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Staking out the Field of Distance Learning

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Editorial
Distance Learning: Pitfalls and Possibilities

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The manifold COVID-19 measures have accelerated digitalization, particularly with regards to staying connected with others and continuing one's education in the face of lockdowns and quarantine. Even before the crisis, digitalization has begun to fundamentally change how we teach and learn (Pettersson, 2021). Yet, the introduction of emergency distance learning in early 2020 has led to an unparalleled pervasiveness of video conferencing-platforms in educational settings. While this certainly comes with multiple challenges for both teachers and students, it may also entail promising opportunities for enhancing traditional educational methods. The current editorial will – cursory and by no means exhaustively – pick up on several open research questions and ongoing developments.

Potential pitfalls

Amongst others, it has been suggested that videoconferencing tools may negatively impact the ability to effectively empathize with others. Studies exist for online psychotherapy (Grondin et al., 2019), but findings may also be transferred to the educational setting. Specific characteristics of the medium are thought to alter the way we socially interact online, such as reduced nonverbal cues (mimics, gestures), a decreased synchronicity and immediacy of feedback, problems with transmission quality, and a transformed content of communication (e.g., face-only instead of whole-body-view, altered eye contact). The increased demands on attentional resources arising from these circumstances may hinder attention and lead to tiredness, all of which has been coined as "Zoom fatigue" (Wiederhold, 2020).

Another challenge is brought on by the fact that – in most cases – we see ourselves on screen when talking to others. Some studies have found this to be distracting and to divert attentional resources from the task and, which, in turn, diminishes performance (Payne et al., 2020). Also, seeing oneself deviates from our common experiences in face-to-face communication and – given the increased self-focus – may be particularly challenging for those who are socially anxious (Clark & Wells, 1995).

At the extreme, videoconferencing platforms may also facilitate cyberbullying. Several instances of teacher and peer bullying have been described since the implementation of COVID-19 associated measures (e.g., Ambrožová, & Kaliba, 2021). Factors which may increase the risk of cyberbullying include protected anonymity, social distance, and ever-present availability; particularly, the lack of eye contact has been hypothesized to act as a facilitator for cyberbullying (Grondin et al., 2019).

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Potential possibilities

Apart from these pitfalls, computer mediated communication may also be used to enhance teaching and learning. For instance, a recent analytical report (Flecha et al., 2020) found that particularly rich and dialogic online interactions may promote empathy in children. Based on the self-awareness theory (Duval & Wicklund, 1972), seeing one's video may be regarded as an enhanced state of self-awareness. Self-awareness, in turn, triggers comparisons between one's current behavior and standards of normative behavior, and hence, may increase empathy (Miller et al., 2017).

Overall, enhancing medium richness seems to be the way to counteracting possible pitfalls of videoconferencing technology: For example, fully immersive virtual reality (VR) technology may overcome some restrictions of 2D-video interactions by allowing for the inclusion of a broader range of nonverbal cues (i.e., body language, gestures) and for embodiment (i.e., being represented in VR via an avatar). In addition, rich media like 3D-VR have also been shown to enhance the experience of social presence. Social presence describes the sense of "being together" and is thought to facilitate digital social interactions (Biocca et al., 2001).

Outlook

Currently, online conferencing tools constitute a less than ideal but necessary tool that enables interaction even in the face of restrictions like those associated with the COVID-19 crisis. Research is presently picking up on key topics of computer mediated communication in the context of education, and the future will certainly bring an improvement in the implementation of these technologies. Open issues include the consideration of different age groups in research; for instance, children and adolescents are expected to adopt new technologies differently from older adults because of their early socialization with technologies and their divergent cognitive and emotional development. Furthermore, to ensure inclusion and participation, culture and gender sensitive studies are needed which focus on the individual needs and prerequisites (e.g., access to technologies) of different societal groups.

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Editors-in-Chief

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Conflict of interest

The Editors-in-Chief declare no conflict of interest.

Discrepancies between Self-Reports and Behavior: Fear of Missing Out (FoMO), Self-Reported Problematic Smartphone Use Severity, and Objectively Measured Smartphone Use

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Abstract
Fear of Missing Out (FoMO) is associated with self-reported problematic smartphone use (PSU) severity, but there is little investigation that includes objectively measured smartphone use. The aim of the current study was to provide insights into this domain. We combined the partially published data from two previous U.S.-based studies with college student samples that tracked smartphone use data with a different focus from the current study. Both data sets included socio-demographic measures, FoMO and PSU scale scores, and data for objectively measured screentime and frequency of screen unlocks over a week, amounting up to more than a thousand observations. FoMO had a strong correlation with self-reported PSU severity; however, FoMO was not associated with objectively measured smartphone use variables. FoMO did not predict behavioral smartphone use over a week in multilevel modeling for repeated measures. Even though FoMO is a strong predictor of self-reported PSU severity, it does not predict objectively measured smartphone use.

***Keywords*:** Fear of Missing Out, FoMO, problematic smartphone use, screentime, phone-checking, smartphone tracking

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1 Introduction

In recent years, a vast amount of research has focused on associations between digital technology use and daily life outcomes. In this light, laypersons as well as academics have been interested in how smartphone use correlates with psychological variables and behavior. One line of research has focused on adverse mental health associations with smartphone use; while this phenomenon has been labeled with several terms (including smartphone "addiction"), scholars have been increasingly using "problematic smartphone use" (PSU) over the past few years (Panova & Carbonell, 2018; but see also Elhai, Yang, & Levine, 2020). Yet, few studies have contrasted objectively measured smartphone use (OMSU) variables with PSU and psychological characteristics.

One of the most robust predictors of self-reported (problematic) smartphone use is fear of missing out (FoMO). FoMO is the fear regarding missing out on rewarding social experiences (Przybylski et al., 2013). FoMO has been treated as a potential causal factor for PSU not only in scientific literature, but also in mass media (e.g., Kelly, 2015). Yet, there are currently no studies that have investigated it in comparison to behavioral smartphone use data. This is important, because recent studies have demonstrated that self-reported smartphone use assessments may not be (strongly) associated with objectively measured, actual smartphone use (Parry et al., 2020).

Of relevance, PSU severity has been associated with various psychopathology symptoms, e.g., depression and anxiety (Elhai, Levine, et al., 2019) and social anxiety (Bian & Leung, 2014). PSU severity is also associated with transdiagnostic factors, or characteristics that tend to overlap between different mental disorders, such as dysfunctional emotion regulation (Fu et al., 2020), procrastination (Wang et al., 2019), and trait neuroticism (Marengo et al., 2020). While correlations between PSU severity and other variables tend to be small-to-medium (e.g., r = .20-.30) in magnitude (Elhai et al., 2017), FoMO has been shown to consistently correlate with PSU, yielding medium-to-large correlations of r around .30 to .50 (Elhai, Yang, & Montag, 2020).

In addition to correlating FoMO with PSU severity in several works (Elhai, Yang, Rozgonjuk, et al., 2020; Wang et al., 2019), FoMO also correlates with other variables that are associated with PSU, e.g., procrastination (Müller et al., 2020), negative affectivity (Elhai, Rozgonjuk, Liu, et al., 2020), and trait neuroticism (Balta et al., 2018; Elhai, Yang, & Montag, 2020; Rozgonjuk et al., 2021). Of note, FoMO and PSU also correlate with nomophobia (Gezgin et al., 2018), or the fear of feeling disconnected to the digital world (Rodríguez-García et al., 2020). Yet, nomophobia is distinct from both of these constructs, since PSU reflects the extent of adversities due to excessive smartphone use (Billieux et al., 2015; Panova & Carbonell, 2018), while FoMO in the context of this work is not necessarily bound to digital settings, it could be treated as a trait-like characteristic, and it can also occur outside of the virtual world (Elhai, Yang, & Montag, 2020; Przybylski et al., 2013). Importantly, FoMO may drive more smartphone use, because the apprehension of missing out on experiences, news, etc., keeps people checking their smartphones and engaging in browsing the web and social media feeds (see Elhai, Yang, & Montag, 2020 for a review).

But this line of research suffers from some major limitations. Namely, most studies relied on cross-sectional data and self-reported smartphone use measures. It is also noteworthy that a number of studies have not found a (strong) association between self-reported and objectively measured smartphone use (Ellis et al., 2019; Loid et al., 2020; Parry et al., 2020). One reason could be that OMSU reflects the extent of PSU in *some* participants, who may be vulnerable for developing this condition, but not in others. In other words, while high engagement in smartphone use may be productive for some (e.g., helping with their job or school), it could be problematic for other people (e.g., leading to procrastination, decreased socializing, etc). Another reason could be in operationalizing "smartphone use" – a given study may have focused on different aspects of logged smartphone use data, e.g., duration (screentime), active vs passive duration (e.g., actively browsing vs watching a video, respectively), and/or frequency of use (phone-checking behavior). Please also see that associations between smartphone use and productivity at school or at the job are not likely linear, but might be best depicted by an inverted U-curve (Montag & Walla, 2016). Hence, the "right kind" of smartphone use makes a person more productive, whereas constant interruptions might result in a loss of productivity (Duke & Montag, 2017). Research taking these ideas into account has been scattered thus far.

Because FoMO seems to be one of the more consistent and strongest correlates of PSU severity (e.g., reviewed in Elhai, Yang, & Montag, 2020), it would also be necessary to investigate if it predicts objectively measured smartphone use, namely, use duration (screentime) and frequency (screen unlocks, or phone-checking). For instance, a recent study showed that FoMO is associated with increased disruptions in daily activities from interruptive smartphone notifications, but not with the number of received notifications (Rozgonjuk et al., 2019). While that study used self-reports, it sets up the hypothesis that smartphone-checking behavior (which could occur as a reaction to prompted notifications) could be associated with FoMO. This aspect is not yet explored in the literature. Similarly, knowledge on the association between FoMO and objectively measured smartphone use (screentime and phone-checking behavior) is limited (Elhai et al., 2021; Sela et al., 2020).

The aim of the current study is to investigate if FoMO predicts objectively measured smartphone use. For comparison, associations between FoMO and PSU severity are also examined. Because several studies have demonstrated the relatively strong link between FoMO and PSU severity (e.g., see Elhai, Yang, & Montag, 2020 for a review), we hypothesize that this is also the case in the current study.

H1: *FoMO and PSU are positively correlated.*

A recent study in a sample of adolescents found that FoMO is associated with objectively measured hours spent on the Internet, yielding a correlation of $r = .37$ (Sela et al., 2020). However, the study by Sela et al. (2020) focused only on adolescents and used the aggregated value of general Internet use in analyses and, therefore, did not implement a repeated-measures study design.

Additionally, FoMO is associated with disrupted activities due to push-notifications (Rozgonjuk et al., 2019). Based on this, our second hypothesis is:

H2: *FoMO is positively associated with objectively measured smartphone use duration and frequency.*[1]

The current study can further clarify the role of FoMO in smartphone use and provide insights into the relationships between self-reported and objectively measured smartphone use.

2 Materials and methods

2.1 Data and samples

We used the combined data of two independent projects that included (but was not used in the published works) the same FoMO measure, coupled with PSU questionnaires, as well as similar retrieval methods of OMSU data (Elhai et al., 2018; Rozgonjuk et al., 2018). Both studies investigated associations between OMSU and other psychological variables. The data sets included socio-demographic variables, the FoMO scale (Przybylski et al., 2013), 10-item Smartphone Addiction Scale (SAS-SV; Kwon, Kim, et al., 2013), and objectively measured smartphone use data.

Specific procedures as well as details about samples could be found in the respective publications; both studies comprised American college student samples who were active iPhone us-

1 In the light of the previous work, there are grounds to hypothesize that FoMO could be especially associated with smartphone checking *after receiving push-notifications*. However, we cannot test that hypothesis in the current study.

ers, since the application Moment used in those studies was only available for iOS smartphones.

In brief, the procedure was as follows: after completing the questionnaires in an online survey, eligible participants were invited to participate in a smartphone tracking part of the study. Participants who were interested were asked to install the Moment application on their phones. The participants were tracked for a total of nine days. However, the data from the first (Moment installation) and last (Moment deinstallation and data retrieval) days of tracking were excluded from the analyses. Of note, the Moment app only tracked general smartphone usage (duration and/or frequency) and did not provide information on specific application uses.

The effective sample comprised n = 169 (age M = 19.62, SD = 3.57; 120 women, 49 men) people who all provided insights into several variables (socio-demographics, FoMO, SAS-SV, and minutes of screentime for seven days). In total, this data set included 169 x 7 = 1183 observations for smartphone pick-ups and 101 x 7 = 707 observations for smartphone screentime, granting sufficient statistical power for analyses.

The effective sample included 94 (56%) freshmen, 48 (28%) sophomores, 14 (8%) juniors, ten seniors (6%), and three (2%) people who responded with "other". Among the effective sample, 85 (50%) college students reported being part-time employed, 12 (7%) study participants were full-time employed, and 72 (43%) people reported being unemployed. 79 (47%) respondents reported being in a relationship, whereas 89 (53%) people were not in a relationship.

2.2 Measures

Socio-demographic variables

While there were different socio-demographic variables queried in the two studies, the overlapping variables were age, gender, employment status, student status, and relationship status.

Fear of Missing Out scale

In both studies, the FoMO scale by Przybylski et al. (2013) was used. It is a 10-item Likert-type scale, with responses anchored to 1 = "not at all true of me" to 5 = "extremely true of me". We used the summed score of FoMO. Cronbach's alpha for the merged data set was α = .89; internal consistency ranged from α = .88 to .89, when analyzed separately for each data set.

Smartphone Addiction Scale short version

Although one of the studies (Rozgonjuk et al., 2018) administered the 33-item Smartphone Addiction Scale (Kwon, Lee, et al., 2013), we extracted the ten-item subset that represents the Smartphone Addiction Scale-Short-Version (SAS-SV; Kwon, Kim, et al., 2013) that was used in the other study. Therefore, in the merged data set, the outcome measure was the summed score of the SAS-SV, where each item's response ranged from 1 = "strongly disagree" to 6 = "strongly agree". This scale measures the extent of experiencing PSU. Cronbach's alpha for the scale was α = .86 in the combined data set and ranged from α = .82 to .89, when analyzed separately for each data set.

Objectively measured smartphone use

Both studies by Elhai, Tiamiyu, et al. (2018) and Rozgonjuk, Levine, et al. (2018) included daily objectively measured smartphone use duration (screentime) measures for seven days. Additionally, the Rozgonjuk, Levine, et al. (2018) data encompassed daily objectively measured smartphone use frequency (phone-checking behavior that we operationalize here as the number of screen unlocks) data for seven days. The two studies used an iOS app (Moment) to obtain iPhone screentime estimates. Daily averages across one week were computed for the merged data set.

2.3 Analysis

The data were analyzed in R software version 4.0.3 (R Core Team, 2021). Data analysis was carried out using the combined data where possible. We computed internal consistency statistics using the *psych* package v 2.1.3 (Revelle, 2021). We used Spearman correlation analysis (p-values adjusted with Holm's method) to investigate relationships between PSU, FoMO, and objectively measured smartphone use variables, using the *RcmdrMisc* package v 2.7-1 (Fox, 2020).

Additionally, we computed latent growth curve models with the *lavaan* package v 0.6-8 (Rosseel, 2012). FoMO was treated as a predictor variable, while the intercept (baseline) and slope (growth over the week) of smartphone use screentime and number of phone-checks (screen unlocks) were estimated with the robust maximum likelihood estimator. The intercept and slope were set to co-vary.

3 Results

3.1 Descriptive statistics and correlation analysis

Descriptive statistics and Spearman correlation coefficients are presented in Table 1; statistics per each data set are presented in Supplementary Table S1.

Bivariate correlation analysis showed that even though the positive correlation between FoMO and PSU measures yielded a large effect size, FoMO was not correlated with OMSU. Phone-checking behavior yielded a medium-sized positive correlation with screentime, and PSU had a small positive correlation with screentime. Age was not associated with these measures. While FoMO had a strong correlation with PSU, associations between FoMO and OMSU variables were very weak.

Table 1. Descriptive statistics and Spearman correlation analysis results (p-values in parentheses)

	Descriptive statistics			Correlations			
Variable	**N**	**M**	**SD**	**1**	**2**	**3**	**4**
1. PSU	168	26.71	9.41	–			
2. FoMO	169	22.23	8.32	.563***	–		
				(< .001)			
3. Screen-time	169	241.99	101.21	.224*	.067	–	
				(.028)	(1.000)		
4. Phone-checking	101	88.20	46.67	.063	-.092	.317*	–
				(1.000)	(1.000)	(.110)	
5. Age	169	19.62	3.57	-.103	-.146	-.139	-.224
				(.733)	(.348)	(.358)	(.171)

Notes. PSU = self-reported problematic smartphone use; FoMO = fear of missing out.
Screentime minutes and number of phone-checking (screen unlocks) are the week's average values. Summed scores for FoMO and SAS-SV (as a measure of PSU) were used. In bivariate correlations, the sample size was the lower number for a given pair's Ns. P-values (exact values in parentheses) were adjusted with the Holm's method. *** p < .001, * p < .05.

3.2 Does FoMO predict screentime and phone-checking over a week?

We also investigated, if FoMO scores predicted OMSU duration and phone-checking behavior over a week. We conducted latent growth curve analyses with screentime measures for a seven-day period for the combined data. The results of this model are presented in Table 2; analyses for these two data sets separately are presented in Supplementary Table S2.

While screentime data were available for both data sets, phone-checking behavior for seven days was available only in Rozgonjuk, Levine, et al. (2018), with n = 101 study participants. Table 2 shows that FoMO was not a significant predictor of OMSU screentime baseline nor growth over one week. In addition, FoMO did not predict the baseline nor growth of smartphone use frequency (smartphone screen unlocks).

4 Discussion

The aim of this study was to investigate if FoMO correlates with self-reported PSU severity as well as objectively measured smartphone use (OMSU) duration and frequency.

Our first hypothesis (H1) was confirmatory – we expected that FoMO and self-reported PSU severity are positively correlated. This hypothesis found support from the data – FoMO and PSU severity had a relatively strong correlation in the merged data set. Therefore, results are consistent with previous findings from other studies outlining FoMO as a significant correlate of self-reported PSU severity (Elhai, Yang, Rozgonjuk, et al., 2020).

We expected FoMO to correlate with objectively measured smartphone use as well (H2). This hypothesis, however, did not find support from the data. In both bi- and multivariate analyses, FoMO did not predict OMSU duration nor frequency. This is surprising, given the strong association between FoMO and self-reported PSU severity, as well as previous findings outlining associations of FoMO and self-reported frequency of disrupted activities due to push-notifications (Rozgonjuk et al., 2019).

It could be that objectively measured smartphone use may reflect *both* problematic and non-problematic smartphone use. In other words, while people may be engaged in using their digital technology to excessive levels (e.g., for a longer time), in some cases, this excessive use may lead to adversities in everyday life. For instance, some people with higher FoMO could use their technology in a more productive way, such as learning new things, socializing, or working, while other people could use the technology in ways that distracts them from their work or school duties. There is some evidence suggesting that specific social media platform uses may mediate the negative effects of

Table 2. Results of latent growth curve analysis with FoMO predicting objectively measured smartphone use variable

	Outcome: minutes of screentime[a]							
	Intercept				Slope			
Variable	**B (SE)**	β	**z**	**p**	**B (SE)**	β	**z**	**p**
FoMO	1.308	.108	1.330	.184	-.176	-.176	-1.090	.276
	(.984)				(.161)			

	Outcome: number of smartphone pick-ups[b]							
	Intercept				Slope			
Variable	**B (SE)**	β	**z**	**p**	**B (SE)**	β	**z**	**p**
FoMO	-.602	-.116	-0.973	.330	.023	.116	.311	.756
	(.618)				(.074)			

Notes. [a] = for 169 people across 7 days = 1183 observations; [b] = for 101 people across 7 days = 707 observations.

social media use on daily life and productivity (Rozgonjuk, Sindermann, Elhai, & Montag, 2020).

Another theoretical explanation is that higher levels in both FoMO and PSU could be explained by underlying causal factors. One such factor could be trait neuroticism. FoMO and PSU are associated with greater neuroticism (Marengo et al., 2020; Rozgonjuk et al., 2021). People with high neuroticism trait tend to worry more – including about their health (Costa & McCrae, 1985), and this may reflect in elevated PSU levels in the context of the current study. Importantly, worry is also associated with higher levels of PSU (Elhai, Rozgonjuk, et al., 2019), and FoMO, by definition, is aligning with worrying tendencies. Finally, the link between neuroticism and OMSU screentime has been found to be small (Montag et al., 2015). All these results suggest that perhaps PSU reflects levels of *worrying about smartphone use*, not *actual smartphone use*. This hypothesis, however, needs to be tested in subsequent research.

The present study has both theoretical as well as practical implications. To our knowledge, this is the first study aiming to predict OMSU variables from FoMO by investigating correlations as well as studying the potential changes of smartphone use over a period of one week. The results showed that while FoMO was associated with PSU, it did not predict OMSU screentime, nor phone-checking behavior. Therefore, these findings suggest that FoMO may not play a major role in the duration and frequency of smartphone use. While reducing FoMO could be the target for reducing the urge or craving to use one's smartphone (as reflected in PSU scores), it may not lead to actual smartphone use reduction. These results also have implications for further research. Specifically, as FoMO does not seem to be (strongly) correlated with OMSU, the results regarding FoMO's associations with self-reported smartphone use should be interpreted with caution. The findings also demonstrate that a person's FoMO levels cannot be directly inferred from how much time or how frequently a person uses their smartphone. At least this phenomenon seems to be true for the present dataset, where the FoMO measure only contained few items related to the online world. Newer measures such as by Wegmann et al. (2017) also include a FoMO-facet called "state FoMO" which deals exclusively with FoMO in an online context and here the results might be different. Additionally, results of the current study direct future research towards focusing on the objective recording of specific application use in relation with FoMO (e.g., see overlap between FoMO and problematic WhatsApp or Facebook use tendencies; Sha et al., 2019), which might explain the consistent and relatively strong relationship between FoMO and PSU found in previous literature. Focusing on specific application usage could differentiate smartphone applications with regards to their interplay with FoMO.

The limitations are primarily related to sample size and composition. Collecting tracked smartphone use data may be challenging, as also indicated by other studies with similar- or smaller-sized samples (e.g., reviewed in Parry et al., 2020). Therefore, although the sample size of this study was in line with previous studies, there may still be a risk of bivariate analyses being underpowered with very small effects. However, that does not change the implications of the main finding: while self-reported (problematic) smartphone use is associated with FoMO, objectively measured smartphone use is not (or at least not with comparable strength). In addition, the sample was biased towards female iOS users – but recent studies have shown that at least gender should not have strong effects on the associations investigated in the present study (Horwood et al., 2021; Rozgonjuk et al., 2021). Another major limitation is the nature of OMSU data: the data do not include a more fine-grained view on what exactly people were doing on their smartphones. Recent work has shown that communication, social media, and instant messaging-based applications may primarily drive engagement in smartphone use (Lowe-Calverley & Pontes, 2020; Rozgonjuk, Sindermann, Elhai, Christensen, et al., 2020), and altering the settings of one's smartphone (e.g., grayscaling the screen, hiding notifications, etc) may reduce one's smartphone usage (Holte & Ferraro, 2020; Olson et al., 2021). Based on these results, one may hypothesize that FoMO, too, may be associated with specific applications use – for instance, reducing the functionality of image and video content-based applications (e.g., Instagram, YouTube, etc) may lead to decreases in the use of those applications, and perhaps also in the long run in FoMO. However, the more general smartphone use duration and frequency data used in the current study do not provide insights into these nuances. Furthermore, there was no differentiation with regards to the type of smartphone use – in addition to specific applications use mentioned above, it should be further investigated how private vs work-related smartphone use is associated with FoMO.

In conclusion, while we replicated the previous findings of FoMO's association with self-reported PSU, the results showed that the FoMO and OMSU duration and frequency do not have as strong links.

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Supplementary Material

Table S1. Descriptive statistics and Spearman correlation analysis results for each data set (p-values in parentheses)

	Elhai et al (2018)						
	Descriptives			Correlations			
Variable	N	M	SD	1.	2.	3.	
1. PSU	68	25.82	10.57				
2. FoMO	68	19.77	7.27	.440**			
				(.001)			
3. Screentime	68	240.48	98.43	.204	.067		
				(.473)	(1.000)		
4. Age	68	19.75	2.03	.064	-.027	-.165	
				(1.000)	(1.000)	(.710)	
	Rozgonjuk et al (2018)						
	Descriptives						Correlations
Variable	N	M	SD	1.	2.	3.	4.
1. PSU	100	27.31	8.54				
2. FoMO	101	23.88	8.60	.606***			
				(<.001)			
3. Screentime	101	243.01	103.52	.213	.054		
				(.236)	(1.000)		
4. Phone-checking	101	88.20	46.67	.063	-.092	.317*	
				(1.000)	(1.000)	(.110)	
5. Age	101	19.54	4.31	-.141	-.127	-.104	-.224
				(.964)	(1.00)	(1.000)	(.195)

Notes. PSU = self-reported problematic smartphone use; FoMO = fear of missing out. Screentime minutes and number of phone-checking are the week's average values. In bivariate correlations, the sample size was the lower number for a given pair's Ns. P-values (exact values in parentheses) were adjusted with the Holm's method. * p < .05, ** p < .01, *** p < .001.

Table S2. Results of latent growth curve analysis with FoMO predicting objectively measured screentime in two separate data sets

	Outcome: minutes of screentime (Elhai et al., 2018)							
	Intercept				Slope			
Variable	B (SE)	β	z	p	B (SE)	β	z	p
FoMO	1.030	.082	0.644	.520	.078	.093	.365	.715
	(1.601)				(.214)			
	Outcome: minutes of screentime (Rozgonjuk et al., 2018)							
	Intercept				Slope			
Variable	B (SE)	β	z	p	B (SE)	β	z	p
FoMO	1.281	.105	1.001	.317	-.228	-.199	-1.087	.277
	(1.280)				(.210)			

Attachment Insecurity and Social Media Fear of Missing Out: The Mediating Role of Intolerance of Uncertainty

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Abstract
Fear of Missing Out (FoMO) is an apprehension that others might be having rewarding experiences from which one is absent. Online social networking sites (SNS) exacerbate FoMO because they frequently expose users to what is happening in other people's lives, which is typically related to leisure activities, such as trips, vacations, and social events. Consequently, when disconnected from social media, users become plagued by a troublesome sense of missing important and exciting events. Recent research indicates that FoMO is associated with difficulties in interpersonal interactions and social relationships. Accordingly, the current study examined the association between individual differences in attachment patterns and FoMO. Participants (N=264) completed measures of adult attachment patterns, social media fear of missing out, as well as intolerance of uncertainty. Results indicated that high levels of attachment anxiety predict high levels of FoMO, and that this association is partially mediated by intolerance of uncertainty. These findings suggest that anxiously attached individuals may be more vulnerable to FoMO, as a result of their inability to tolerate uncertainty. Hence, stress the need for awareness and treatment when individual develop an excessive dependency on SNS.

Keywords: online social networks, Fear of Missing Out, attachment, intolerance of uncertainity

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1 Introduction

With growing exposure to and use of social media, the experience of "Fear of Missing Out" (FoMO) has become a target of social and psychological interest and research. FoMO is defined as "a pervasive apprehension that others might be having rewarding experiences from which one is absent, and is characterized by the desire to stay continually connected to what others are doing" (Przybylski, et al., p. 1841).

Although FoMO is not limited to the online world, social media use has made it an increasingly common and significant experience. Social networking sites (SNS) exacerbate FoMO because they expose users to what is happening in other people's lives, such as leisure activities, trips, vacations, and social events (Chou & Edge, 2012). As a result, when individuals are disconnected from social media, they become plagued by a troublesome sense of missing important and exciting events (Przybylski et al., 2013).

Recent research indicates that FoMO is associated with difficulties in interpersonal interactions and social relationships (e.g., Beyens, et al., 2016; Fabris, et al., 2020), and negative family environments (Sela, et al., 2020). Accordingly, the current research examines how behavioral patterns in close interpersonal relationships, in specific attachment style, relates to experience of FoMO on social media. Attachment theory (Bowlby, 1969/1980, 1973, 1982) offers a model for understanding individual differences in interpersonal relations, and therefore seems to be a relevant theoretical framework for exploring the psychological mechanisms underlying FoMO.

In addition, the current research seeks to gain understanding of the psychological mechanism that underlies the predicted association between attachment patterns and social media FoMO, by exploring the mediating role of intolerance of uncertainty (IU) in this relation. IU is defined as the tendency to respond negatively to ambiguous situations that are characterized by the absence of crucial information about the potential consequences of the situation and its implications (Carleton, 2012; Carleton et al., 2016). IU is thought to be related to the experience of FoMO on social media, as FoMO is fundamentally an emotional response to an ambiguous situation in which desired information is unavailable.

2 Social Media FoMO

Although FoMO is not experienced exclusively by social media users, SNS users report increasing levels of FoMO as frequency of use rises (e.g., Baker, et al., 2016; Beyens et al., 2016; Blackwell, et al., 2017; Przybylski et al., 2013; Sela et al., 2020). The fact that SNS apps are available for use at all times through a smartphone may explain the associations found between FoMO and the addictive use of mobile phones (Coco et al., 2020; Elhai, et al., 2016; Oberst, et al., 2017; Wolniewicz, et al., 2018), social media addiction (Fabris et al. 2020; Fang, Wang, Wen, & Zhu 2020; Liu & Ma, 2018), and problematic Internet use in general (Alt & Boniel-Nissim, 2018; Blackwell et al. 2017; Wegmann, et al., 2017).

One of the key research findings on FoMO to date is that this experience is intensified by problems in interpersonal relationships. In a study among adolescents (ages 11-19), Fabris, et al. (2020) found an association between FoMO and sensitivity to stress associated with neglect and negative reactions by online peers. Similarly, Beyens et al. (2016) found an association between FoMO and stress related to Facebook use, when measured both in terms of popularity (number of likes, share, etc.) and belonging (number of friends).

Lai, et al. (2016) studied the association between FoMO and neural responses to stimuli of social inclusion and social exclusion. They found an association between FoMO and increased neural activity in the brain in response to social inclusion stimuli but not in response to social exclusion. Using both correlational and experimental study designs, Dugan (2019) found that people with interdependent self-construal (whose sense of self is embedded into the context of interpersonal relations and group affiliation) have a greater tendency to develop FoMO compared to people with independent self-construal (whose sense of self is more individualistic, egocentric, and idiocentric).

Sela, et al. (2020) found that FoMO mediates the association between negative family environment (characterized by low family expressiveness and high family conflict) and problematic Internet use in adolescents (ages 12–16). They also found an association between FoMO, depression, and duration of Internet use.

3 Attachment and Social Media FoMO

Although attachment theory refers to a categorical division of childhood attachment patterns (secure, avoidant, and anxious-ambivalent; Ainsworth, et al. (1978/2015), research on romantic attachment in adulthood typically refers to two dimensions: anxiety and avoidance (Bartholomew & Horowitz, 1991; Brennan, et al., 1998). High levels of attachment anxiety in adulthood are characterized by preoccupations with one's lovability, and concerns regards rejection and abandonment. High levels of attachment avoidance are characterized by compulsive self-reliance and reluctance to engage in emotional involvement with others.

To date, the direct association between attachment patterns and FoMO was investigated in two empirical studies: Both Blackwell et al. (2017) and Liu and Ma (2019) found a positive association between attachment anxiety and FoMO. The study by Blackwell et al. (2017) found an association between attachment avoidance and FoMO, but this finding was not replicated by Liu and Ma (2019). In both studies, FoMO mediated the association between attachment anxiety and social media addiction.

Theoretically, an expected association between attachment insecurity and FoMO is based on several assumptions: First, as Blackwell et al. (2017) noted, when people have concerns about their relationships, it is reasonable to assume that they are concerned about social rejection. Individuals with high levels of attachment anxiety tend to fear rejection in their relationships, and such fear may be generalized to a fear of social rejection in broader contexts such as SNS (Rom & Alfasi, 2014). Therefore, FoMO may be an expression of their fear of rejection, which leads to an increased need to remain informed and continually connected to what is happening on SNS.

Moreover, research on the psychological motivations of SNS use (Chen, 2019; Lin, 2016) found that attachment anxiety is related to an unmet need for relatedness and social support. Studies show that FoMO is heightened by an unmet need for relatedness (Przybylski et al., 2013; Xie et al. 2018) and increased need for social support (Przybylski et al., 2013).

4 The current research: The mediating role of intolerance of uncertainty

The findings reviewed above offer preliminary support for the theoretical logic of the assumption that attachment insecurity will predict high levels of social media FoMO. Accordingly, the purpose of the current study is to explore this association and its underlying psychological mechanism. To this end, the mediating role of IU in the association between attachment patterns and social media FoMO is examined.

IU manifests as perceived lack of control over the occurrence of negative events, and the inability to prepare for them in a manner that might mitigate their negative effects. High levels of IU increase the perceived risk of external threats, and trigger and sustain a sense of anxiety (Dugas, et al., 2005; Dugas, et al., 2004). Consequently, people with high levels of IU tend to avoid ambiguous and uncertain situations as much as possible, and find it difficult to function in these situations (Buhr & Dugas, 2006; Dugas, et al., 2004).

Uncertainty is an inherent component of close relationships – from a child's uncertainty of the availability of their attachment figure when needed, to the uncertainty of the availability of the attachment figure in their close interpersonal relationships in adulthood. Research to date, on the association between IU and adult attachment patterns found an association between

IU and high levels of both attachment anxiety and attachment avoidance (Sternheim et al., 2017; Wright, et al., 2017). Similarly, Boelen, et al. (2014) found an association between IU and adult separation anxiety, which is characterized by excessive apprehensions of separation from close attachment figures.

So far, the association between IU and FoMO has not been investigated. Yet, the theoretical logic underlying the expectation of such an association is based on the notion that FoMO in its basis is an event of uncertainty: An individual who experiences FoMO is responding to an ambiguous situation in which the information that interests them is unavailable. Therefore, there are reasonable theoretical grounds to assume that the negative emotional effects that accompany the experience of FoMO are related to difficulties in coping with ambiguous situations and missing or incomplete information, which is characteristic of uncertainty.

The current research therefore examines the following hypotheses:

H1. Attachment anxiety and FoMO will be positively correlated.
H2. Attachment anxiety and IU will be positively correlated.
H3. IU and FoMO will be positively correlated.
H4. IU will mediate the association between attachment anxiety and FoMO.

In view of the fact that the findings concerning the association between attachment avoidance and FoMO (Blackwell et al., 2017; Liu & Ma, 2019) are not conclusive, hypotheses related to attachment avoidance were not formulated, and the current study examines the association between attachment avoidance and the remaining study variables for exploratory purposes only.

5 Method

5.1 Participants and procedure

Participants were Israeli Facebook users (N=264, 65% Female, M_{age} = 30.2, SD_{age} = 9.55, range: 18-49) recruited via advertisements on Facebook News Feed and academic Facebook groups designated for recruiting research participants. Participants received a URL link to the study's survey, which was created on the Google Forms platform. The survey included general demographic information, and measures of adult attachment patterns, IU, and social media FoMO. Participants received a detailed explanation of the study in the questionnaire and were informed that they could leave the study at any time. Participants were also given contact information if they wished to receive additional information on the study after its conclusion. The introduction to the electronic questionnaire stated that completing the questionnaire constitutes informed consent to participate in the study.

Post-hoc power analysis was calculated using Monte Carlo power analysis for indirect effects (Schoemann, et al., 2017). With 1,000 power analysis replications, 2,000 Monte Carlo draws per replicions, and 95% confidence interval, a power effect > .99 was detected, which exceeds the accepted .80 in the literature (MacCallum, et al., 1996).

5.2 Materials and descriptive statistics

Adult Attachment patterns were assessed by the Experiences in Close Relationship Scale (ECR)–Short Form (Wei, et al., 2007), which measures attachment patterns in adult romantic relationships. Participants were instructed to think about their prototype experiences in romantic relationships, and rate their agreement with each item on a scale from 1 (*strongly disagree*) to 7 (*strongly agree*). In total, six items assessed Attachment Anxiety (e.g., "I worry that romantic partners won't care about me as much as I care about them."; M = 3.25, SD = 1.21, Cronbach's α = .84) and six items assessed Attachment Avoidance (e.g., "I try to avoid getting too close to my partner"; M = 2.44, SD = 1.13, α = .86).

Fear of Missing Out was assessed using seven items adapted from Wegmann, et al.'s (2017) Online-Specific FoMO measure. Participants were asked to indicate their agreement with statements such as "I continuously log-on to Facebook in order not to miss out on anything," and "I fear not to be up-to-date with what's going on Facebook." To create clarity and consistency for the participants, items were rated on a scale from 1 (*strongly disagree*) to 7 (*strongly agree*), as in Brennan et al.'s (1998) attachment measure, with higher scores indicating higher levels of FoMO (M = 2.80, SD = 1.23, α = .83).

Intolerance of Uncertainty was assessed using the Intolerance of Uncertainty Scale–Short Form (IUS-12; Carleton, et al., 2007). The IUS-12 is a 12-item abbreviated form of the original 27-item IU Scale (Freeston et al., 1994) that measures responses to uncertainty, ambiguous situations, and the future (sample items are "Unforeseen events upset me greatly" and "I must get away from all uncertain situations"). Items were scored on a 7-point Likert scale ranging from 1 (*not at all characteristic of me*) to 7 (*very characteristic of me*; M = 3.54, SD = 1.20, α = .91).

6 Results

6.1 Preliminary analyses

Zero-order correlations between the study variables are presented in Table 1. Attachment anxiety was positively associated with IU and with FoMO. Attachment avoidance was also positively associated with IU, but not associated with FoMO. IU and FoMO were positively associated. Age was negatively associated with IU, and positively associated with FoMO. Male participants reported higher levels of FoMO (M = 3.01, SD = 1.19) than females (M =2.67, SD = 1.24; t(265) = 2.17, p = .031). There were no gender differences in the remaining variables.

Table 1. Zero-order correlations for the study variables.

	1	2	3	4
1. Anxiety				
2. Avoidance	.29**			
3. IU	.39**	.29**		
4. FoMO	.29**	.08	.32**	
5. Age	-.10	-.08	-.15*	.25**

Notes: * $p < .05$; ** $p < .001$; Anxiety = Attachment anxiety; Avoidance = Attachment avoidance; IU = Intolerance of uncertainty; FoMO = Fear of Missing Out.

6.2 Hypotheses testing

To test for the mediation effect of IU in the association between attachment anxiety and FoMO, a mediation model analysis was performed (Baron & Kenny, 1986; Table 2) using the PROCESS add-on (V. 3.3) to SPSS (V. 25) (Hayes, 2009).

Results indicated that attachment anxiety (independent variable) predicted FoMO (dependent variable) while controlling attachment avoidance, age and gender ($\beta = .34$, $P = .000$). Additionally, attachment anxiety predicted IU (mediator), while controlling for attachment avoidance, age and gender ($\beta = .33$, $P = .000$), and IU predicted FoMO while controlling foe attachment anxiety, attachment avoidance, age and gender ($\beta = .30$, $P = .000$). The effect of attachment anxiety on FoMO when adding IU to the model decreased but remained significant ($\beta = .24$, $P = .000$), indicating a partial mediation effect. To test for the significance of the mediation effect, a bootstrapping procedure was used to test the indirect effects (Figure 1). Results indicated a significant indirect effect of IU on the association between attachment anxiety and FoMO ($b = .10$, $se = .03$,95%*CI* [.05,.16]).

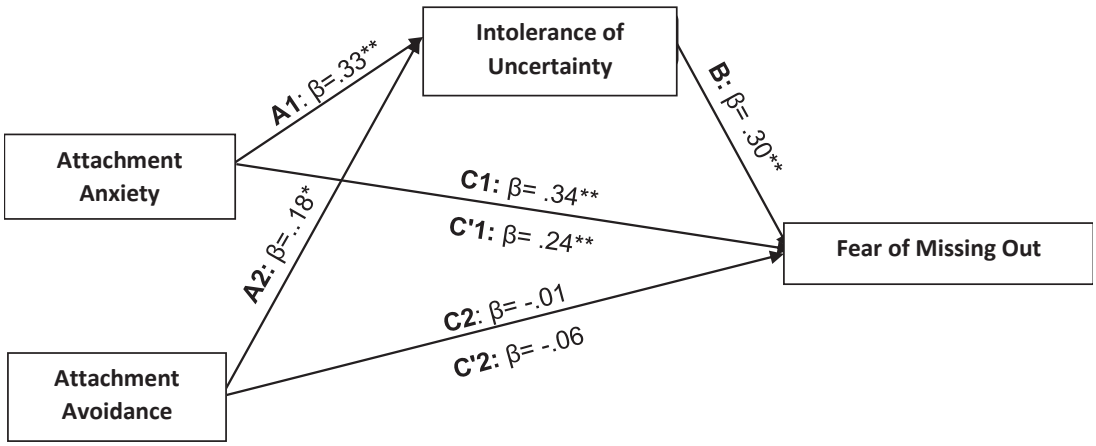
Table 2. Direct and indirect effects of attachment anxiety and avoidance, IU, age and gender, on FoMO.

Effect	b(se)	Beta	Significance	95% CI
	Mediator Variable Model DV = IU $R^2 = .19, F(4,259) = 15.63, p < .001$			
Anxiety	.33(.06)	.33	<.001	[.21, .44]
Avoidance	.19(.06)	.18	.002	[.07, .32]
Gender	-.06(.14)	-.02	.68	[-.34, .22]
Age	-.01(.01)	-.10	.07	[-.03, .001]
Constant	2.45(.35)		<.001	[1.76, 3.13]
	Dependent Variable Model DV = FoMO $R^2 = .26, F(5,258) = 17.73, p < .001$			
Anxiety	.25(.06)	.24	<.001	[.13, .37]
Avoidance	-.07(.06)	-.06	.28	[-.19, .06]
IU	.30(.06)	.30	<.001	[.18, .42]
Gender	-.30(.14)	-.11	.04	[-.58, -.02]
Age	.04(.01)	.30	<.001	[.03, .05]
Constant	.09(.37)		.81	[-.65, .82]

Notes: CI = Confidence intervall; DV = Dependent variable; Anxiety = Attachment anxiety; Avoidance = Attachment avoidance; IU = Intolerance of uncertainty.
Gender: 0 = Male, 1 = Female.

In conclusion, higher levels of attachment anxiety predicted social media FoMO and IU, supporting Hypothesis 1 and Hypothesis 2. IU predicted social media FoMO, supporting Hypothesis 3. IU partially mediated the positive association between attachment anxiety and social media FoMO, partially supporting Hypothesis 4.

Figure 1. Mediation model of IU on the association between attachment anxiety and avoidance, and FoMO, controlling for age and gender.



Notes: * $p < .01$; ** $p < .001$; C1 = Total effect of attachment anxiety on FoMO; C'1 = Direct effect of attachment anxiety on FoMO; C2 = Total effect of attachment avoidance on FoMO; C'2 = Direct effect of attachment avoidance on FoMO.

7 Discussion

The aim of the current study was to examine the association between attachment insecurity and social media FoMO, and the mechanisms that underlies this association. The findings indicate that high levels of attachment anxiety predict high levels of FoMO, and that this association is partially mediated by IU. That is to say, people with high levels of attachment anxiety experience higher levels of social media FoMO, at least partially as a result of their difficulty to tolerate uncertainty.

The finding that indicates that high levels of attachment anxiety predict social media FoMO is consistent with findings of previous studies (Blackwell et al., 2017; Liu & Ma., 2019). The current findings add to previous research by providing evidence of an association between attachment anxiety and social media FoMO in an adult sample. In the current study, participants' mean age is 30.2, compared to 19.9 (Liu and Ma, 2019) and 22.1 (Blackwell et al., 2017) in previous studies.

The main contribution of the current research is by providing evidence that IU plays a role in the association between attachment anxiety and social media FoMO. This finding helps to better understand the psychological mechanism that leads to a more intense experience of FoMO in individuals with high levels of attachment anxiety. The positive association found in the current study between social media FoMO and IU provides empirical support for the theoretical premise that uncertainty is a component of the experience of FoMO. A significant aspect of FoMO is the individual's need to cope with a lack of information on "what is happening now." The need to be continually informed about what is happening on SNS apparently stems, at least partially, from individuals' need to alleviate the negative effects triggered by such lack of information.

The findings of the current study suggest that people with high attachment anxiety, who typically lack a sense of a secure base (Ainsworth, et al., 1978/2015; Mikulincer & Shaver, 2007), find it more difficult to tolerate the lack of knowledge that accompanies FoMO. The lower one's ability to tolerate the uncertainty of being uninformed, the stronger the experience of FoMO on social media. These findings support and provide a new context for the role of attachment security in ambiguous situations and the negative implications of its absence.

Another explanation for the mediating role of IU in the association between attachment anxiety and social media FoMO is found in the extensive literature on the association between attachment anxiety and emotional regulation mechanisms (e.g., Allen & Miga, 2010; Brenning & Braet, 2013; Mikulincer, & Shaver, 2007). The findings of the current study provide empirical support for the argument that people high in attachment anxiety find it difficult to regulate the negative emotions that stem from being uninformed, which intensifies their FoMO when they are not connected to or informed about what is happening People high in attachment anxiety tend to fixate on or overestimate negative emotions. These individuals, whose emotional regulation strategy is "emotion-centered coping," find it difficult to recruit the necessary mental resources to effectively resolve the problem that triggered their negative emotions (Mikulincer & Shaver, 2007). Instead, they focus and ruminate on the emotions themselves, which are powerfully experienced. According to response styles theory (Nolen-Hoeksema, 2004), rumination is a form of response to stress that includes repetitive speech or thoughts related to stress symptoms (the negative emotions and sensations). This is a passive response mechanism that does not involve active coping or attempts to resolve the causes of their stress. Rumination is a dysfunctional mechanism that is used when knowledge is lacking and increases the degree of stress one experiences (Yook, et al., 2010). A recent study on emerging adults – an age group that is especially relevant for the experience of FoMO – found that individuals high in attachment anxiety tend to make more use of rumination as a response strategy to stress events (Gardner, et al., 2020).

The current study supports the findings of Liu and Ma (2019) concerning the lack of association between attachment avoidance and social media FoMO. In effect, the correlation between attachment avoidance and social media FoMO in the current study is almost identical to the correlation obtained in the study by Liu and Ma (2019). These findings are inconsistent with the findings of the study by Blackwell et al. (2017), which found a positive, weak, yet statistically significant correlation between attachment avoidance and FoMO. This inconsistency may be attributed to the fact that the current study and the study by Liu and Ma (2019) used a similar instrument to assess attachment dimensions – the short form of ECR (Brennan et al., 1998), developed by Wei et al. (2007). In contrast, the study by Blackwell et al. (2017) used an instrument that was developed Baek, et al. (2014) and adapted to the context of SNS use.

In any case, there appears to be a weak association, at most, between attachment avoidance and social media FoMO, which may be attributed to the fact that people high in attachment avoidance primarily make instrumental use of SNS (Rom & Alfasi, 2014). Instrumental use is characterized by the use of SNS to search for and share information, and to a lesser degree with social and interpersonal communication needs – which is consistent with the deactivation strategy used by high attachment avoidance individuals to avoid interpersonal closeness and emotional involvement (Mikulincer & Shaver, 2007). Such use of SNS may trigger less FoMO because it is possible for them to gain information on their targets of interest in alternative ways (Such as newspapers and general websites).

The findings of the current study support evidence from previous research (e.g., Fabris et al., 2020; Lai et al., 2006) indicating that FoMO is typically experienced in a social context, and involves a fear of being socially disconnected or even rejected. The fact that an association was found between attachment anxiety – characterized by a strong desire for emotional engagement with others, combined with a fear of rejection – and FoMO, while no association was found between attachment avoidance – characterized by a tendency to retain a distance in interpersonal relations – and FoMO suggests that the key component in

the experience of FoMO is the fear of not being socially up-to-date.

Finally, interesting findings emerged with regards to the demographic variables: First, age and social media FoMO were positively correlated. This finding contradicts previous findings (e.g., Blackwell et al. 2017; Elhai et al., 2018) that indicated negative correlations between age and FoMO. An explanation for this might be that the current sample comprised older participants compared to previous studies. Indeed, an analysis of the association between age and social media FoMO for age subsamples of the current study revealed a positive association between age and FoMO in the upper age quartile of the sample, but no significant association was found in the lower three quartiles.

Furthermore, in the current study, men reported higher levels of social media FoMO than women, which contradicts findings from previous research (e.g., Beyens et al. 2016; Elhai et al. 2018), which reported higher FoMO scores for females compared to males. The relatively high age mean of the current sample may also explain this inconsistency: While a subsample of participants below the age median (ages 18–27) showed no gender effect on social media FoMO, in the subsample above the median (ages 28–49) men had significantly higher levels of social media FoMO than women.

Taken together, these findings suggest that the experience of FoMO on social media varies across age groups. This may be the case because young individuals use social media mainly to satisfy socioemotional needs, while older users do so for more instrumental purposes (Rom & Alfasi, 2014). If so, the current findings suggest that in this type of usage, women experience less social media FoMO than men. Additionally, the experience of social media FoMO becomes stronger with age, possibly as a result of comparisons with other members of one's online social network with respect to professional achievements, standard of living, and material assets.

8 Limitations and future directions

Despite the significance of the current study's findings for our understanding of the association between individual differences in attachment patterns and the experience of FoMO on social media, the current study has several limitations: First, the current study examined FoMO in the specific context of Facebook use, as Facebook is the SNS with the largest number of users (Alexa, 2018). Other SNS do, however, have unique features. For example, Instagram is an image-based SNS, whereas Twitter is based on brief textual messages. Therefore, a task for future research may be to examine whether fear or missing out is the result of the unique features of Facebook, or are the current findings related to FoMO generalizable to other SNS.

In addition, the current study had a correlational design that precludes causal interpretations. Therefore, future research may seek to examine whether an experimental induction of a sense of attachment security reduces social media FoMO. Priming attachment security (e.g., by asking participants to visualize and write about a person with whom they have a secure attachment) can have an effect that is similar to dispositional attachment security in terms of influence on beliefs about the self and interpersonal relationships (Carnelley & Rowe, 2007).

9 Conclusion

FoMO is a phenomenon that is the target of increasing attention in public discourse in the social-cultural context of millennials, and has recently become the focus of academic research on online behaviors and their psychological implications. The current study contributes to the growing base of knowledge on FoMO by offering empirical support for the association between individual attachment patterns and the frequency and intensity of FoMO on social media. The findings of the current study suggest that people with a strong fear of rejection and abandonment may be more vulnerable to social media FoMO as a result of their inability to tolerate uncertainty or being uninformed. These findings expand our theoretical understanding of the psychological mechanisms underlying the phenomenon of FoMO on social media, and stress the need for awareness and treatment when individuals develop excessive dependency on SNS use.

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Emergency Distance Learning in Austria during COVID-19: Selected Findings and Implications

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Highlights

(1) Adequate preparation (e.g., providing technical equipment, didactical adaptation of teaching materials, fostering digital literacy in students, …) is needed for distance learning to succeed.
(2) Disadvantaged students need special support to avert a widening of the educational gap between students from different social backgrounds and with different learning abilities.
(3) Distance and online learning should be designed to address the satisfaction of the basic psychological needs to promote student well-being and positive learning outcomes.

Keywords: COVID-19, distance learning, online learning, basic psychological needs, self-determination theory, digitalization

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1 Introduction

The global pandemic caused by the outbreak of the Coronavirus (COVID-19) in late 2019 forced educational institutions worldwide to implement distance teaching and learning to mitigate the spread of the virus. In Austria, all secondary schools were closed as of March 2020 and only fully reopened again in May 2021 (Bundesministerium für Bildung, Wissenschaft und Forschung (BMBWF), 2021a). Over the entire period, the digitalization of teaching and learning remained a major topic. Studies from before the pandemic suggest that online teaching and learning can be just as effective as face-to-face instruction (e.g., Means et al., 2013), if the technical infrastructure is in place, the appropriate didactic concepts have been developed, and both students and teachers have been prepared for online learning. Early on, however, concerns were raised that this was not the case in emergency distance learning provided during COVID-19 (e.g., Bozkurt, 2020), as planned distance learning is often voluntary and, above all, must be well thought out and carefully planned to be successful. Thus, numerous studies on emergency distance learning under COVID-19 have addressed its impact, pointing to the risks regarding students' learning success and well-being (e.g., Holzer et al., 2021; Huber et al., 2020; Schober et al., 2020a; Steiner et al., 2021), particularly for children from disadvantaged families. In this paper, we give a brief overview of the development of emergency distance learning in secondary schools in Austria during COVID-19, focusing then on selected research findings and proposing trajectories for further research and policy development.

2 Emergency distance learning in Austria during COVID-19

The National Education Report Austria 2018 (Breit et al., 2019; Oberwimmer et al., 2019) stated that digitalization had not yet sufficiently taken hold in Austria's secondary schools. Early reports of teachers' and students' experiences with emergency distance learning during COVID-19 confirmed these findings and indicated that neither students nor teachers were adequately prepared for the full transition to online learning (Steiner et al., 2021; S-Clever Consortium, 2021). For example, not all students and teachers had access to the necessary technical equipment. This was particularly alarming as it made it difficult for students from disadvantaged families to attend classes, potentially widening the educational gap (Huber et al., 2020; S-Clever Konsortium, 2021). Moreover, Steiner and colleagues (2021) found that teachers often did not know how to didactically adapt the learn-

ing content to the online setting. During the initial lockdown, students complained that they were overwhelmed with using a variety of different communication and learning platforms, did not understand assignments, had difficulty connecting with their teachers, and often did not receive enough feedback (Pelikan et al., 2021). They also struggled with organizing their learning and keeping up their daily routines (Huber et al., 2020; Pelikan et al., 2021).

Some of these problems were addressed during the following lockdowns. The 8-point program for digitalization, which was formulated by the Austrian federal government (BMBWF, 2020) in response to the education report and aimed at preparing educators and students for digitally supported teaching and learning, was now implemented in an accelerated form: Clearer guidelines as to what, how, and where online teaching should be provided were issued by the Federal Ministry for Education, Science and Research (BMBWF, 2021b). New communication routines were established, and synchronous online lessons were offered to a greater extent in addition to the asynchronous lessons that had been prevalent during the first lockdown (Schober et al., 2021b). While this addressed the problems expressed in the past, students then reported that the accompanying increased screen time left them severely fatigued, and, in some cases, even led to physical symptoms such as tension and headaches (Schober et al., 2021b).

3 The importance of basic need satisfaction and self-regulated learning in emergency distance learning

Considering the findings on learning under COVID-19 in Austrian schools presented in the previous section, it is noticeable that several aspects of emergency distance learning were particularly challenging: Students felt overwhelmed and undersupported, had difficulty motivating themselves and organizing their learning, and missed contact with teachers and peers. A psychological theory that can be applied to explain the impact of these different aspects is self-determination theory (SDT). SDT offers a framework for human motivation and has been established in research on well-being and successful learning in various studies in traditional as well as the distance learning context (Deci & Ryan, 2000; Dettweiler et al., 2017; Holzer et al., 2021; Niemiec et al., 2009; Pelikan et al., 2021).

According to SDT, the satisfaction of the needs for autonomy, competence, and social relatedness leads to higher intrinsic motivation and well-being. The need for autonomy refers to experiencing one's own actions as self-determined and internally controlled. Distance learning offers, in general, more autonomy, e.g., in terms of organizing time freely. However, a recent study on learning during COVID-19 by Holzer and colleagues (2021) found that, in a sample of Austrian secondary school students, the effect of perceived autonomy on positive emotion and intrinsic learning motivation was less salient compared to perceived competence and social relatedness. This implies that, although the need for autonomy should have been promoted by distance learning, the forced character of emergency distance learning may have impaired autonomy satisfaction. Maximizing student choice in assignments (e.g., offering different but similar texts to read) and social forms (e.g., allowing working in groups or individually) may support autonomy and mitigate the negative effects of forced emergency distance learning. The need for perceived competence is supported by setting smaller achievable goals, providing regular feedback, offering tasks with the right level of difficulty, and consciously reflecting on successes. It is fulfilled when one feels self-efficacious and is able to meet the demands of the environment. Pelikan and colleagues (2021) showed that students who felt competent in distance learning, experienced higher intrinsic motivation, and sought help when they needed it. They also incorporated more self-regulated learning (SRL) strategies, such as setting achievable goals and planning their time, which is increasingly important in the less structured environment of emergency distance learning (Klingsieck et al., 2012). Finally, frequent interaction with peers and teachers (e.g., through peer learning and regular feedback sessions) satisfies the basic psychological need for social connection. After multiple lockdowns and more than a year of restricted social contact, increasing rates of depression, anxiety symptoms, and insomnia among students have been observed, which studies have linked to social isolation and loneliness during the pandemic (Pieh et al., 2021). This is not surprising, as previous studies have shown the important functions schools fulfill in addition to knowledge transfer, one of which is providing a social environment (Angelico, 2020; Holzer et al., 2021). This suggests that in emergency distance learning, even with increased synchronous interaction, important social needs of students were not adequately met.

4 Implications

Findings from studies on learning and schooling during COVID-19 bear practical implications for school functioning, providing guidelines for structuring curricula and teaching in a distance learning format during school closures to foster pupils' and students' online learning process:

(1) For emergency distance learning (as well as digital supported learning in traditional schooling) to be successful, teachers and students must be adequately prepared. It is crucial that teachers have media-didactic knowledge and competencies, including on how to prepare and share content online and how to best support students with motivational and organizational difficulties. As called for by the education report Austria (Breit et al., 2019; Oberwimmer et al., 2019) and other studies (e.g., Seufert et al., 2018), students' digital literacy skills and their motivation to engage in digital learning as well as their self-regulated learning competencies need to be fostered. Moreover, computer-based learning must be

implemented into everyday school life, so that it is no longer perceived as a threat to autonomy in times of crisis.

(2) To mitigate the increasing educational gap between students from different social backgrounds, the necessary technical infrastructure must be established. In addition, special efforts must be made to assist students at risk, e.g., because of learning deficits, language barriers or lack of support from their family (Steiner et al., 2021).

(3) Distance learning should be designed to fulfill the basic psychological needs, as they are essential for students' positive school outcomes and well-being. Learning environments should offer an adequate choice between different tasks, activities, and learning materials (autonomy). Particularly if paired with individualized difficulty levels and regular and constructive feedback (Bubb & Jones, 2020), this can lead to deeper understanding and enhanced feelings of accomplishment and enhance perceived competence. Video conferencing and chat rooms for sharing and reflecting in groups can be implemented to foster a sense of collaborative learning, supporting social relatedness.

COVID-19 and the resulting Distance-Learning have challenged all actors in the educational system and continues to be demanding. On the other hand, the situation also promoted positive changes. The pandemic has encouraged many people to rethink schooling and how it can be designed to benefit more students (Bubb & Jones, 2020). The resulting momentum in an otherwise rigid system may be used as an opportunity to lastingly improve education and to rethink the role of education research as a resource for educational policy and practice. Educational policy, educational research and educational practice must work closely together to enable the necessary research and subsequently to respond appropriately to current and future challenges.

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Art and Design Education in Times of COVID-19: Distance Learning and the Importance of Interaction and Empathy

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Highlights
At the period of worldwide public health emergency of COVID-19, the majority of educational institutions in the world have faced the forced emergency lockdown and migration into the digital, online or virtual learning and teaching environments. Basically, it must be stated up front that digital media and processes have long been part of art instruction, and the maker movement has introduced 3-D printing, especially in design classes. But distance learning presents yet another set of challenges for these subjects. This article examines how this change has affected the teaching of art and design, looks at two case studies (secondary school and university) and refers to discussions at art education conferences and papers on the post-pandemic challenges of digitization in the arts.

Keywords: interaction, art and design education, distance teaching, 21st century skills, COVID-19

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1 Introduction

During the worldwide public health emergency that is the COVID-19 pandemic, the majority of educational institutions have been facing emergency lockdowns and experienced a forced migration into digital spaces, online or virtual learning and teaching environments. While digital media and digital processes have long been part of art instruction, e.g. 3D-printing as introduced by the maker movement, and especially also of design classes, distance learning presents yet another, complex set of challenges for these subjects. Certainly a distinction has to be made in general regarding the use of digital media and computer mediated communication (CMC) methods, which have been used especially by the pandemic as a teaching method also in art and design classes.

This article examines how this shift from analogue to digital has affected art and design education, as the subjects tend to be called in Austria. First two case studies will be presented, Due to personal experience as a teacher in both secondary and tertiary education and specific interest in the area of applied didactics this article will start by presenting two case studies which will be illustrate the issue of ZOOM fatigue in practice and how it happened at school and university. Further it refers to discussions at art and design education conferences and papers on the post-pandemic challenges of digitization in the arts.

2 Case study 1

A secondary school in Austria. During the first COVID-19-related lockdown in Austria, most of the schools continued education via emails. Only some schools immediately moved to using CMC where it was possible to see each other 'in virtual person', such as Zoom or Teams etc. Based on personal experience and reports from colleagues, students displayed very high motivation and active participation. For some students, CMC was the only way to see and interact with their teachers face to face. Indeed, it appears that ZOOM allowed for much closer interaction than the physical classroom, which may be due to the fact that in a physical, 'real' classroom or lecture hall, not everybody gets to sit in the first row right in front of the teacher; some students sit further away or in the back. In ZOOM, however, everybody has a front row seat, making interactions much more personal and almost intimate. However, even at the beginning of the ZOOM classrooms, it soon became obvious that holding a lesson via ZOOM is different: it requires a lot more interaction such as individual or group work; otherwise the lesson will be mostly taught ex-cathedra, which quickly leads to fatigue. A student art teacher taught a class on senses for the first time. She had prepared interactive sessions, which she thought of as a question-answer method. The starting point was a slide that represented icons for all five senses. The students, however, immediately discovered the possibilities of drawing in ZOOM and scribbled

the answers directly on the slide containing the questions. The student reacted positively and was pleased with the numerous interactions that took place, not verbally, but visually, for the time being. However, this experience already indicates the tangible that becomes possible with digital teaching. The tasks can be given in increasingly visual ways in the form of drawings, and words are relegated to the background. Visual literacy is practiced and encouraged. Even if this example involved 'overwriting', a certain form of aesthetics emerged spontaneously. A concrete change in art lessons in the future could be the use of digital communication tools, so that tasks of theoretical teaching can already be designed visually and interactively.

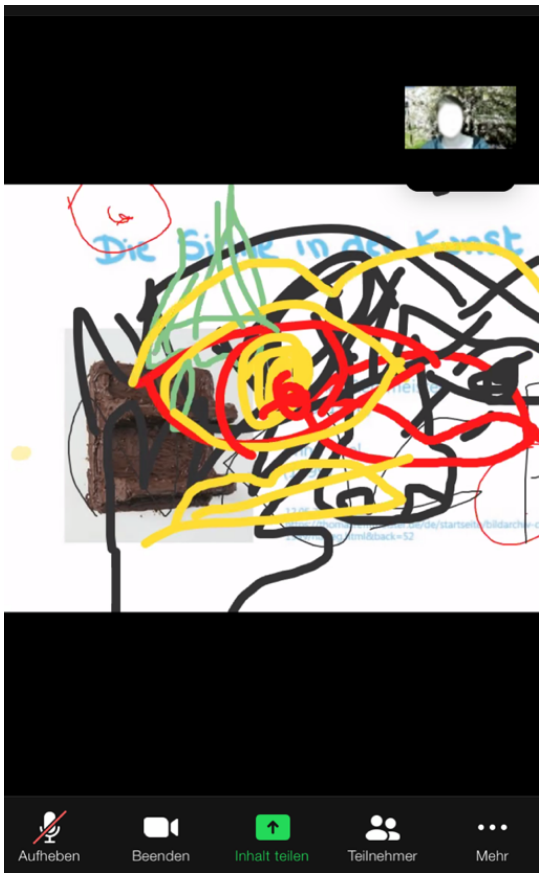

Figure 1. Zoom interaction in a secondary art class @ Ruth Mateus-Berr

3 Case study 2

Art University seminar, first semester Students were introduced to digital communication. This assignment was about getting to know each other, reflecting on the importance of communication, 'reading faces of children and others – with pandemic constraints', learning about facial expressions as an essential element of a character portrayal in a graphic novel, and understanding CMC´s mechanisms. Students explore how the lack of body language in CMC and having to deduce meaning from facial expressions alone, restrains and reduces the capacity to generate empathy and thereby heavily impacts teaching rationales as well. Students were sent into ZOOM break-out rooms in pairs and asked to mimic five different emotions. Subsequently, they were asked to put the fotos of their faces onto Padlet (a low-threshold computer interaction tool). They experienced how difficult it is to 'read faces' when wearing a mask on and how much certain parts of the face have to be overemphasized in order to recognize the expressed feeling well.

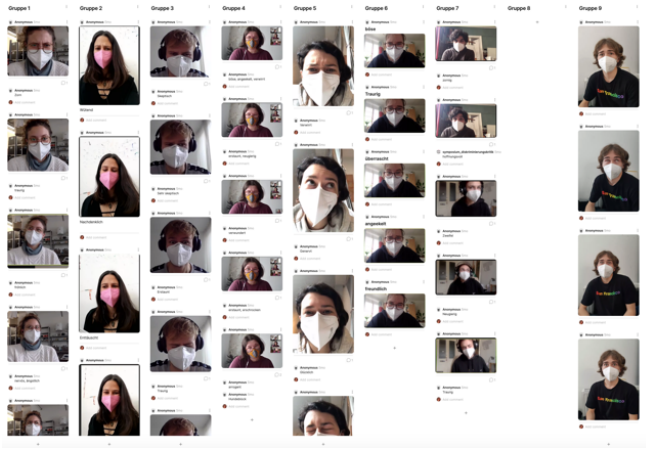

Figure 2. Padlet interaction with Padlet at Art University @ Ruth Mateus-Berr

They were instructed to watch a short video about intercultural communication and the whole class discussioned how misunderstandings come into existence through interpretations of body language. Art & Design didactics here interacts a lot with the reference science of psychology and pedagogy. The special feature of art and design education, however, is that it integrates visual interactions. Overall, this was at the same time an exercise for the design of characters that they should create in their graphic novel on a position in didactics for art, which formed part of their grade for this seminar.

Here, too, the digital possibilities changed the form of the lessons: real exercises – like with the mask, would take far more time to do in an analogue way and would not give the students the opportunity to look at and reflect on the overall results as quickly. The possibility of faster interactive processes is also due to the program ZOOM, which makes it possible to randomly sort people into groups. This eliminates the decision-making process of individual persons, which of course could also be criticized. In general, this form of teaching as certainly evoked the already long-awaited change in the teacher role. Kaur & Bhatt noticed (2020, 41) that this emergency migration to the digital changed the teacher's role from input provider to facilitator. Marić (2020) believes, that "the main challenge of online or remote distance teaching will probably include addressing the emotional and psychological needs of both learners and teachers (specifically physical and mental health)" and according to Kaur & Batt (2020, 42, cited in Maric 2020), "the access to information would no longer be the primary concern, and the next greatest

challenge for teachers would be to equip themselves with 'interpersonal skills' and keep the students engaged, interested and invested in their education", highlighting the importance of lifelong learning. The less interaction takes place, the more fatigue is produced. But there exists another challenge: CMC requires a high level of sustained, as illustrated by considerable effort needed just to read others' reactions in their faces. This attitude, also named 'empathy', is essential. However, normally an emphatic encounter takes place in person, one sees, hears, smells and feels each other in a room. CMC is usually limited to facial perception only. Empathy is our capacity to grasp and understand the mental and emotional lives of others (Lanzoni, 2019), and it lies at the core of prosocial development. It serves to regulate relationships, and to support collaboration and group cohesion by facilitating awareness, understanding and sensitivity to others' perspectives and feelings (Decety & Jackson 2004): it is a higher-order mental process which includes (1) the rapid sharing of another's emotional state from multiple sensorial afferences (affective resonance), (2) appreciating the other's point of view and prior experience (perspective taking/ Theory of Mind, ToM), and (3) the ability to modulate one's own affective response to the sharing of another's emotional experience (emotion regulation). Yet, the ability to effectively empathise has been suggested to be negatively impacted by the usage of videoconferencing tools (Turkle, 2016) and the question arises how to close this gap in teacher training at the tertiary level – especially in arts training, which is very much determined by continuous feedback. In studio teaching, the role of empathy in the relationship between teachers and students is particularly relevant, which probably cannot be closed so easily by CMC.

4 Recent discussion in the field of art and design education

General experience was exchanged at the INSEA (International Society for Education through Art) conference 2020: 'Art Education in Times of Coronavirus' at the live discussion on re-learning, re-thinking, re-framing art education. The participants discussed the post-pandemic situation of art education, talked about the transformative power of the pandemic, as it will change art education, the accessibility of all to digital means, the so-called 'digital poverty'. They stated that art education delivers the possibility to express the feelings as for example to express 'the fear' at the moment of the Lockdown, they mentioned the missing interaction and how a new way, how and where we teach, what kind of new spaces will arise. It was discussed how the 'new normal in art education' (Kuchah Kuchah 2020) will look like, and how artists will react to the pandemic. It has been observed that students who create at home invest more time and that students come into focus who would never stand out in a classroom. They were discussing the function of art education. The healing aspect of art education was reflected, too, and its importance of well-being (SDG 3).

Judith Burton (2020) gets it to the point when she says: "As we find ourselves forced into the broad-sale implementation of online learning far sooner than anyone anticipated, our current crisis highlights all the deepest weaknesses in our education system – but it also offers us an unprecedented opportunity for change."

Students are already accessing online resources of their interest and are connected with other students around the world (examples: maker movement, interactive practices with museums etc.). Material -based education such as Tinkering and improvisational Design proven to work well during the quarantine. Students could dock directly to their living environment and discover things at home that they could incorporate into artistic projects. There are many artistic possibilities with digital means, which students might teach themselves, if led by interest. What then should the art teacher do?

Precht (2020, 169) stresses that "No other challenge is likely to force our schools and universities to rethink as much as preserving and nurturing the intrinsic motivation of our children" and this intrinsic motivation should arise especially for areas of interest that do not necessarily count those of the students but are components of general education. The solution may lie in making connections: Gebeshuber (2020) argues that what we need today: teachers that convey understanding and not primarily knowledge.

Regardless of specific changes brought about in art and design education by E-learning, one form is still unresolved: until the 20th century – art and design education consisted primarily of the method of imitation, digital learning opens up a variety of interaction. Lines of development of didactics of drawing and art pedagogical thinking often correspond with epochal breaks and paradigm shifts, which characterize, for example, the visual arts in the transition from the Middle Ages to the Renaissance or from an imitation of nature, which was still essential until the end of the 19th century, to an autonomous art of modernity, which primarily thematizes its own means. The ruptures and paradigm-shifts in the field of visual arts usually reflect changes in the world view and expansions of people's possibilities of thinking, which are never limited to individual countries, but at least in Western and Central Europe gain great influence everywhere (Legler 2013, 10-11; Mateus-Berr & Reitstätter 2017).

This is not a problem with digital learning (forced by COVID-19) – there were already before COVID-19 – innumerable instruction courses for art and design production, except – and this is essential: students do not have access to the Internet and also do not have the possibility to carry out realizations by means of digital procedures (keyword 'digital poverty'). What definitely comes up short is the very individual and frequently used feedback that is common in art classes, which is particularly essential for conveying personality (Mateus-Berr & Poscharnig 2014, 502; Mateus-Berr & Jochum 2020) and, above all, 21st century skills in the overall curriculum.

This article described two small examples of the impact of CMC on art and design instruction and argued for moderate, if possible, hybrid instruction in these subject areas.

As examples showed there are new possibilities in presentations and work, opportunities for the subjects, but too much CMC leads to zoom fatigue and low motivation. If CMC is used, interactive teaching methods are preferable to purely frontal teaching methods.

CMC has certain advantages for art and design teaching, such as easier and shorter grouping and work, but at the same time also some disadvantages, such as the absent possibility to 'look over the shoulder' of the art and design practitioners and to be able to give a variety of feedback, which unfortunately can only be done on results and not – as usual – on the process. Long-term effects of distance teaching in art and design education are not yet known and studies are still lacking in the field itself.

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Piloting of Virtual Patient-Based Online Self-Study Quizzes for Developing Undergraduate Medical Students' Clinical Reasoning Skills

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Abstract

Clinical reasoning – the application of medical knowledge to a patient's problem – requires training in a safe environment. With learning tasks based on Virtual Patients (VP-tasks) the clinical setting can be simulated in a save way and these tasks can be easily integrated into blended-learning environments as synchronous tasks (face-to-face or online) or as asynchronous online tasks. This article presents the editorial process for developing VP-based self-study quizes (SSQs) and analyses field-study results on students' learning experiences and study habits. The editorial process initially only involved experienced clinical, educational and technical experts. To better match the tasks' difficulty to the knowledge level of the students, junior doctors and advanced medical students joined the editorial team at a later stage. Students (n = 351) agree that the SSQs (n = 10) developed by the expanded team match their knowledge better than the SSQs (n = 13) developed by the initial expert editorial team. Additionally, the students rate the online SSQs as more helpful than the similar face-to-face VP-tasks. The students' free comments indicate their high acceptance of the SSQ-format.

The SSQ-format is a feasible option for providing systematic online training in clinical reasoning, especially when working with a multi-level-educational editorial team and when the editorial work is driven by a systematically structured blueprint of topics and learning goals.

***Keywords*:** Virtual patients, Clinical reasoning, Quiz development, Editorial process, Self-study quiz

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1 Introduction

Clinical reasoning is a crucial competence for physicians. As a complex cognitive skill, clinical reasoning requires wide medical knowledge and comprehensive procedural knowledge on how to apply medical knowledge, when diagnosing and treating patients' problems (Braun, Zwaan, Kiesewetter, Fischer, & Schmidmaier, 2017). Faulty clinical reasoning processes result in diagnostic errors and put the safety of patients at risk as demonstrated by the rate of diagnostic errors uncovered in autopsies (8.0–22.8%) (Shojania, Burton, McDonald & Goldman, 2002).

Medical educators have been and are still looking for ways to develop the clinical reasoning skills of medical students systematically in the workplace while ensuring patient safety (Wagner-Menghin, Hirsch, & Pokieser, 2018). Due to the considerable increase of medical students over the last centuries, the emergence of numerous disciplines in medicine and the limited resources in teaching hospitals the exposure of students to real patients is limited. Thus, developing clinical reasoning skills systematically in classrooms gained importance (Hege, Kononowicz, Tolks, Edelbring & Kuehlmeyer, 2016).

During the 20th century information technology (IT) became increasingly common for communicating remotely and for documenting patients' symptoms, problems, and treatment plans. This facilitated compiling authentic medical case material as Virtual Patients (VPs) for case-based learning (CBL) in the classroom. Furthermore, organising online learning with blended learning scenarios including VPs, has been facilitated by employing web conference systems and learning platforms, which proved crucial in light of recent developments related to the outbreak of Covid-19.

CBL is a highly accepted experiential tool for teaching and learning clinical reasoning skills. Students apply previously acquired medical knowledge when engaging in clinical cases. Thus, through CBL the students learn how their medical knowledge contributes to later clinical practice. As such, CBL pro-

motes self-directed, active learning, increases motivation and promotes deeper conceptual understanding (Thistlethwaite et al., 2012; Turk, Ertl, Wong, Wadowski & Loffler-Stastka, 2019). For students that do not have the opportunity to reach relevant learning goals by bedside-teaching, VPs are a convenient supplement as VPs can serve a large number of students simultaneously (Hege et al., 2016). The complexity of interactive online-VP scenarios can be adjusted to the ability level of the learner by including irrelevant information as decoy, emotionally complex situations or time pressure (Hege, Kononowicz, Berman, Lenzer & Kiesewetter, 2018). These scenarios can also provide immediate feedback, allowing the learner to study purposefully and to focus on individual areas of weakness. To train the clinical reasoning process of students and strengthen their pattern recognition of different illnesses, it is recommended to create a large pool of short and focused VPs with varying complexity and a variety of problems (Hege et al., 2018).

2 Piloting systematic, classroom-based online learning with Virtual Patients

In 2017/18 Virtual Patient-based learning tasks (VP-tasks) in the format of online self-study quizzes (SSQs) were introduced to the curriculum for undergraduate medical students at the Medical University of Vienna in their 5th year of the human medicine programme at Medical University of Vienna. Furthermore, an editorial process for managing the collaboration of the various experts involved was initiated. A field study evaluated the students' learning experiences and study habits. The following chapter presents the editorial process, the didactic features of the SSQs, and the field-study results on the students' learning experiences and their study habits related to SSQs.

3 Results

3.1 The editorial process

An experienced Event- and Content-Manager (ECM) directs the editorial process for each set of VP-tasks. The ECM keeps track of each step and the editorial deadlines and arranges the required editorial meetings.

Defining the quiz's general topic
The editorial process starts by clarifying the topic and the overarching learning goals that should be covered. Typically, the Module Coordination, who commissions the production of a quiz, draws on material such as the study curriculum and up-to-date learning-objective-catalogues (Medizinische Universität Graz, Medizinische Universität Wien, Medizinische Universität Innsbruck & Medizinische Fakultät Linz, 2020) to define the general topic of a quiz.

Establishing the collaboration with a clinical expert
Equipped with a list of general topics and/or overarching learning goals that should be covered in the quiz the ECM contacts a content expert, who is clinically active. After a collaboration is agreed on the ECM arranges a meeting between the clinical expert and a member of the editorial team.

Editorial work with the clinical expert – 1st review from the learner's perspective
Based on discussions with the editorial team, the clinical expert chooses a specific case that is suitable to illustrate the clinical decision making and reasoning process related to the given learning objective and theme. The expert then anonymises the patient material. Subsequently, members of the editorial team (junior doctors or advanced medical students), who introduce the learners' perspective, work with the clinical expert to develop clinical decision prompts, which are phrased as open questions and should guide the students through diagnosing and treating this VP from the perspective of a clinician. Additionally, the clinical expert or the editorial team phrases so-called expert answers for the prompts providing a state-of-the-art solution and further explanations.

Didactic and technical review – 2nd review from the learner's perspective
The didactic and technical experts of the editorial team review and edit the clinical decision prompts and expert answers to meet the required didactic and technical standards.

Additionally, the experienced medical students on the editorial team take on the learners' role and try to complete the prompts and to understand the expert answers. This step ensures that the challenges provided by the prompts match the learners' medical knowledge adequately and are not set too high (or too low).

Implementation into the e-learning platform by the technical team
The moodle quiz-tool is used to gradually present the clinical setting, the unfolding patient's story, the clinical decision prompts, and the expert answers.

Release and post production
The ECM releases the finalised online SSQ for the student cohort. During the run time of the quiz, the ECM monitors the students' learning behaviour, sends deadline reminders and organises technical fixes. Questions concering the quiz content are forwarded to and answered by the clinical expert.

3.2 The didactic features of a self-study quiz

Clinical reasoning is a highly cognitive process. Beginners need to be tasked with making and justifying a clinical decision (= apply medical knowledge). They also need to be provided

with insights into the cognitive processes underlying the performance of experts (Stalmeijer, Dolmans, Wolfhagen & Scherpbier, 2009). As such, a SSQ starts by presenting the patient record in an authentic clinical setting and a prompt, requiring the student to come up with a clinical decision (*Figure 1*).

Upon responding to the first prompt, the student is provided with the expert answer and tasked to evaluate the concordance of their own approach with the expert answer. (*Figure 2*).

The quiz continues by presenting further prompts and expert answers. The prompts in our SSQs simulate the clinical tasks of a 6th year medical student. Each SSQ was designed to take students 15–25 minutes to complete.

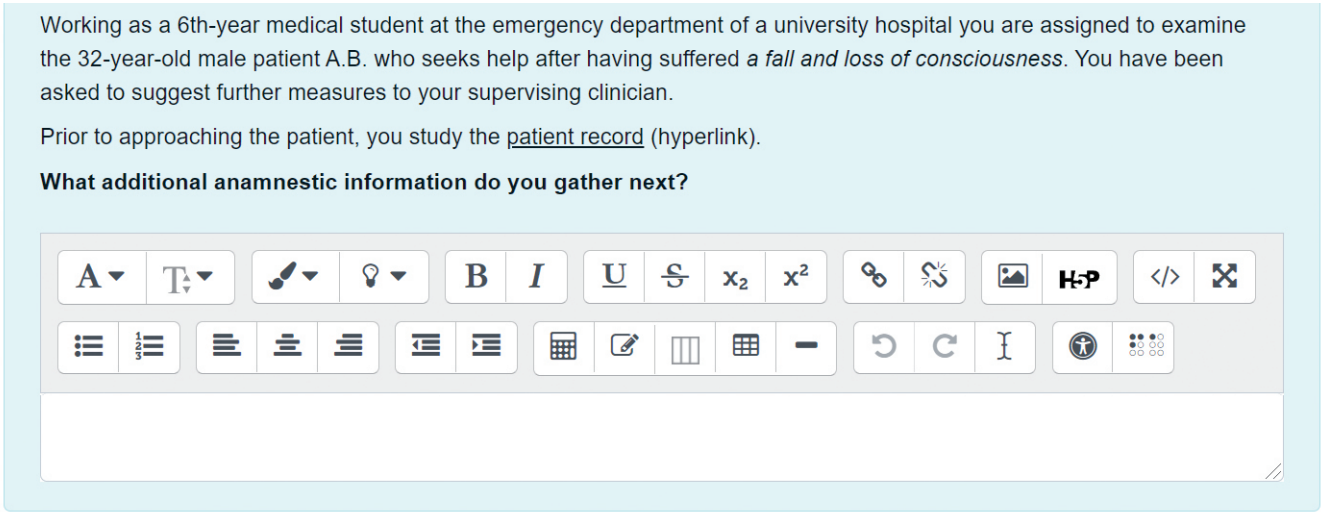

Figure 1. Simulating an authentic clinical situation in a self-study quiz (SSQ): clinical setting = emergency department, patient' situation = 32-year-old patient describing 'a fall and loss of consciousness', student's task = examine the patient, clinical decision = what additional anamnestic information do you gather next?

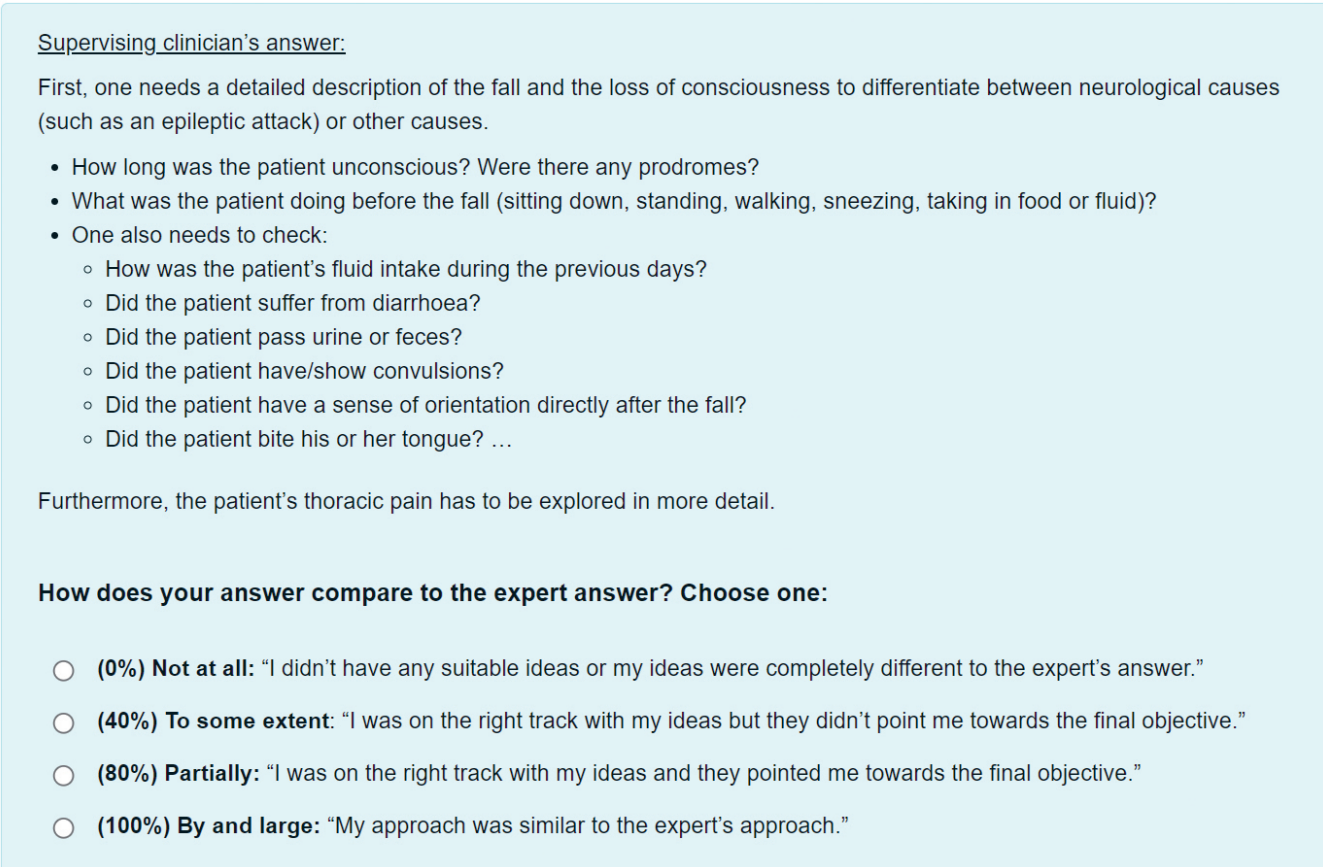

Figure 2. Providing students with insight into the expert's approach.

3.3 Students' learning experiences and study habits related to SSQs

Sample, material, and setting

The 2017/2018 cohort of 5th year medical students (n=624) were invited to participate in the study and to complete an online-questionnaire after having completed the last online assignment of their course on diagnosing and treating patients. 404 students consented to having their concordance ratings and their free comments for each quiz included in this study. In the online questionnaire 351 of these students gave information on study habits, rated the helpfulness of the learning activities (SSQs and interactive presentations) and judged how well the SSQs' difficulty matched their knowledge.

For 5th year medical students thirteen SSQs for the winter term 2017/18 and ten for the summer term 2018 were developed as part of a weekly scheduled, blended-learning course on diagnosing and treating patients, covering a broad variety of medical disciplines. It was recommended to students to complete the online SSQs at home prior to attending the face-to face interactive presentation (F2F, IP-task) in the lecture theatre together with the whole cohort. In the F2F IP-task cases and tasks that are structurally similar to the cases and tasks of the SSQs are presented and students are encouraged to share their clinical approach by discussing the questions quietly with the students next to them before sharing an answer with the presenter and the audience using the lecture's live-chat function. When the buzzing of these 'buzz-groups' (IP/buzz group task, F2F) in the lecture theatre dies down and the chat shows some relevant answers, which approximately takes 60 to 90 seconds, the clinical expert continues with the case presentation to share the expert approach in a short summary (IP/case summary, F2F) and comment briefly on students' answers in the chat.

The editorial team for the winter term consisted of content, didactic and technical experts; in the summer term, near-level peers were included to achieve a better match between task difficulty and student knowledge to boost motivation during self-study. The SSQs included in average 5,4 tasks (min = 3/max = 8) and could be completed by most of the students within 15–20 minutes. The interactive presentations also included 3–5 tasks per presentation and were scheduled for strictly 15 minutes.

Helpfulness ratings and free comments

Students rated doing the online SSQ tasks and the concordance ratings at home as being more helpful for learning than participating in the interactive presentation's face-to-face buzz-group tasks and the presentation of the case summary in the lecture theatre with the whole cohort. Chi^2 tests indicate a difference between the SSQ-task distribution and the IP-buzz group-tasks distribution (Chi^2 = 168,315; df = 3; p<0,05) as well as between the SSQ/concordance rating distribution and the IP/case summary distribution (Chi^2 = 199,575; df = 3; p<0,05) (*Figure 3)*. On average 9% (SD = 3%) of the students gave free comments per quiz, expressing predominantly (76%) satisfaction (e.g. 'great case' or 'thank you!') or neutrality (e.g. 'nothing in particular').

Matching the tasks' difficulty and the students' knowledge

Only about half of the students indicate to have 'rather enough knowledge' (52%) or 'enough knowledge' (2%) to work on the winter term tasks. For the summer term tasks this share in-

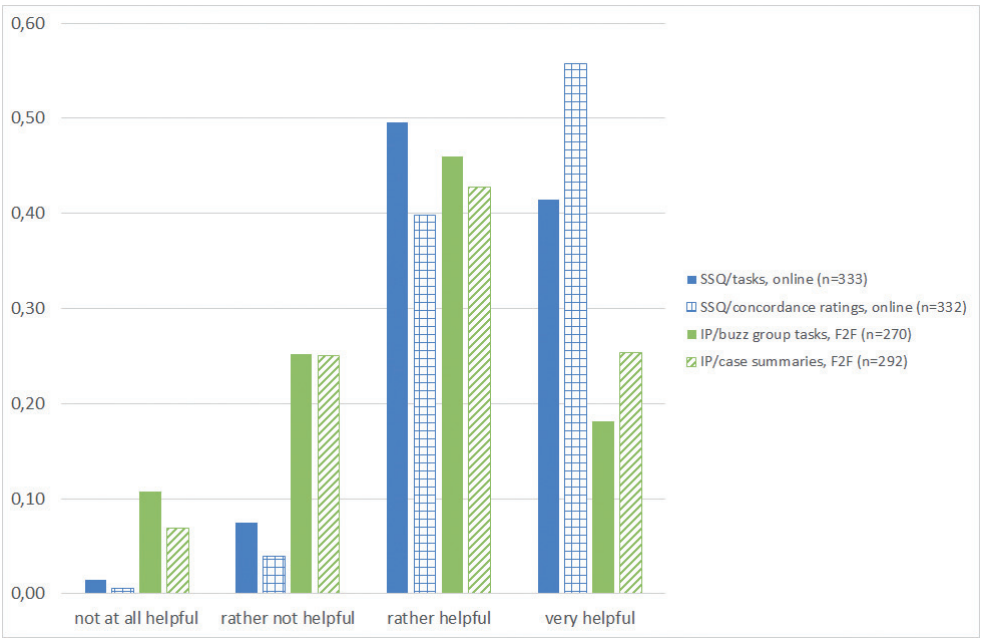

Figure 3. Helpfulness ratings (relative frequencies) for Virtual Patient tasks – summer term; SSQ = self-study quizzes; IP = interactive presentations; F2F = face-to-face.

creases up to 78% ('rather enough knowledge') and 7% ('enough knowledge'; $Chi^2 = 153{,}768$; df = 3; $p<0{,}05$; N = 328).

Study habits

Students' self-evaluation resulted in a mean concordance score of 82% (SD = 9%). The majority of students rate themselves as being 'rather critical' (70%) or 'extremely critical' (10%) when evaluating the concordance between their approach and the expert's approach. About half of the students consider finishing each quiz with a high concordance score as 'rather important'. The majority of students indicate to 'often' (31%) or 'sometimes' (44%) use reference material when working on the quizzes.

4 Discussion

In general, the use of VP-tasks and online SSQs enriches the training of undergraduate medical students and offers many benefits for teachers of medicine as well as medical students. We successfully piloted the use of online SSQs in the human medicine curriculum of the Medical University of Vienna by implementing the described editorial process to produce the 23 SSQs as well as the matching 23 interactive presentations. The editiorial approach of having the tasks for the learning activities edited not only by the content experts, but also by a multi-level-educational editorial team proved beneficial. When medical students are involved in the editorial process they can give feedback to clinical experts on which tasks are manageable for students of this educational level. Matching the tasks' difficulty and the students' knowledge is expected to have a positive impact on study motivation. However, we have no data on this so far.

Our field study on self-reported study habits of students showed that online SSQs, which were completed at home, were considered more helpful than the study activities during the F2F-lecture in the large lecture theatre. Especially the possibility to compare one's own approach to the expert answers was considered very helpful when studying online. In theory, students can also compare their approach with the expert's approach during the F2F-lecture. Thus, this result may be percieved as counterintuitive at first sight and we have no data on why students do not take advantage of this opportunity during the F2F-lecture. However, considering the busy atmosphere in the lecture theatre with more than 400 students in combination with the strictly scheduled interactive presentation, which can only last 15 minutes, one may understand why students prefer the self-paced, more quiet environment when working on the online SSQs at home. During the rather busy lecture in the lecture theatre students might have problems focusing on studying. One might also speculate that students are more prepared to engage in the most likely difficult reflection process of comparing their approach with the expert answers, when studying on their own as they can work at their own pace, which is not the case during the lecture.

The majority of students state to 'often' or 'sometimes' use reference material when working on the quiz and to be 'rather' or 'extremely' critical when rating their own performance. This result is supported by the mean concordance score of 82%, indicating that students see room for improvement in regard to their performance. Both results are quite promising in terms of self-regulated learning. Timely feedback on the performance of students is essential to drive learning, especially when errors occur, since learners learn best from errors if they receive feedback immediately and when they can see why an error happened and how it can be prevented in future (Heitzmann, Fischer, Kühne-Eversmann & Fischer, 2015; Kilminster & Jolly, 2000). The combination of clinical decision tasks and immediate feedback can, therefore, reduce the misperception of understanding, support students with weaker learning prerequisites to seek help efficiently and serve as 'real time clinical guidance' for the learners (Hege et al., 2016; Heitzmann et al., 2015).

Despite the promising results on the helpfulness of the SSQs, the efficiency of the editorial processes and favourable effect of the SSQs on self-regulated learing, we need to acknowledge that these results are based on a field study using a questionnaire based approach. We chose this approach to observe medical learners in a typical learning situation, however, this came with the limitation of not being able to strictly control the sequence of working on the SSQs and the participation in the IP. Due to limited resources it was also not possible to evaluate the quality of the students' self-rating by having their answers rated by an expert. To validate these results experimental studies need to be done.

Many factors limit student exposure to real patients and to bedside-teaching (Poulton & Balasubramaniam, 2011). VP-tasks can not only be prepared systematically based on learning goals, but can also serve a large number of students simultaneously either in a face-to-face or an online learning setting. VP-based SSQs allow self-paced and self-directed study. The clinical decision prompts followed by immediate feedback require the use of medical knowledge in a specific clinical situation and, thus, foster 'the bridging of theory to practice' as well as contribute to the development of clinical reasoning skills.

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