of a smartphone sleep significantly less and report more sleeping problems than non-owners. However, according to the longitudinal study by Van den Eijnden et al. (2021), SMU frequency did not significantly predict the perceived quality of sleep.

Three possible mechanisms can explain the pathways through which SMU may impair adolescents' sleep. First, according to the time replacement theory, SMU affects sleep duration because it might displace sleep time (LeBourgeois et al., 2017; Scott & Woods, 2018). Second, emotionally arousing social media content and interactions might make it more difficult to fall and stay asleep due to the activity it causes in the brain (LeBourgeouis et al., 2017; Levenson et al., 2016; Titova et al., 2015). Third, the bright blue light of smartphones can disturb the melatonin production and sleep rhythm of adolescents (LeBourgeois et al., 2017, Chang et al., 2015)**.** Based on these previous studies, SMU is hypothesized to have a negative impact on adolescents' sleep problems (Hypothesis 2).

In addition, it has been found that a reduced amount of sleep is associated with decreased academic performance (Dewald et al., 2010; Shochat et al., 2014). According to Dewald et al. (2020) sleep quality is crucial to adolescents' school performances since it affects brain functioning. This is in line with three reviews indicating that later school starting

times increase sleep quality, and subsequently adolescents' school performances (Minges & Redeker, 2016; Wahlstrom & Owens, 2017; Wheaton et al., 2016). Therefore, it is expected that sleep problems will have a negative effect on adolescents' school performances (Hypothesis 3). Moreover, it is hypothesized sleep problems will play a mediating role in the longitudinal relationship between SMU and school performance (Hypothesis 4).

The role of attention problems

A second mechanism that could underlie the effect of SMU on school performances is attention problems. In several cross-sectional studies, SMU has been associated with attention problems (Rosen et al., 2013; Paul et al., 2012). In the study by Kloosterman and Van Beuningen (2015), two out of five adolescents indicated their SMU negatively impacts their ability for sustained attention. Several studies show adolescents are strongly distracted by social media during academic tasks (Rosen et al, 2013; Levine et al., 2007). The external stimuli generated by smartphones, such as sounds and vibrations, are difficult to ignore for young adolescents, which may limit adolescents' capacity to focus on school tasks (Becker et al., 2013). SMU places a burden on cognitive processing capacity, which negatively affects the ability for sustained attention (Junco et al, 2012). Bowman et al. (2012) found that students who engaged in social media need more time to complete tasks (e.g., reading a passage in a textbook) than those who did not use social media. This is somewhat in line with the longitudinal study by Boer et al. (2020) who found that SMU problems, but not SMU intensity, increased ADHD-symptoms over time, which makes it plausible that problematic SMU mediates the relationship between SMU and attention problems. Because of this, SMU is hypothesized to have a negative impact on adolescents' attention problems (Hypothesis 5).

Moreover, it has been shown that the aforementioned reduced capacity for sustained attention is negatively associated with adolescents' academic performance (Jacobsen & Forste, 2011; Rosen et al., 2013; Polderman et al., 2010). The longitudinal study by Breslau et al. (2008) also shows that adolescents with attention problems have poorer academic performance. An explanation is that adolescents with attention problems have difficulty completing tasks and often do not process all the instructions properly, which increases the chance that they understand and master the subject matter less well (Herman et al., 2007).

Based on this convincing amount of empirical evidence, it is expected that attention problems will have a negative effect on school performances (Hypothesis 6). Finally, it is hypothesized attention problems will play a mediating role in the longitudinal relationship between SMU and school performance (Hypothesis 7). Based on these five hypotheses, a research model was constructed (see Figure 1).

The current study

Although overall findings indicate SMU is mainly negatively associated with school performance, there is hardly any longitudinal research testing the impact of SMU on adolescents' school performances. The only longitudinal study we are aware of, the study by Van den Eijnden et al. (2018) has not tested possible mechanisms underlying the effect of SMU on school performances. Therefore, the present study will use a longitudinal design to gain more insight into the directionality of the relationship between SMU and adolescents' school performances. Moreover, two hypothesized mediators will be tested, namely sleep problems and attention problems, simultaneously. Several studies asked for future studies to examine some of these links (Dewald et al., 2010; Rosen et al., 2013). By filling this gap of knowledge, this study makes an contribution to the existing literature. Besides, this study is innovative because it focuses on a variety of social media platforms in contrast to most studies that mainly focus on Facebook use.

The study is of societal relevance for parents and teachers because the results may help to raise awareness about the effects of SMU on adolescents' school performances. Insights on how SMU may influence adolescents' school performances may be used for the development of interventions and policies aiming at the regulation and reduction of adolescents' SMU and/or improvement of school performances among adolescents.

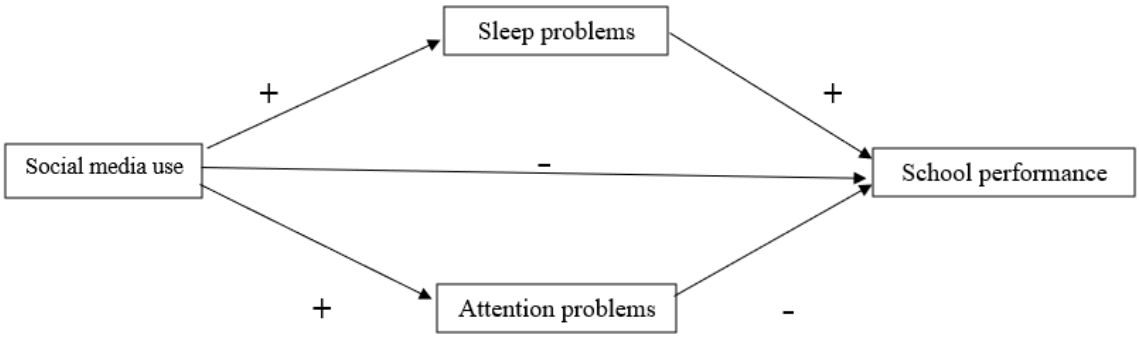

Figure 1. Research model. A negative relationship between social media use (SMU) and school performance, negatively mediated by sleep problems and attention problems.

Method

Design and procedure

The data from this study were obtained from the Digital Youth Project (DiYo), a longitudinal study that started in 2015 with annual measurements. Data were collected among students in 7th and 8th-grade classes of several secondary schools. The study procedures were carried out in accordance with the Declaration of Helsinki and were approved by the board of

ethics of the Faculty of Social Sciences at Utrecht University (FETC16-076 Eijnden). All participants were fully informed about the study and were granted the right to refuse participation at any time. Parental permission for participation of their child was obtained through passive informed consent. Adolescents completed a computer-based questionnaire at school during regular school hours. The duration of the survey is about 30 to 40 minutes and is supervised by a research assistant.

Participants

The data of waves T3 (2017) and T4 (2018) from the 'Digital Youth Project' were used for this current study. In total, 1856 adolescents filled in the T3 questionnaire and had a value on GPA at T3. However, adolescents were only included in the final sample when they also participated in the follow-up wave and when we received information from schools about their GPA at T4. This final sample consisted of 1038 participants (dropout: 44.07%), including 501 males (48.3%) and 537 females (51.7%) with an age range of 11 to 17 years (M = 13.59, SD = 1.22) at T3, and with 82.9% of participants being of Dutch origin. At T4, 31.3% of the sample was attending a low education level, 9.5% was attending a middle education level and 59.2% was attending a high education level. Non-response was mainly due to dropout of whole classes and dropout of single adolescents because of illness or other reasons for absence during the data collection.

An attrition analysis was performed using binary logistic regression with the dropout group (participating at T3, but not at T4) and the completers group, (participating at T3 and T4) as latent variables. Results showed that adolescents who scored significantly lower on GPA at T3 were more likely to drop out at T4 (OR= 1.954). Furthermore, the dropout group consisted of more boys, more adolescents with a low educational level and higher age and adolescents with a migration background (ORrange = .515 to 2.325). The magnitudes of these associations varied from small (OR < 1.5) to large (OR < 3) (Sullivan & Feinn, 2012), indicating associations between dropout and some of our study variables. Finally, the results showed that 23.5% of the variance could be explained by demographic variables and 8.4% % of the variance could be explained by GPA.

Measuring instruments

SMU Frequency. SMU frequency was measured by two items about passive and four items about active use of social networking sites (e.g., Facebook, Instagram, and Twitter), and instant messaging applications (e.g., WhatsApp, Snapchat, and Facebook messenger). The questionnaire included questions as 'How often a day do you check social networking sites?'

and 'How often a week do you like a post, picture or video of another person on social networking sites?' (Van den Eijnden et al., 2016). These questions were measured on a seven-point scale ranging from ranging from 1(*less than once a day/week*) to 7 (*more than 40 times a day/week*). SMU frequency was calculated taking the mean of all six questions to make one scale. The reliability analysis revealed good reliability for this scale at T3 (Chronbach's α = .835).

School performance. School performance was measured by the Grade Point Average (GPA) that was calculated based on basis of the school grades that were provided by the schools. GPA was computed as the average grade of six courses and ranged from 0 to 10.

Sleep problems. Sleep problems were measured by five items of the Groninger slaapkwaliteit schaal (GSKS) (Meijman et al., 1988). These questions were measured on a five-point scale ranging from 1 *(never)* to 5 *((almost) always)* and included questions as 'I have the feeling that I did not sleep enough', 'When I wake up at night, I cannot sleep well anymore', and 'I feel rested'. In addition, one more item was used that was included in the Depressive Mood List (Kandel & Davis, 1982), namely the item 'Having trouble falling asleep or staying asleep'. These six questions were taken together into one scale after recoding one question. The reliability analysis revealed good reliability for this scale at T3 (Chronbach's α = .819 and at T4 (Chronbach's α = .828). Factor analysis was conducted and indicated that the assumptions for unidimensionality were met. One factor was identified as underlying the six questionnaire items. A factor analysis was conducted and indicate that the scale was unidimensional. The initial solution explained 54.68 % of the total variance, which is considered to be good.

Attention problems. Attention problems were measured by nine items of the 'AVL-scale' (Scholte & Van der Ploeg, 2010). Questions as 'I avoid tasks that require longer effort, and 'I pay little attention to details and make unnecessary mistakes' were measured on a five-point scale ranging from 1 *(never)* to 5 *(very often).* An average score of the nine items was calculated. The reliability analysis revealed good reliability for this scale at T3 (Chronbach's α = .867) and at T4 (Chronbach's α = .879).

Data-analysis

To analyse the data, IBM SPSS Statistics 26 was used. The data were checked for missing values and answering trends. Subsequently, scales were calculated with help of reliability analyses and factor analysis. To deal with missing values on item-level, the mean score of the variable 'SMU frequency' was calculated in case of at least 50% non-missing

values. Furthermore, descriptive statistics for all variables were requested.

Education level was recoded into low (VMBO), middle (HAVO and VMBO/HAVO) and high (VWO and HAVO/VWO) education level. For the dummy variable ethnicity, participants were categorized as having a migrant background if they, or one of their parents, were born abroad.

Thereafter, correlations between the independent, dependent, mediators, and demographic variables were requested and reported in a correlation matrix (Table 2). Pearson's r and Spearman's rho were used to gain insight into possible influential demographic variables. For correlations that included gender, educational level, or ethnicity, Spearman's rho was used. Pearson's correlation coefficient was used for all other correlations. Demographic variables were included as a control variable in the multiple regression analysis when they met the criteria of a possible confounding variable; being significantly associated with both the independent and the dependent variable.

The assumptions of normality, linearity and homoscedasticity were checked separately before each regression analysis. For the main research question regarding the effect of SMU frequency T3 on GPA T4, hierarchical multiple regression was conducted. The demographic variables and GPA T3 were entered as predictors in the first step, and the main effect of SMU T3 was entered in the second step. To test for a mediation effect of attention problems, the Baron and Kenny (1986) method was used. This first step of this method was already conducted when testing the first hypothesis regarding the main effect of SMU frequency on GPA. In the second step, the link between SMU frequency T3 and the mediating variable T4 (i.e., sleep problems or attention problems) was investigated, while controlling for all demographic variables and the mediator variable T3. In step 3, the link between the mediating variable T4 and GPA T4 was investigated, while controlling for all demographic variables and GPA T3. In the final fourth step, the link of SMU T3 and the mediating variable T4 on GPA T4 was examined, after controlling for all demographic variables, GPA T3 and the mediating variable T3. In addition, a Sobel test was used to determine the significance of the mediator (Sobel, 1982).

Results

Descriptive statistics

In Table 1, the descriptive statistics of the main and mediating variables are presented. There was a significant decrease between GPA T3 (M=6.78, SD=.73) and GPA T4 (M=6.47, SD=.70); t(1037)=14.95, p=000. Moreover, there was a slight decrease in mean score for SMU frequency between T3 (M=3.80, SD=1.30) and T4 (M=3.72, SD=1.22), t(1037)=2.71,

p=.007. The mean of sleep problems is 2.60, this means that on average participants almost never or sometimes have troubles with sleeping. The mean of attention problems is 2.33 indicating that on average participants almost never experience attention problems.

Table 1

Descriptive statistics of study variables.

	N	M	SD	Minimum	Maximum
SMU frequency T3	1038	3.80	1.30	1.00	7.00
SMU frequency T4	1038	3.72	1.22	1.00	7.00
GPA T3	1038	6.78	.73	4.38	8.95
GPA T4	1038	6.47	.70	4.59	9.38
Sleep problems T3	1035	2.59	.87	1.00	5.00
Sleep problems T4	1030	2.61	.87	1.00	5.00
Attention problems T3	1037	2.27	.72	1.00	5.00
Attention problems T4	1034	2.40	.76	1.00	5.00

Correlations

A correlation matrix of all research variables (i.e., SMU frequency, GPA, sleep problems, attention problems) and all demographic variables (i.e., gender, age, migration background, and educational level), is shown in Table 2. SMU frequency is negatively correlated with GPA, both cross-sectionally and longitudinally.

The correlation matrix shows a positive correlation between SMU T3 and attention problems T4, and a negative correlation between attention problems T4 and GPA T4. Moreover, SMU frequency T3 is positively correlated with sleep problems T4, indicating that more use of social media is associated with more sleep problems. However, sleep problems and GPA T4 are not significantly correlated, which means that the assumptions for testing mediation are not fully met.

Moreover, all demographic variables show significant correlations with either independent or dependent variables or both. First, gender is positively correlated with smartphone use T3, sleep problems, and GPA, which means that girls report more SMU, sleep problems and have a higher GPA than boys. Having a higher age is associated with more frequent SMU, more sleep problems and a lower GPA. A higher educational level is positively related to SMU and GPA, which means that adolescents with a high educational

level have a higher GPA and use social media more frequently compared to adolescents with a low educational level. Finally, having a migration background is negatively correlated with GPA T4, meaning that adolescents with a migrant background on average have a lower GPA. The correlations were analysed to check for possible confounding factors. It was decided to control for the following (demographic) variables: age, gender and high educational level.

Table 2

Correlations between social media use (SMU) frequency and GPA, the mediating variables and demographic variables.

Main variables	1	2	3	4	5	6	7	8	9	10
1.SMU frequency T3	1.00	-.197**	-.160**	.142**	.147**	.077*	.211*	-.021	-.034	-.065*
2.GPA T3		1.00	.537**	-.054	-.135**	.146**	-.396**	-.050	.074*	.159**
3.GPA T4			1.00	-.006	-.169**	.139**	-.157**	-.073*	-.311**	.102**
Mediators										
4.Sleep problems T4				1.00	.446**	.153**	.118**	.047	-.059	.068*
5.Attention problems T4					1.00	-.009	.045	-.016	-.038	.072*
Demographics										
6.Gender T4[a]						1.00	-.041	.034	.038	.201**
7.Age T4							1.00	.013	-.311**	.161**
8.Migration backgroundT4[b]								1.00	.057	-.012
9.Eductional level middle T4									1.00	-.391**
10.Educational level high T4										1.00

Note. Spearman's Rho was used for correlations with gender, school-levels, and ethnicity Spearman's rho was used. Pearson's correlation coefficient was used for all other correlations. [a]Reference category = boys. [b] Reference category = Dutch *$p < .05$. **$p < .01$. ***$p < .001$.

SMU frequency and GPA

Hierarchical multivariate regression analysis was used to examine if SMU frequency T3 predicted subsequent lower scores on GPA T4. Table 3 shows a significant negative effect

of SMU T3 on GPA T4, even after adjusting for GPA T3, gender, age and high educational level.

Table 3

The predictive role of social media use (SMU) frequency T3 on GPA T4

	B	*SE*	*Beta*	*p*	ΔR^2
Model 1: Control variables					.322
Gender	1.95	.37	.05	.040**	
Age	.04	.02	.07	.014**	
Educational level high	-.02	.04	-.013	.630	
GPA T3	.56	.03	.58	.000***	
Model 2:predictor					.009
SMU frequency T3	-.05	.01	-.10	.000***	

Note. *p<0.05 **p<0.01.***p<0.001.

The mediating role of sleep problems

To test whether sleep problems mediate the effect of SMU frequency T3 on GPA T4, linear regressions were performed following the four steps of Baron and Kenny (1986). As mentioned earlier, in Table 3, the linear regression analysis showed a significant main effect of SMU frequency T3 on GPA T4. However, SMU frequency T3 does not significantly predict sleep problems T4 (Table 4.1). In addition, sleep problems T4 do not significantly predict GPA T4 (Table 4.2). This means there is no evidence for a mediating effect of sleep problems in the relationship between SMU and GPA. The fourth step is performed for confirmation and indeed showed no mediation effect because SMU frequency T3 still significantly predicts GPA T4 after controlling for sleep problems T4 (Table 4.3).

Table 4.1

The predictive role of social media use (SMU) frequency T3 on sleep problems T4

Model	*B*	*SE*	*Beta*	*p*	ΔR^2
Model 1: control variables					.342
Gender	.15	.05	.09	.001**	
Age	.06	.02	.09	.001**	

Educational level high	.00	.05	.00	.974	
Sleep problems T3	.55	.03	.55	.000***	
Model 2: predictor					.002
SMU frequency T3	.03	.02	.05	.080	

Note. *p<0.05 **p<0.01.***p<0.001.

Table 4.2

The predictive role of sleep problems T4 on GPA T4

Model	*B*	*SE*	*Beta*	*p*	ΔR^2
Model 1: control variables					.321
Gender	.07	.04	.05	.048*	
Age	.04	.02	.07	.015*	
Educational level high	-.02	.04	-.01	.668	
GPA T3	.56	.03	.58	.000***	
Model 2: predictor					.000
Sleep problems T4	-.01	.02	-.01	.667	

Note. *p<0.05 **p<0.01.***p<0.001.

Tabel 4.3

The predictive role of social media use (SMU) frequency T3 on GPA T4 and sleep problems (M)

Model	*B*	*SE*	*Beta*	*p*	ΔR^2
Model 1: control variables					.321
Gender	.07	.04	.05	.048*	
Age	.04	.02	.07	.015*	
Educational level high	-.02	.04	-.01	.668	
GPA T3	.56	.03	.58	.000***	
Model 2: mediator					.000
Sleep problems T4	-.01	.02	-.01	.667	
Model 3: predictor					.008
SMU frequency T3	-.05	.02	-.10	.000***	

Note. *p<0.05 **p<0.01.***p<0.001.

The mediating role of attention problems

To test whether attention problems is a mediator in the relationship between SMU frequency T3 and GPA T4, the procedures of the Baron and Kenny method (1986) were followed again. The first and second step show significant effects, SMU frequency T3 had a significant positive effect on attention problems T4 (Table 5.1), which in turn had a significant negative effect on GPA T4 (Table 5.2). This means that all assumptions of Baron and Kenny (1986) were met. Lastly, the complete model, including the mediator and independent variable, showed that SMU frequency T3 continued to have a significant effect on GPA T4, even after controlling for the possible mediator attention problems T4 (Table 5.3), indicating that there may be a partially mediating effect. However, the Sobel test (1982) shows this partial mediation was only marginally significant, z = -1.78, p = .074 (a: .032; b: -.095, SEa: .016; SEb: .024), which means that attention problems is not a convincing partial mediator in the effect of SMU frequency T3 on GPA T4.

Table 5.1

The predictive role of social media use (SMU) frequency T3 on attention problems T4

Model	*B*	*SE*	*Beta*	*p*	ΔR^2
Model 1: control variables					.291
Gender	.02	.04	.01	.620	
Age	-.04	.02	.06	.019*	
Educational level high	.09	.04	.06	.026*	
Attention problems T3	.57	.03	.54	.000***	
Model 2: predictor					.003
SMU frequency T3	.03	.02	.05	.049*	

Note. *p<0.05 **p<0.01.***p<0.001.

Table 5.2

The predictive role of attention problems T4 on GPA T4

Model	*B*	*SE*	*Beta*	*p*	ΔR^2
Model 1: control variables					.321
Gender	.07	.04	.05	.045*	
Age	.04	.02	.07	.013*	
Educational level high	-.02	.04	-.01	.640	

GPA T3	.56	.03	.58	.000***	
Model 2: predictor					.010
Attention problems T4	-.10	.02	-.10	.000***	

Note. *p<0.05 **p<0.01.***p<0.001.

Table 5.3

The predictive role of social media use (SMU) frequency T3 on GPA T4 and attention problems (M)

Model	*B*	*SE*	*Beta*	*p*	ΔR^2
Model 1: control variables					.321
Gender	.07	.04	.05	.045*	
Age	.04	.02	.07	.013*	
Educational level high	-.02	.04	-.01	.640	
GPA T3	.56	.03	.58	.000***	
Model 2: mediator					.010
Attention problems T4	-.10	.02	-.10	.000***	
Model 3: predictor					.006
SMU frequency T3	-.05	.01	-.08	.002**	

Note. *p<0.05 **p<0.01.***p<0.001.

Discussion

The main goal of this longitudinal study was to examine the effect of SMU on the school performances of Dutch adolescents and to test whether this effect is resulting from an increase in sleep problems and/or attention problems. The results demonstrated that more frequent SMU has a negative effect on adolescents' school performances one year later. It has been found that adolescents who use social media more frequently, report more attention problems and, in turn, have lower school performances. However, the increased level of attention problems resulting from SMU hardly seems to explain the decline in school performances. Finally, sleep problems do not explain the found effect of SMU on school performances.

Social media use and school performance

The results from this study confirm the first hypothesis, that higher levels of SMU would predict a lower school performance one year later. This is in line with the findings of recent review studies which found SMU is correlated with a lower GPA (Hew, 2011; Liu et

al., 2017). The negative impact on school performances might be more pronounced among certain subgroups, e.g., adolescents with attention deficit hyperactivity disorder (ADHD), since they are more likely to be distracted by social media (American Psychiatric Association, 2013). Future research should therefore address whether certain dispositional factors moderate the impact of SMU on school outcomes.

The mediating effect of sleep problems

Firstly, sleep problems have been investigated as a possible explanation for the effect of SMU on school performances. The longitudinal findings imply that more frequent SMU did not predict an increase in sleep problems one year later (H2). Secondly, sleep problems were not associated with lowered school performances (H3). This means that no evidence has been found for a mediating effect of sleep problems (H4).

As stated before, according to the time replacement theory, time spent on social media might displace sleep time (LeBourgeois et al., 2017; Scott & Woods, 2018). However, according to this theory, SMU can also displace time spent on schoolwork (Englander et al., 2010; Liu et al., 2017). Several studies show adolescents are strongly distracted by social media during academic tasks (Rosen et al, 2013; Levine et al., 2007). This makes it plausible that adolescents spend relatively much time on social media during school hours or while doing their homework. As a result, a higher amount of time spent on social media may cause lower school performances.

Moreover, this study focused on daily smartphone while several cross-sectional studies found a positive link between late-night SMU and sleep problems (Arrona-Palacios, 2017; Bruni et al., 2015; Fobian et al., 2016; Harbard et al., 2016). Future research could investigate whether smartphone use before going to bed negatively impacts adolescents' school performances.

The current study found an association between SMU and sleep problems but found no evidence for an effect of SMU on sleep problems over time. However, there could be an effect in the opposite direction since tiredness might reduce the motivation to participate in active behavior and in turn stimulate SMU (Levenson et al., 2016; Magee et al., 2014). Based on this, a promising direction for future research would be the investigation of the effect of sleep problems on SMU.

The mediating effect of attention problems

A second possible explanation that was studied was attention problems. Results of this study indicate that SMU increases subsequent attention problems (H5). This is somewhat in

line with the recent study by Boer et al. (2020), who states that SMU problems increased ADHD-symptoms over time. The results of this study indicate that attention problems were associated with lowered school performances (H6). However, attention problems hardly seem to explain the effect of SMU on school performance (H7). Partial mediation was only marginally significant, which means that increased attention problems probably play no or only a limited role in the relationship between SMU and school performances. A possible explanation for this marginally significant mediation effect may be that the negative impact on attention problems and school performances might be more pronounced among certain subgroups of adolescents (e.g., girls, low-educated) who are more susceptible to media effects than others (Valkenburg & Peter, 2013). Therefore, future research could investigate the longitudinal relations between social media behaviors and attention problems for different subgroups separately.

Moreover, participants could have experienced difficulty estimating their SMU frequency and ADHD-symptoms, which could have led to a deviation between self-reported and observed ADHD- and social media behaviors (Orben & Przybylski, 2019).

Strengths, limitations and future directions

The foremost strength of this study is its two-wave longitudinal design since it offers potential insight into the over-time relationships between SMU and adolescents' school performances. Another strength is the strict hypothesis testing, which required adjusting for previous levels of the dependent variables and demographic characteristics. Because of these rigorous statistical tests, we believe that even small effects that were found can be meaningful.

However, the findings should be interpreted in the light of several limitations as well. Firstly, the yearly time intervals have the drawback that potential relations between daily fluctuations in social media behaviors and attention- or sleep problems could not be observed since behaviors may influence each other within a shorter time frame (Orben, 2020). Moreover, this study only used two waves of data to test the mediation effects. However, three waves of data are required to control for previous measurements and to investigate effects over time with more certainty (Ployhart & MacKenzie, 2014). Another limitation of the present longitudinal design is that causal influences cannot unambiguously be identified since not everything can be controlled for, as is possible with an experimental design. It cannot be ruled out that a third unmeasured factor would be (partly) responsible for the longitudinal associations between SMU and subsequent school performance. Taking these

limitations into account, more longitudinal research on SMU and school performance using more waves and shorter time intervals is desired to replicate the conclusion of this study.

Additionally, all measures in this study were based on adolescents' self-reports, which might be subject to reporting biases (Andrews et al., 2015). According to Parry et al. (2020), SMU frequency may be difficult to recall and estimate since SMU occurs fragmented throughout the day. The use of objective measures such as smartphone applications measuring time spent on social media would be promising, as such measures provide more reliable estimates (Junco, 2013). Future research using these applications in combination with momentary assessments of ADHD-symptoms or sleep time may provide more objective insights into the relationship between SMU, sleep- and attention problems over time (Orben & Przybylski, 2019).

Furthermore, the somewhat overrepresented native and highly educated adolescents compared to the general adolescent population in the Netherlands limit the generalizability of our findings. In addition, there are some differences between participants who dropped out and those who remained in this longitudinal study. The attrition analysis showed that the dropout group scored significantly lower on GPA at T3. Furthermore, the dropout group consisted of relatively more boys, adolescents with a low educational level, older adolescents and adolescents with a migration background. Some of these characteristics may be associated with a stronger relationship between SMU and school performance (Sampasa-Kanyinga et al., 2019), which suggests the effects may be stronger than was found in this study. These significant group differences might limit the unbiasedness of the sample and the generalizability of the results. Therefore, more longitudinal research with a more representative sample is desired to replicate the conclusion of this study.

Finally, our conceptualization of SMU frequency combines passive (e.g., viewing social media) and active social media activities (e.g., responding to messages). Our findings should be interpreted in light of this operationalization. When examining overall SMU, SMU and sleep- and attention problems do not seem to be associated over time. To consolidate this conclusion, there is a need for research the effects of passive and active SMU separately.

Conclusion and implications

This study extends current knowledge obtained by cross-sectional research and highlights the importance of investigating the influence of SMU frequency on adolescents' school performances The findings suggest that SMU frequency decreases school performance among adolescents aged 14 to 18. However, although the findings indicate SMU negatively impact adolescents' sustained attention, and attention problems negatively impact school

performances, attention problems do not seem to explain the effect of SMU on school performances. Moreover, there is no evidence that this relationship can be explained by an increase in adolescents' sleep problems. Future research should examine whether sleep- and attention problems indeed cannot explain the effect of SMU on adolescents' school performances. Furthermore, there is a need for research aiming at the mechanisms through which SMU may influence school performances. For instance, it could be further investigated whether certain dispositional factors or late-night SMU moderate the impact of SMU on school outcomes.

The current study provides some practical implications and input for further research. Firstly, practitioners, school staff, and parents should become more aware of the way SMU might affect school performance since school performances to a large extent determine how adolescents' lives eventually evolve (Huang, 2014). The outcomes can be used to inform policymakers and innovators to think about policies, programs or technologies to regulate and reduce SMU, and to improve adolescents' school performances.

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