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The association between the use of social network sites, sleep quality and cognitive function during the day



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ABSTRACT

Previous studies have suggested that excessive use of the internet can affect the daily cognitive functioning of users. Furthermore, it has been argued that excessive users of the internet could demonstrate addiction behaviour patterns. Social network sites (SNS) are currently one of the most popular applications of internet use and have almost one billion active users. Studies which examined the dependence on the use of internet have found significant association with sleep deprivation. This study examined associations between questionnaire measures of SNS use, sleep quality and everyday cognitive failures in 324 users of SNS. The sample ranged from 18 to 58 years old and was drawn from 29.6% males and 70.4% females from diverse countries and educational backgrounds. Additionally, behaviours indicating potential dependence on SNS were examined with a new-developed questionnaire. Results indicated that increased dependence on SNS was correlated with decreased sleep quality and with increased everyday cognitive failures. The correlation of SNS use with cognitive failures was mediated by sleep quality. Finally, the final nine items of the new developed questionnaire indicated Withdrawal and Compulsion as two distinct but correlated aspects of possible dependence on SNS.

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1. Introduction

The use of the internet constitutes an integral part of daily life activities, especially among young adults (Jones, Johnson-Yale, Pérez, & Schuler, 2007). However, since 1996 an increasing number of researchers have described individuals, using the internet to such an extent, that they started to demonstrate behavioral and psychological patterns seen in other forms of addiction such as drugs, alcohol or gambling (Brenner, 1997; Greenfield, 1999; Young, 1996). The use of internet applications, such as Social Network Sites (SNS) has been increasingly observed since 2004. According to Boyd and Ellison (2007) SNS are:

“Internet applications that allow people to design a public or semi-public profile within a bounded system, interact with a list of other users with whom they share a connection, and view profiles of their list of connections and those made by others within the system” (p. 211).

Studies suggest that SNS are mainly used by young adults (Sheldon, 2008) and that their usage has dramatically increased during the last few years (Kuss & Griffiths, 2011). The increase of SNS and the time spend on them led to the question whether excessive use could lead to dependence symptoms (Echeburua & Corral, 2010). Studies have demonstrated that using SNS to address loneliness and stress (Xu & Tan, 2012) and to maintain and establish new relationships (Wan, 2009; Walsh, White, & Young, 2007) significantly predicted dependence symptoms.

Recent studies have used either adapted versions of the Internet Addiction Test (Young, 1998a; e.g. Cam & Isbulan, 2012; Wan, 2009) or have developed their own scales (e.g. Alabi, 2012; Andraessen, Tosheim, Brunborg, & Pallesen, 2012; Koc & Gulyagci, 2013) to measure SNS addiction. Participants who were identified in these studies as SNS addicted varied from 1.6% to 34% mainly because these studies had used specific and convenient samples (university students and adolescents) and different measures to evaluate SNS addiction. Additionally, they assessed addiction only on one SNS (Griffiths, Kuss, & Demetrovics, 2014). Alternatively, the current study examines dependence on more than one SNS by examining a sample from different educational backgrounds and age groups.

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1.1. The relationship between SNS and poor sleep quality

Studies found that television, computer games and the internet can lead to declination of sleep quality (Choi et al., 2009; Van den Bulck, 2004). Furthermore, a recent literature review (Lam, 2014) suggested that participants who reported sleep problems had 1.5 more chances to be classified as Internet Addicted compare to those who did not report any sleep disturbance.

Moreover, Andraessen et al., 2012 suggested that dependence on SNS was associated with late sleep and late waking hours. Similarly, Wolniczak et al. (2013) found that the participants who were identified as SNS dependent, had 1.3 times greater prevalence of poor sleep quality, than participants who did not report any SNS dependence symptom. However, Wolniczak et al. (2013) examined only Peruvian undergraduate students and investigated dependence on one SNS (Facebook®).

1.2. The relationship between poor sleep quality and cognitive functioning

It has been argued that sleep quality affects the functioning of the prefrontal cortex of the brain which is linked to cognitive activities, such as creativity, integration and planning (Cursio, Ferrara, & De Gennaro, 2006). Furthermore, Wilkerson, Boals, and Taylor (2012) examined the relationship of insomnia and everyday cognitive failures in a large sample ($N = 941$) of young adults (college students) and suggested that insomnia and poor sleep quality were associated particularly with cognitive failures related to distractibility, blunders and poor memory for names. Interestingly, Stickgold and Walker (2007) suggested that sleep quality affects the new learning process, which relates to the ability of the brain to store new learned task to long-term memory and subsequently leads to everyday cognitive failures.

Therefore the aims of this study were to investigate the following research questions: (i) Is there any significant correlation between dependence on SNS, sleep quality and everyday cognitive failures? (ii) Does sleep quality mediate the relationship between SNS dependence and everyday cognitive failures?

We predicted that increased dependence on SNS would be associated with poor sleep quality and an increased level of cognitive failures and that sleep quality would explain the relationship between dependence on SNS and the frequency of everyday cognitive failures.

2. Method

2.1. Participants

A total of 340 participants completed the questionnaires. However, some of the participants were excluded from the present study ($n = 16$), because they reported specific reasons (e.g. noisy housemates, medication) for not being able to have adequate sleep during the past month. The final sample ($N = 324$) consisted of 101 males ($M_{\text{age}} = 26.11$, $SD = 6.54$) and 231 females ($M_{\text{age}} = 24.76$, $SD = 6.37$) ranging from 18 to 58 years old from diverse countries (Greece = 61%, UK = 22.6%, other = 16.4) and educational backgrounds (Bachelor = 49.7%, Postgraduate = 31.1%, College degree and High School = 19.2%).

2.2. Materials

2.2.1. Internet addiction diagnostic questionnaire

SNS dependence was examined with the Internet Addiction Diagnostic Questionnaire (IADQ; Young, 1998b), which we adapted for this study to measure dependence on SNS (Appendix C). The

only change was that the word internet was replaced by the word SNS in each of the items. The IADQ consists of eight two-choice questions (yes/no). A cutoff of five or greater indicates possible dependence. Cronbach's alpha of IADQ in this study indicated an acceptable reliability ($\alpha = .64$).

2.2.2. Social media use questionnaire

In order to examine thoroughly aspects specifically related to the dependence on SNS, we developed a 21-item questionnaire (Appendix A) and evaluated each item based on a five-point Likert scale, ranging from 0 (*never*) to 4 (*always*). We named this questionnaire the Social Media Use Questionnaire (SMUQ).

The questions in the initial version of SMUQ were generated based on the gambling addiction symptoms described in the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; DSM-5; American Psychiatric Association, 2013), from the Internet Addiction Test (IAT; Young, 1998a) and Fagerstrom Test for Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991).

2.2.3. Pittsburg sleep quality index

The differentiation between efficient and poor sleep quality was assessed using the Pittsburg Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The PSQI consists of 19 items asking about seven domains of sleep patterns, in the preceding one month period. The components refer to domains such as daytime dysfunction; subjective sleep quality; sleep duration; use of sleep medication; sleep latency; sleep disturbances and habitual sleep efficiency. The Cronbach's alpha for the current sample was .72.

2.2.4. Cognitive failures questionnaire

Everyday cognitive failures were assessed with Cognitive Failures Questionnaire (CFQ; Broadbent, Cooper, FitzGerald, & Parkes, 1982). The CFQ is a 25 item questionnaire, which examines the frequency of minor mistakes, which relate to perception, distractibility, memory and motor functioning during the last six months. The Cronbach's alpha of CFQ in the current study was ($\alpha = .93$).

2.3. Design

We designed an online cross-sectional study, using iSurvey which is the online survey generating tool of the University of Southampton.

2.4. Procedure

The study was reviewed and approved by the ethics committee of the University of Southampton. The recruitment of participants was based on two different pathways. The study was advertised at the University of Southampton and undergraduate psychology students ($n = 83$) were offered with research credits, in exchange for participation. Additionally, SNS pages in the two most popular SNS (Facebook® and Twitter®), advertised the study in UK and Greek social media groups and contained a link to the online survey ($n = 245$). Participants gave informed consent, filled in the questionnaires and read a page of debriefing information online.

2.5. Statistical analyses

SMUQ was analysed using Principal Component Analysis (PCA) to investigate the structure of the construct of SNS dependence (Tabachnick & Fidell, 2014) with oblique rotation (direct oblimin), due to the expectation that components would be correlated.

Pearson's correlation was used to examine the association

between the IADQ, SMUQ's subscales, PSQI and CFQ. Socio-demographic characteristics of the participants were not controlled because of the low and non-significant correlation that they had with the study's variables. Bias corrected and accelerated bootstrap 95% confidence intervals (CIs) are reported in square brackets.

We conducted mediation analysis using PROCESS method (Hayes, 2013) to investigate whether sleep quality mediated the relationship between SNS dependence and cognitive failures. PROCESS (Hayes, 2013), estimates the coefficients of the mediation using OLS regression (for continuous outcomes) and maximum likelihood regression (for dichotomous outcomes) and produces the direct and indirect effects in mediation analysis with a single or multiple mediators.

3. Results

3.1. Reduction of number of items

An initial PCA was conducted on the 21 items of SMUQ to examine the communality and the significance of correlations values between the items. Two items were excluded from the final analysis due to non-significant correlation ($p > .05$). Furthermore, 10 items were excluded from the final analysis due to the low communalities values (MacCallum, Widaman, Zhang, & Hong, 1999), suggesting that the variance that these items shared with the remained items was low (Field, 2013).

3.2. PCA and final solution of SMUQ

A PCA was conducted (Table 1) on the remaining 9 items with oblique rotation (direct oblimin). The Kaiser–Meyer–Olkin (KMO) measure verified the sampling adequacy for the analysis, $KMO = .87$ and all KMO values for individual items were greater than .85, which is well above the acceptable limit of .5 (Field, 2013). Bartlett's test of sphericity confirmed that the correlations between the items were appropriate for PCA, $\chi^2(36) = 1249.21$, $p < .001$. An initial analysis was run to obtain eigenvalues for each component in the data. Two components had eigenvalues above Kaiser's criterion of 1 and in combination explained 62.67% of the variance. The scree plot showed inflexion that would justify retaining two components. The items that clustered on component one represented *Withdrawal* symptoms, the second component was related to *Compulsion* symptoms (Appendix B). The two components were significantly correlated ($r = .51$). However, the correlation between the two components was moderate and thus, they might have explained unique part of variance. Therefore, we conducted the subsequent analyses by keeping the subscales separate.

3.3. Internal reliability of SMUQ

Cronbach's alpha was $\alpha = .83$, for the *Withdrawal* component and $\alpha = .82$ for the *Compulsion* component. Cronbach's alpha was even higher for all the items of SMUQ, $\alpha = .87$.

3.4. Construct validity of SMUQ

Statistical significant association was found between the total scores of the *Withdrawal* component and the standardised IADQ, $r(324) = .65$, 95%BCa CI [.58, .72], $p < .001$. The effect size was large and explained 42.25% of the total variance in IADQ scores. *Compulsion* component was significantly associated with IADQ scores, $r(324) = .72$, 95%BCa CI [.66, .78], $p < .001$. The effect size was large and explained 51.84% of the total variance in IADQ scores.

3.5. Correlations between SMUQ, IADQ, PSQI and CFQ

Total *Withdrawal* and *Compulsion* scores were significantly associated with PSQI. The results indicated that the more dependent an individual was on SNS the poorer sleep quality they reported. Additionally, *Withdrawal* and *Compulsion* scores' were significantly correlated with CFQ scores. The results suggested that dependence on SNS use was associated with more frequent cognitive failures. Finally, a significant correlation between PSQI and CFQ scores suggested that poor sleep quality was associated with increased numbers of cognitive failures (Table 2).

The finding that SNS dependence indexed by *Withdrawal* and *Compulsion* scores was correlated with CFQ and PSQI was supported by similar correlations between the modified IADQ with CFQ and PSQI (Table 2).

3.6. Analysis of mediation of the relationship between withdrawal subscale, PSQI and CFQ

PROCESS (Hayes, 2013) was selected to examine whether sleep quality indicated by PSQI scores, mediated the effect of *Withdrawal* component on everyday cognitive failures (CFQ). There was a significant indirect effect of *Withdrawal* component of SMUQ on cognitive failures (CFQ) through sleep quality (PSQI), $b = 0.68$, 95% BCa CI [0.49, 0.98]. This represented a medium to large effect size $\kappa^2 = .17$, 95% BCa CI [.12, .24] (Fig. 1).

3.7. Analysis of mediation of relationship between compulsion subscale, CFQ and PSQI

PROCESS (Hayes, 2013) was selected to examine whether sleep quality indicated by PSQI scores, mediated the effect of SNS dependence indexed by *Compulsion* component, on everyday

Table 1

Principal component analysis with oblique rotation on 9 items of the social media use questionnaire. components loadings, communalities, total correlation are reproduced.

Item	Component 1	Component 2	Communalities	Corrected item-Total correlation
1. I struggle to stay in places, where I will not be able to access SNS.	.84	−.06	.67	.68
2. I feel anxious, when I am not able to check my Social network account	.77	.10	.69	.72
3. I feel angry, when I am not able to access my social network account	.75	.03	.60	.62
4. I use SNS when I am in the company of friends	.74	−.07	.51	.52
5. My relatives and friends complain that I spend too much time using SNS	.64	.14	.51	.57
6. I feel guilty for the time I spend on SNS	−.18	.88	.64	.54
7. I stay online longer than I initially intended	.09	.76	.66	.67
8. I spend a large proportion of the day using SNS	.23	.70	.71	.70
9. I lose track of time when I use SNS	.26	.63	.64	.65

Note. Component 1 = component loading of *Withdrawal*, Component 2 = component loading of *Compulsion*. Boldface indicates that the item belongs to this particular component. $N = 324$.

Table 2

Sample sizes, means, standard deviations and correlations between withdrawal, compulsion, CFQ, PSQI and IADQI.

	<i>M</i>	<i>SD</i>	Withdrawal	Compulsion	CFQ	PSQI	IADQI
Withdrawal	4.72	3.86					
Compulsion	6.48	3.59					
CFQ	33.85	15.50					
PSQI	5.12	2.96					
IADQI	2.59	1.80					

Note. Median (*M*), Standard Deviation (*SD*)^a Correlation is significant at the .001 level (two tailed). BCa bootstrap 95% CIs reported in brackets, *N* = 324.

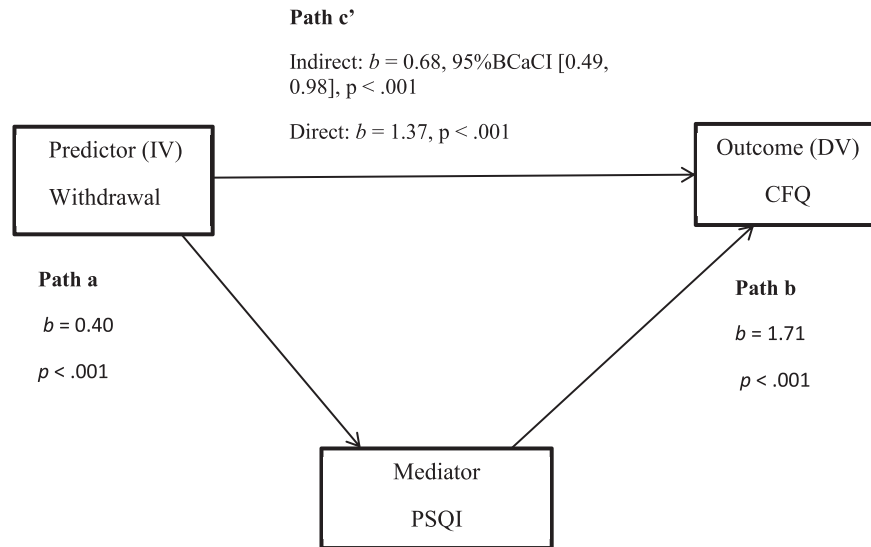


Fig. 1. Regression coefficients for *Withdrawal* component (SMUQ) as a predictor to cognitive failures (CFQ) mediated by the sleep quality (PSQI). The confidence interval for the indirect effect is a BCa bootstrapped CI based on 1000 samples. Path a = the effect of predictor on mediator. Path b = the effect of mediator on outcome. Path c' = the effect of predictor on outcome when mediator is included in the model. *N* = 324.

cognitive failures (CFQ). There was a significant indirect effect of *Compulsion* component of SMUQ on cognitive failures (CFQ) through sleep quality (PSQI), $b = 0.62$, 95%BCa CI [0.40, 0.86]. This represented a medium to large effect size $\kappa^2 = .15$, 95% BCa CI [.10, .21] (Fig. 2).

4. Discussion

This study was conducted to examine the relationship between dependence on SNS, sleep quality and frequency of everyday cognitive failures. Increased dependence on SNS use was associated

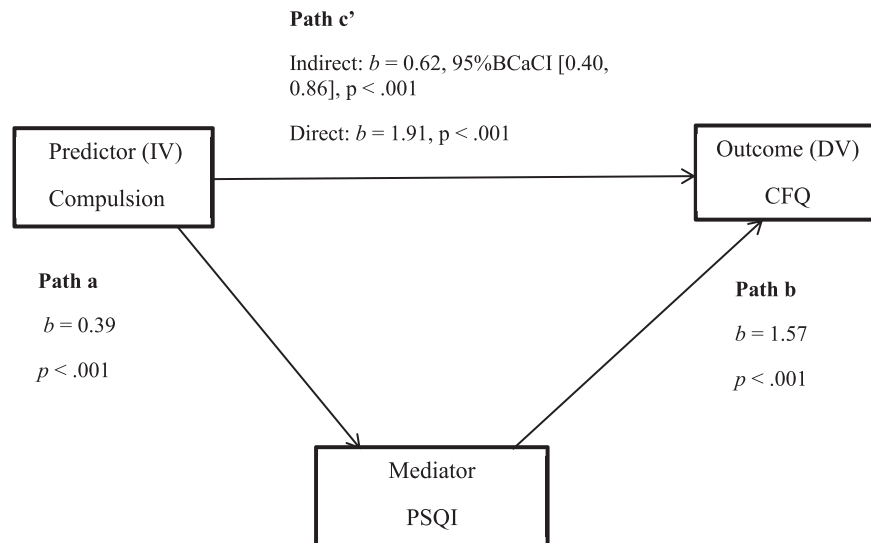


Fig. 2. Regression coefficients for *Compulsion* component (SMUQ) as a predictor to cognitive failures (CFQ) mediated by the sleep quality (PSQI). The confidence interval for the indirect effect is a BCa bootstrapped CI based on 1000 samples. Path a = the effect of predictor on mediator. Path b = the effect of mediator on outcome. Path c' = the effect of predictor on outcome when mediator is included in the model. *N* = 324.

with decreased sleep quality and an increased number of cognitive failures during the day.

These results were in accordance with previous findings, which suggested that, excessive use of SNS (Andraessen et al., 2012; Wolniczak et al., 2013), was highly associated with poor sleep quality. Presumptive interpretations of the relationship between SNS and sleep quality might be that individuals, who have developed dependence on SNS, possibly spend a great amount of time using them in bed and might have less sleep hours, because of the night logins (Wolniczak et al., 2013). As a result they expose themselves to the light of blue end spectrum, which causes disturbance to circadian rhythm and thus, disrupts sleep quality (Barion & Zee, 2007). However, our study's design does not allow us to make such a conclusion and we can only assume that this might be a possible explanation of our findings.

Our study adds to the large body of evidence for the link between sleep quality and the frequency of everyday cognitive failures (Stickgold & Walker, 2007; Wilkerson et al., 2012). A potential explanation for the association between sleep quality and cognitive failures could be the impact that poor sleep has on the prefrontal cortex area of the brain, which is associated with the process of new learning (Stickgold & Walker, 2007) that is affected by sleep quality (Altena, Van Der Werf, Strijers, & Van Someren, 2008; Hauri, 1997; Schneider, Fulda, & Schulz, 2004; Schneider-Helmert, 1987).

We hypothesized that if increased dependence on SNS leads to poor sleep quality it would subsequently increase cognitive failures during the day. Mediation analysis indicated that sleep quality can explain the relationship that we initially reported between the dependence on SNS and cognitive failures, suggesting that SNS dependence affects cognitive failures because of the effect it has on the sleep quality of participants.

However, the mediation model indicated that there was also a direct effect of SNS use on cognitive failures, suggesting that dependence on SNS is associated with increased cognitive failures even when the effect of sleep quality was controlled. This finding could be interpreted by previous findings, which found that multitasking, which refers to the simultaneous performance of two or more cognitive or information activities (Borst, Taatgen, & van Rijn, 2010) and subsequent divided attention profoundly affect cognitive performance (Owens, McLaughlin, & Sudweeks, 2011; Strayer & Johnston, 2001). Furthermore, increased use of SNS was associated with poor performance on memory tasks and this association was significant even when SNS were not used during the tasks (Frein, Jones, & Gerow, 2013).

The lack of existing questionnaires designed to measure dependence on SNS generally rather than on one particular SNS (Griffiths, 2012), led us to modify the widely used IADQ (Young, 1998b) to test our hypotheses (e.g. Wolniczak et al., 2013). We also designed a new questionnaire specific to SNS use (SMUQ), which aimed to be more sensitive, and also to ask about wider range of both SNS and features of addiction than the existing measures of internet or SNS addiction.

In our initial items we endeavored to reflect a broad range of aspects of dependence such as withdrawal, compulsion, impact on daily functioning and relationships, and tolerance or desire for increased amount of time-spend on SNS. However, PCA generated two components in our study (*Withdrawal*, *Compulsion*), suggesting that SNS use might have only these behavioral patterns as indicators for potential dependence. Both subscales had similar correlations with the study's variables. However, the *Compulsion* component of SMUQ which was related to the decreased sense of control around SNS use had higher correlation with IADQ compare to *Withdrawal* component. An explanation for this outcome could be the similar context of questions in both measures. Finally, mediation analysis indicated that sleep quality could explain better

the effect of SNS dependence on cognitive failures when the predictor was the *Withdrawal* component instead of *Compulsion*.

4.1. Implications

This study is unique in the field of research into SNS dependence as most other studies have examined dependence on a specific SNS based activity (e.g. messaging, gaming) or on a single SNS e.g. Facebook® (Griffiths et al., 2014). Therefore individuals who did not use Facebook® but were dependent on an alternative site would have been classified as not SNS dependent.

Furthermore, the questionnaire in our study comprised of two subscales for dependence on SNS and can be used from other researchers to examine not only, the validity of our findings, but also to explore other indicators for dependence on SNS in other samples. Secondly, the study's questionnaire and results were generated from a sample consisted of participants from different age groups, education levels something that was noble in the field of research into SNS dependence, as previous studies had used mainly undergraduate psychology students (Griffiths et al., 2014).

Concerning the implications of the study for clinical practice, we could argue that individuals who suffer from sleep disturbances should become aware of one potential factor (SNS) that might contribute to their poor sleep quality. Secondly, clinicians could use the study's questionnaire to design more targeted interventions (Gupta, Arora, & Gupta, 2013) for SNS dependence which would be based on individual's scores in each subscale. Moreover, clinicians could be aware of one probable cause of poor sleep quality, when they are designing interventions and care plans. Thirdly, individuals who work in positions, where skills such as attention and memory are integral parts could benefit from our results, which indicated the association of SNS dependence with the frequency of everyday cognitive failures.

4.2. Limitations and future research

It may be necessary to interpret the results of this study with caution. Particularly, one of the limitations was the examination of the relationship between SNS, sleep quality and cognitive failures, with correlation methods and self-report data. Hence, our findings suggest that there is only an association between the above-mentioned variables and not causality (Field, 2013). Secondly, dependence on SNS was not evaluated with an already validated and widely used questionnaire. A validated questionnaire that was modified for the current study (IADQ) and a new developed questionnaire particularly for this study (SMUQ) were used to examine the dependence on SNS. Thirdly, the results might be affected by the online cross-sectional design of the study. Specifically, the absence of face-to-face interaction between the researcher and participants has some profound drawbacks; such as the lack of awareness of the participants' behavior, mood or identity (British Psychological Society, 2013). Finally, the study's sample came mainly from British and Greek female participants and thus this limits the generalizability of our results.

Future studies could use SMUQ to evaluate individuals from more cultural backgrounds and from sample with equal amount of male/female participants to explore the generalizability of our results and increase the external validity of the questionnaire.

Moreover, future research could further explore the relationship between SNS, sleep quality and cognitive failures, by examining other variables that could mediate their relationship. Particularly, future studies might include a questionnaire of depression severity, due to the high correlation that it has with poor sleep quality (Baglioni et al., 2011). Finally, future studies could use experimental designs, to explore the direction of the relationship between our

study's variables and to provide more concrete explanations for the reported results.

5. Conclusion

The number of SNS users has increased dramatically, reaching one billion users during the last decade. However, recent studies have reported negative consequences in daily functioning and addiction-like symptoms related to SNS use. This study examined the relationship between the dependence on SNS, sleep quality and everyday cognitive failures. A new scale was designed to measure SNS dependence and comprised of questions related to *Withdrawal* and *Compulsion* symptoms. Results suggested that increased dependence on SNS was associated with decreased sleep quality and everyday cognitive failures. Findings suggested also, that sleep quality can explain the effect of SNS dependence on everyday cognitive failures. Interestingly, there was a significant direct effect of SNS on cognitive failures even when the effect of sleep quality was controlled. The study's results could potentially benefit the field of SNS dependence by providing a new questionnaire. Finally treatment and prevention plans for poor sleep habits could be informed from our results.

Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.chb.2015.09.004>.

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