Facebook Social Use and Anxiety: A replication attempt

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The relationship between social media use and mental health remains under scrutiny by researchers, policy makers, and the general public. Recently, researchers have addressed whether Facebook use is beneficial to people with high social anxiety. The findings from such studies are mixed, partly due to differences in how variables are operationalised. A well-cited study by McCord et al (McCord, B., Rodebaugh, T. L., & Levinson, C. A., 2014. Facebook: Social uses and anxiety. *Computers in Human Behavior, 34*, 23-27) suggested that the inclusion of a new variable, Facebook-centric social anxiety, helps explain the complex relationship between general social anxiety and frequency of usage of socially-interactive Facebook features. We undertook two studies (N=202 and N=542; majority British and non-student participants) with the aim of replicating McCord et al (2014), using the original measures (general social anxiety, Facebook-centric social anxiety, and frequency of usage of socially-interactive Facebook features). Replicating the original study, we found a significant positive association between general social anxiety and Facebook-centric social anxiety. However, unlike the original study, we did not find evidence that general social anxiety and Facebook-centric social anxiety interacted to predict frequency of usage of socially-interactive Facebook features. We discuss the implications for future research on social Facebook use.

Introduction

The relationship between Facebook use and mental health and wellbeing continues to be of interest to researchers, policy makers, and the broader public (e.g., House of Commons Science and Technology Committee, 2019; Ryan, Reece, Chester, & Xenos, 2016; Seabrook, Kern, & Rickard, 2016). A key line of enquiry centres on whether Facebook use could be beneficial to people with high social anxiety. Social anxiety is characterised by difficulties in face-to-face social interactions; some of these difficulties might be mitigated in online interactions, where people have greater control over self-presentation (Kamalou, Shaughnessy, & Moscovitch, 2019). The social compensation hypothesis explains that social networking sites (SNSs) such as Facebook may offer socially-anxious individuals a space free from some of the hindrances to face-to-face social interaction, such as eye contact and blushing, and may thus facilitate communication within a less pressurised space (Fernandez, Levinson, & Rodebaugh, 2012; Rauch, Strobel, Bella,

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Odachowski, & Bloom, 2014). Indeed, socially anxious people report an increased preference for online over face-to-face social interactions (e.g. Caplan, 2007; Weidman et al., 2012). The idea that SNSs could provide an alternative to difficult face-to-face interactions has led researchers to suggest that social anxiety and Facebook usage might co-occur. However, a systematic review considered 20 papers that investigated SNS usage and social anxiety, and reported that 16 of those found such a relationship, although some of the reported relationships were positive whereas others were negative (Dobrean & Păsărelu, 2016). A meta-review of internet use more broadly concluded that social anxiety was not significantly correlated with time spent online overall (Prizant-Passal, Shechner, & Aderka, 2016).

The discrepant findings could arise in part because the amount of time that people spend on Facebook is difficult to capture accurately, and in any case may not reveal how people use the different features of Facebook. Facebook features differ in the extent to which they are socially interactive, and also in the extent to which they could benefit users who suffer difficulties in face-to-face interactions. Socially anxious people might benefit from socially interactive uses of Facebook, such as providing status updates, posting publicly, or chatting online, which have been associated with greater feelings of bonding, social capital, and lower loneliness (Burke, Marlow, & Lento, 2010). Yet, Facebook usage might not benefit socially anxious users if it consists of passive content consumption, such as checking profiles or browsing the newsfeed, as this has been associated with weaker ties with Facebook friends and increased loneliness (Burke et al., 2010). Further, the SNS environment may be unappealing for socially anxious individuals, as it can be as socially complex as face-to-face interactions (Seabrook et al., 2016), and provide opportunities for self-threatening social comparisons (Steers, Wickham, & Acitelli, 2014). Indeed, the social enhancement hypothesis suggests that it may be individuals with superior social skills who are particularly engaged in using SNSs, as this allows them to find additional opportunities to interact with others (see Sheldon, 2008). Given this heterogeneity in Facebook usage possibilities, the elusive relationship between social anxiety and Facebook use is perhaps unsurprising.

The implementation of different measures of Facebook use complicates matters further. Shaw and colleagues (2015), for example, found that higher levels of social anxiety were significantly related to passive uses of Facebook but not to content production uses of Facebook (a finding echoed in a more recent systematic review, Seabrook et al., 2016). Muzaffar et al. (2018) did not find any relationship between social anxiety symptoms and Facebook behaviours, although their Facebook behaviour scale measured both passive and more social Facebook behaviours. In a final study, which is the focus of our research reported below, McCord, Rodebaugh & Levinson (2014) examined the relationship between Facebook use and social anxiety. They created a new questionnaire tool, the 'Facebook-Social Interaction Anxiety Scale', which assessed Facebook-centric social anxiety, thereby allowing a distinction between people's general social anxiety, and their social anxiety when using Facebook interactive features; this allows for further nuance of the social compensation hypothesis if, for instance, some socially-anxious people (those whose anxiety is diminished outside face-to-face contexts) find relief from their social anxiety when interacting on Facebook. McCord et al. (2014) pre-

dicted (but did not find) that people with greater social anxiety would be less fre-
quent users of socially-interactive features of Facebook. Their next prediction was
borne out: they found that greater social anxiety co-occurred with higher levels of
Facebook-centric social anxiety. Finally, they examined interactions between so-
cial anxiety, Facebook-centric social anxiety, and social Facebook use. They found
that the relationship between social anxiety and social Facebook use was qualified
by levels of Facebook-centric social anxiety. Specifically, among people who were
generally highly socially anxious, the people who used Facebook the most were
also particularly anxious about using the socially-interactive features of Facebook.
In contrast, among people who had lower levels of social anxiety, there was little
difference in Facebook usage frequency between the people who did or did not ex-
perience high levels of Facebook-centric social anxiety. These findings suggest that
the inclusion of Facebook anxiety helps to make sense of the somewhat complex
relationship between social anxiety and social Facebook use.

Replication of McCord et al. (2014)

Here, we undertake a replication of McCord et al (2014). This is a paper that
has been, and continues to be, regularly cited (>125 citations to date on Google
Scholar), in relation to a number of different aspects of the original paper. For
instance, McCord et al.'s Facebook Social Interaction Anxiety Scale has been used
in modified format (Lee & Jang, 2019) and as the basis for an Instagram Anxiety
Scale (Mackson, Brochu, & Schneider, 2019), while McCord et al.'s Facebook Ques-
tionnaire / FBQ, which focuses on the frequency of socially interactive Facebook
usage, has been used both wholesale (Mikorski & Szymanski, 2017) and as the
basis of subsequent Facebook usage questionnaires (Encel, Mesagno, & Brown,
2017; Munzel, Meyer-Waarden, & Galan, 2018; Muzaffar et al., 2018). Further, oth-
er papers refer to the correlation that McCord et al. (2014) reported between social
anxiety and anxiety on Facebook (Bright, Kleiser, & Grau, 2015; Frost & Rickwood,
2017; Galbava, Machackova, & Dedkova, 2021; King, O'Rourke, & DeLongis, 2014;
Mackson et al., 2019; Shaw et al., 2015). Similarly, other authors cite the McCord et
al. (2014) findings that social anxiety and anxiety on Facebook interact to predict
social Facebook use (Dobrean & Păsărelu, 2016; Zhang & Rau, 2021). Finally, other
papers credit the McCord et al. (2014) findings that social Facebook use predicts
social anxiety after accounting for anxiety on Facebook (Bright et al., 2015; King
et al., 2014). Taken together, it is clear that both the findings from the McCord
et al study and the study's Facebook-Social Interaction Anxiety Scale continue to
inform research in this area and as such there is value in replicating this study.
Replication studies are increasingly seen as important to increase confidence in
findings, and assess the performance of a research field (McEwan, Carpenter, &
Westerman, 2018; Zwaan, Etz, Lucas, & Donnellan, 2018). Given that the findings
from recent systematic reviews concerning social anxiety and SNS use are mixed
(e.g., Dobrean & Păsărelu, 2016) and that McCord et al. (2014) is cited in reviews
(e.g., Zhang & Rau, 2021), there is value in undertaking replication studies that
form the basis of these systematic reviews. In this study, we undertake a repli-
cation effort based on two studies rather than a single attempt, and adopt open
science conventions of pre-registration and full disclosure of our data files and
analysis scripts. We therefore scrutinise the four findings reported by McCord et
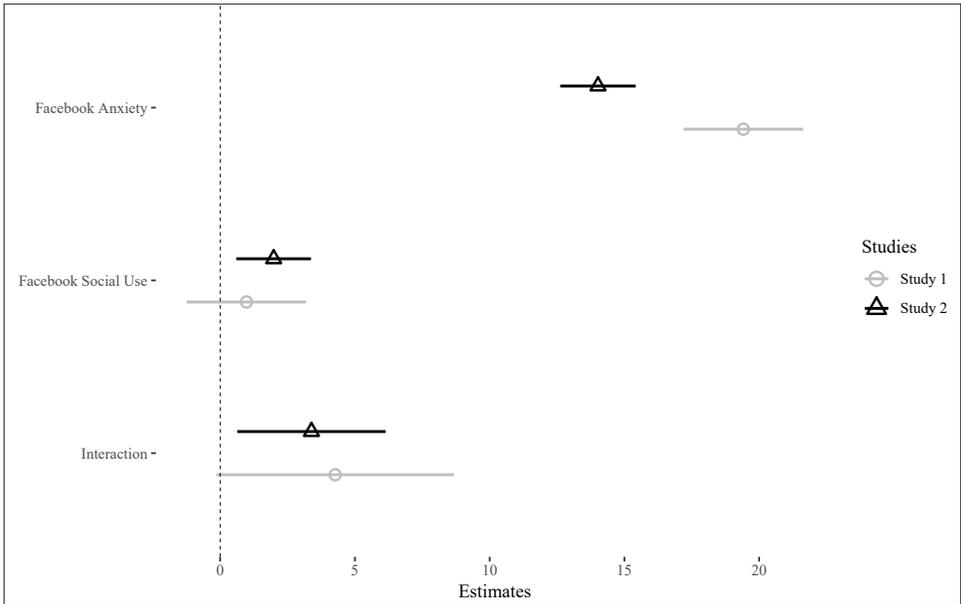
Figure 1. Parameter estimates of Facebook Anxiety, Facebook Social Use, and the interaction (Facebook Anxiety * Facebook Social Use) as predictors of Social Anxiety (OLS regressions with 95% confidence intervals). Estimates are scaled following Gelman's (2008) suggestion.
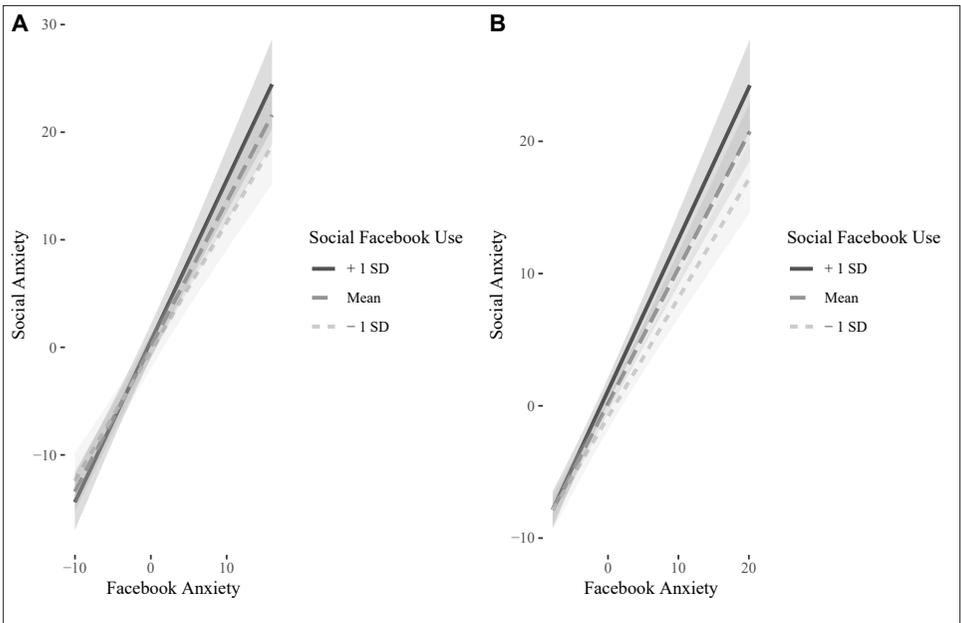

Figure 2. Interaction between Facebook Anxiety and Social Facebook Use on Social Anxiety. A= Study 1, B= Study 2.

al. 2014: that anxiety on Facebook is positively correlated with social anxiety (1); that social Facebook use is not correlated with social anxiety (2); that social anxiety and anxiety on Facebook interact to predict social Facebook use (3); that social Facebook use predicts social anxiety after accounting for anxiety on Facebook (4).

Study 1

Method

Participants. Participants were recruited by a Psychology Master's student using advertisements that indicated that any participants must have a Facebook account. 202 participants (89 men, 109 women, 4 undisclosed gender) completed the survey (M= 30.10 years, SD = 10.57 years). The majority indicated that they were British (87%) and not students (62%).

Measures. The Facebook Questionnaire / FBQ, taken from McCord et al. (2014), focuses on the frequency of socially interactive Facebook usage, and consists of 7 items (see Table 1), each rated on a seven point Likert scale (*1 = about once a month or less, 7 = many times per day*). The Facebook Questionnaire has not been validated to our knowledge, but we found that it had good internal consistency (α = .79), and it has been used since its creation both in part (Encel et al., 2017; Munzel et al., 2018; Muzaffar et al., 2018) as well as in its entirety (Mikorski & Szymanski, 2017). In this latter study, which recruited undergraduate male participants, responses on the Facebook Questionnaire were found to correlate with the 'power over women' subscale of the Conformity to Masculine Norms Inventory-46 (Parent & Moradi, 2011), and with a modified version of the 'body evaluation' and 'undesired explicit sexual advances' subscales of the Interpersonal Sexual Objectification Scale (Kozee, Tylka, Augustus-Horvath, & Denchik, 2007). Below, we refer to the Facebook Questionnaire (McCord et al. 2014) as Social Facebook Use / usage frequency of socially-interactive Facebook features.

The social anxiety measure (McCord et al.'s "SIAS-SPS-12") combines the 6 item social interaction anxiety scale (SIAS) and the 6 item social phobia scale (SPS), and is rated on a 5-point Likert scale (*0 = Not at all characteristic or true of me, 4 = Extremely characteristic or true of me*). It includes items such as *I have difficulty talking with other people, I tense up if I meet an acquaintance in the street*, and *I worry I might do something to attract the attention of other people*. Both scales combined into a scale with excellent reliability (α = .95), which was used for further analysis, and referred to below as Social Anxiety / general social anxiety. While the original scales

Table 1. *Items making up the Facebook Questionnaire (McCord et al., 2014)*

	Item
1	I send messages to friends
2	I send chat messages to friends
3	I write on group or event walls
4	I write on friends' walls
5	I send friend requests
6	I post comments on friends' status updates, pictures, etc.
7	I update my status

underpinning this composite have been validated (Mattick & Clarke, 1998; Peters, Sunderland, Andrews, Rapee, & Mattick, 2012), this composite has not been validated to our knowledge.

The Facebook-Social Interaction Anxiety Scale (McCord et al.'s "F-SIAS") was developed by McCord et al. (2014) to capture social anxiety relating to interactions on Facebook, and consists of 7 items (see Table 2), also rated on a 5-point Likert scale (*0 = Not at all characteristic or true of me, 4 = Extremely characteristic or true of me*). This scale showed very good internal consistency (α = .89). We refer to it below as Facebook Anxiety / Facebook-centric social anxiety. It has not been validated to our knowledge, although it has been used subsequently as the basis for an Instagram Anxiety Scale (Mackson et al., 2019), and elsewhere in modified format (Lee & Jang, 2019).

Procedure. The study was approved through the ethical approval system of the authors' university. The study was presented as an online questionnaire. After providing informed consent, participants provided sociodemographic data such as age, gender, and student status via an online survey. Next, they completed the measures used by McCord and colleagues (2014), namely: the Facebook Questionnaire, followed by the social anxiety measure, followed by the Facebook-Social Interaction Anxiety Scale.

Table 2. *Items making up the Facebook-Social Interaction Anxiety Scale (McCord et al., 2014)*

	Item
1	When sending someone a Facebook message, I worry that I will not get a reply
2	I feel tense communicating with someone on Facebook chat
3	I have difficulty coming up with what to say in a status update
4	I get nervous when writing on someone's Facebook wall
5	I feel uncomfortable posting on the wall of a Facebook group or event
6	I am unsure whether to send a friend request to someone I do not know very well yet
7	I have difficulty commenting on someone's status or other post

Analyses. We used R 4.0.2 (R Development Core Team, 2008) to perform the same analyses as McCord and colleagues. Variables were centered prior to regression analyses (Aiken & West, 1991). We report the parameter estimates and concomitant confidence intervals visually (Gelman, 2008). The analysis plan was preregistered (Brandt et al., 2014). Our analysis document, data, and code, including further analyses (e.g., Bayesian regression modelling Buerkner, 2015), can be found at https://osf.io/e4msd/.

Results

Correlations (aim 1-2). We replicated McCord and colleagues' findings of a positive correlation between Social Anxiety and Facebook Anxiety (*r*=.77, *p*<.001); that is, people with greater general social anxiety also tended to have greater

Facebook-centric social anxiety. There was no relationship between Social Facebook Use and Social Anxiety (*r*= -.03, *p* = .661). We additionally investigated the correlation between Social Facebook Use and Facebook Anxiety, and found no relationship (*r* = -.08, *p* = .263). That is, people who were more socially anxious, whether in general terms or specifically in relation to Facebook usage, did not use socially-interactive Facebook features any more or less than people who were less socially anxious.

Predictors of Social Facebook Use (aim 3). Unlike McCord et al. (2014), we found no evidence that Social Anxiety, Facebook Anxiety, or an interaction between the two predicted Social Facebook Use in any of our regression models (all *p's* >.2, see (https://osf.io/e4msd/)). That is, again, frequency of usage of socially-interactive Facebook features was not predicted by people's social anxiety (either general, or Facebook-centric).

Predictors of Social Anxiety (aim 4). We replicated McCord et al.'s findings that Facebook Anxiety predicted Social Anxiety in a hierarchical regression (*F*(1,201)= 229.53, *p*<.0001) (i.e. as reported above, people with greater general social anxiety tended to have greater Facebook-centric social anxiety). Contrary to the findings from McCord et al.'s regression model, there was no suggestion that Social Facebook Use (how often people used socially-interactive Facebook features) predicted Social Anxiety (*F*(1,200)= 0.447, *p*=.504). The interaction between Facebook Anxiety and Social Facebook Use was not statistically significant, *F*(1,199)= 3.63, *p*=.058, but the found significance was similar to that in the original paper (*p*=.053). The interaction model for our study is summarised in Figure 1 and 2A. As Figure 2A demonstrates, high Facebook Anxiety better predicts Social Anxiety amongst those scoring higher on Social Facebook Use: in other words, among people who used Facebook's socially-interactive features frequently, the two types of social anxiety (Facebook-centric, and general) tended to go hand-in-hand. In contrast, among people who were less likely to use Facebook's socially-interactive features, the relationship between the two types of social anxiety was less apparent.

Discussion of Study 1

Study 1 corroborated most findings of McCord et al. (2014). First, we replicated the correlation between Social Anxiety and Facebook Anxiety; if anything our association was slightly stronger. Similarly to McCord et al. (2014), we found no support for a correlation between Social Facebook Use and Social Anxiety, and the interaction between Facebook Anxiety and Social Facebook Use as predictors of Social Anxiety was not statistically significant (*p* = .058, original: *p* = .053). Unlike the original paper, however, we failed to find that Social Anxiety and Facebook Anxiety interacted to predict Social Facebook Use. Moreover, albeit similar to the methods employed in the original paper, the data were collected via the personal networks of a researcher. In addition, our sample size was slightly smaller than the original study. Therefore, in Study 2, we further examined the interaction effect in a larger online sample collected via an online platform (Prolific; Peer, Brandimarte, Samat, & Acquisti, 2017). Research suggests that samples from Prolific are more diverse in terms of ethnic background than those from Amazon's MTurk (Peer et al., 2017).

Study 2

Method

Participants. We recruited 542 British participants (168 men, 372 women, 2 undisclosed gender; *M* = 35.31 years, *SD* = 12.30 years) via an online platform (Prolific; Palan & Schitter, 2018) who were required to have a Facebook account to participate, and were paid (£0.85) for their participation. The majority indicated that they were not students (74%).

Procedures and measures. The procedure was the same as in Study 1. The three scales demonstrated very good reliabilities (Social Facebook Use: *α* = .87; Social Anxiety: *α* = .91; Facebook Anxiety: *α* = .92).

Analyses. We followed the same preregistered analytical procedures as in Study 1. Our analysis document, data, and code, including further analyses, can be found at https://osf.io/e4msd/.

Results

Correlations (aim 1-2). As in Study 1, Social Anxiety and Facebook Anxiety were positively correlated (*r*=.64, *p*<.001), meaning that people who were socially anxious in general were also socially anxious around Facebook usage. Unlike Study 1, there was a significant negative correlation between Facebook Anxiety and Social Facebook Use (*r*=-.18, *p*<.001). In contrast, there was no correlation between Social Anxiety and Social Facebook Use (*r*= -.03, *p* = .514). That is, taken together, the people who used socially-interactive Facebook features the most frequently were those who were less socially anxious about Facebook usage, but not necessarily those who were less socially anxious in general terms.
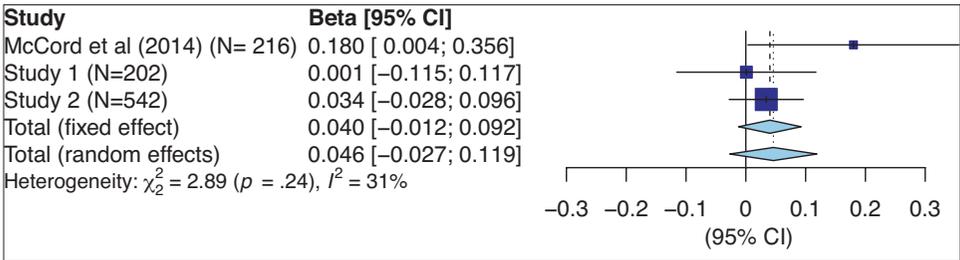

Study	Beta [95% CI]
McCord et al (2014) (N= 216)	0.180 [0.004; 0.356]
Study 1 (N=202)	0.001 [−0.115; 0.117]
Study 2 (N=542)	0.034 [−0.028; 0.096]
Total (fixed effect)	0.040 [−0.012; 0.092]
Total (random effects)	0.046 [−0.027; 0.119]
Heterogeneity: χ_2^2 = 2.89 (*p* = .24), I^2 = 31%	

Figure 3. Mini-meta-analysis on interaction effect with Social Facebook Use as dependent.

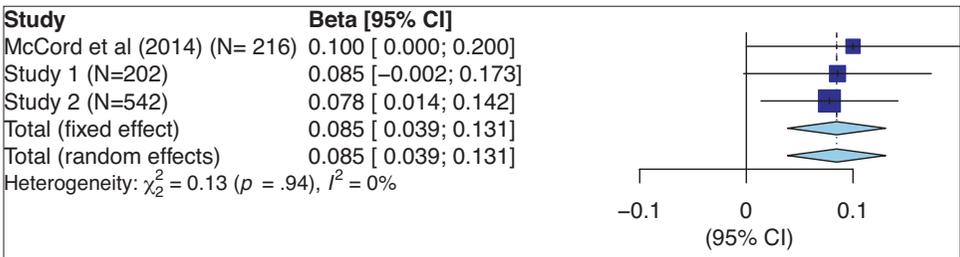| Study	Beta [95% CI]
McCord et al (2014) (N= 216)	0.100 [0.000; 0.200]
Study 1 (N=202)	0.085 [−0.002; 0.173]
Study 2 (N=542)	0.078 [0.014; 0.142]
Total (fixed effect)	0.085 [0.039; 0.131]
Total (random effects)	0.085 [0.039; 0.131]
Heterogeneity: χ_2^2 = 0.13 (*p* = .94), I^2 = 0%	

Figure 4. Mini-meta-analysis on interaction between predictors of Social Anxiety.

Predictors of social Facebook use (aim 3). Table 3 summarises the hierarchical OLS regression models. Social Anxiety did not significantly predict Social Facebook Use only in Model 1; in the second and third models, with the addition of the predictors Facebook Anxiety and then the interaction, there were significant main effects of Social Anxiety and Facebook Anxiety as predictors of Social Facebook Use. That is, participants used the socially-interactive Facebook features more, if they had greater general social anxiety, or lower Facebook-centric social anxiety. Unlike McCord et al. (2014) but in line with Study 1, there was no evidence that Social Anxiety and Facebook Anxiety interacted to predict Social Facebook Use (Figure 2B and Model 3; see https://osf.io/e4msd/ for additional analyses).

Predictors of social anxiety (aim 4). Hierarchical regression showed that Social Anxiety was predicted both by Facebook Anxiety ($F(1,541)= 368.23$, $p<.0001$) and by Social Facebook Use ($F(1,540)= 6.89$, $p=.009$): greater social anxiety was experienced by people who had higher social anxiety when using Facebook, or who used the socially-interactive features of Facebook more frequently. The model also supported an interaction effect between Facebook Anxiety and Social Facebook Use to predict Social Anxiety ($F(1,539)= 5.66$, $p=.017$). This interaction model is summarised in Figure 1B and 2B, but in brief, as in Study 1, the effect of Facebook Anxiety on Social Anxiety is stronger for those scoring higher on Social Facebook Use.

Table 3. *Hierarchical regression models to predict Social Facebook Use (Study 2)*

	Social Facebook Use		
	Model 1	Model 2	Model 3
Social Anxiety	−0.028 (0.043)	0.143**(0.055)	0.133*(0.055)
Facebook Anxiety		−0.268***(0.055)	−0.284***(0.056)
Social Anxiety * Facebook Anxiety			0.034 (0.032)
N	542	542	542
R^2	0.001	0.044	0.046
Adjusted R^2	−0.001	0.040	0.040
Residual Std. Error	1.000 (df = 541)	0.979 (df = 540)	0.979 (df = 539)
F Statistic	0.426 (df = 1; 541)	12.296*** (df = 2; 540)	8.590*** (df=3; 539)

*$p < .05$; **$p < .01$; ***$p < .001$

Mini-meta-analyses

Using the 'meta' package (Schwarzer, 2016), we performed mini-meta-analyses to synthesise the interaction effects (Goh, Hall, & Rosenthal, 2016). These are summarised in Figures 3 and 4. As expected, these show no evidence that Social Anxiety and Anxiety on Facebook interact to predict Social Facebook Use (Figure 3). There is, however, evidence that Anxiety on Facebook and Social Facebook Use interact to predict Social Anxiety (Figure 4, Estimate from random effect meta-analysis: $\beta = .085$, 95% CI = .039 to .131).
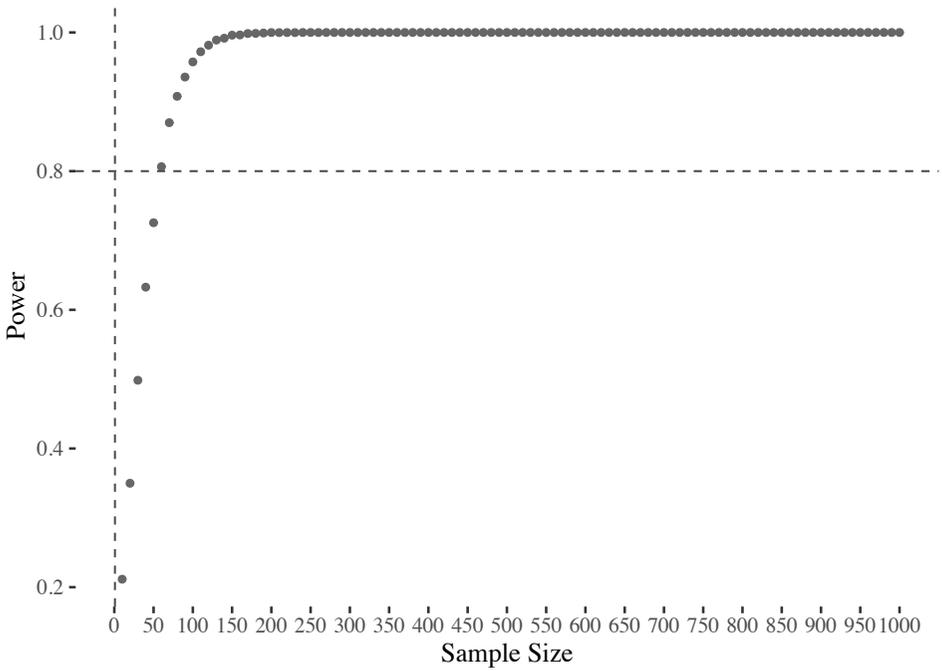
Figure 5. Power estimates based on 10,000 simulations for a main effect.
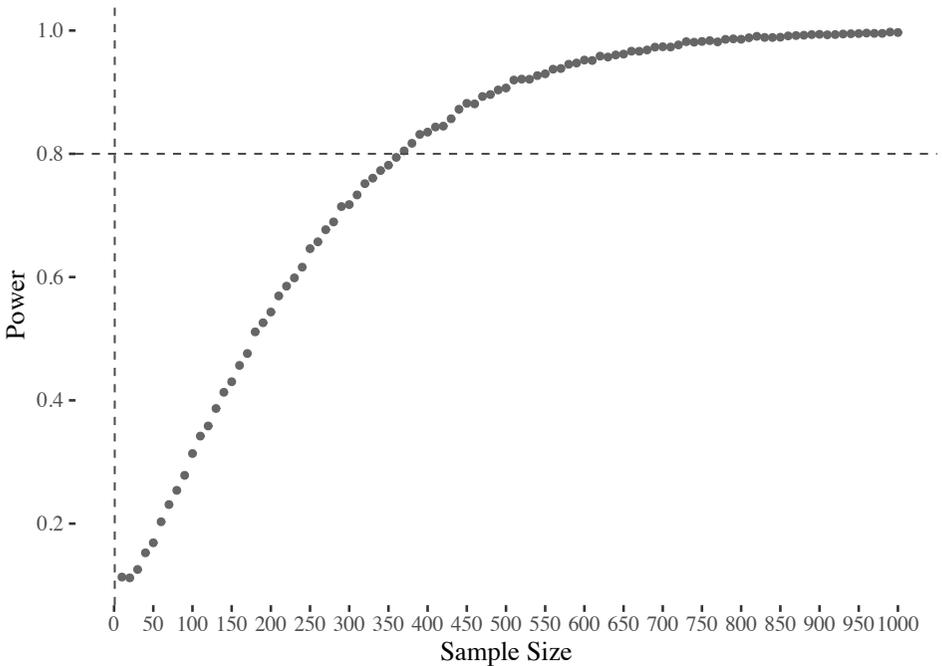

Figure 6. Power estimates based on 10,000 simulations for an interaction effect.

Power Simulation

Given that we found varying support for the interaction effect(s), but consistent support for key main effects, it is possible that this is due to differential statistical power. To evaluate this possibility, we ran simulations of McCord et al. (2014)'s multiple regression models using the 'simglm' package in R (LeBeau, 2020). We simulated power estimates for sample sizes ranging from 10 to 1,000 with 10,000 replications each. We specified the model as an ordinary least squares regression with the same design as the interaction model for predicting social Facebook use from McCord et al. (2014), as specified in Equation below (Social_FB = Social Facebook Use , Social_anx = Social Anxiety, FB_anx = Anxiety on Facebook, ε = error term).

$$\text{Social\_FB} = \beta_1(\text{Social\_anx}) + \beta_2(\text{FB\_anx}) + \beta_3(\text{Social\_anx} \times \text{FB\_anx}) + \epsilon$$

We assumed normal error variances and that regression assumptions were upheld (e.g., no heteroscedasticity, non-linearity, Berry, 1993; Ernst & Albers, 2017). Thus, if anything, what we report below will likely be overconfident, a best case scenario.

For this simulated multiple regression model, we presuppose a weak to moderate effect size for the interaction term, where the effect size is Pearson $r = .2$. This corresponds to a magnitude of the coefficient, β_3, for the interaction term of 0.15 (see Peterson & Brown, 2005). Given that the interaction term is operationalized as the product of the coefficients for the main effects, β_1 and β_2, we have assumed that each of these therefore has a magnitude of 0.387 (i.e., $0.15 — 0.387 \times 0.387$). Inputting these respective β values into the simulation yields estimates of statistical power as a function of sample size. These are shown separately for the main effect in Figure 5 and the interaction effect in Figure 6. Figure 5 shows that one would only need a very small sample to test for a main effect with a power of 80% (point estimate: n = 60). However, in order to achieve the same statistical power to reliably detect a small to moderate interaction effect, one needs quite large samples of approximately n > 350. We can also use the same approach to estimate the statistical power to detect an interaction effect of $\beta = .15$ for varying sample sizes. This leads to an estimate of 56.8% for McCord et al. (2014)'s sample (n = 216), 54.7% for Study 1 (n = 202), and 92.6% for Study 2 (n = 542). Thus, only Study 2's sample was adequately powered to investigate interaction effects. In contrast, for main effects in our simulations the estimated statistical power was 99.9% or higher for all three sample sizes.

General Discussion

We set out to replicate McCord et al.'s (2014) study of the manifestation of social anxiety within Facebook usage, given the mixed predictions around whether Facebook might facilitate or challenge the interactions of socially anxious people. As we explain in the Introduction, we focused on this study as our replication target because it has been and continues to be well cited (both generally and also

in relation to the three key findings that were reported), because the questionnaire developed in that study is used as the basis for ongoing questionnaire development, and because understanding the somewhat complex relationship between social anxiety and Facebook usage is a concern of policymakers, the public, and the academic literature. The most consistent finding, across our two studies and the original work of McCord et al. (2014), was that people with higher levels of general social anxiety were also more anxious about using the socially-interactive features of Facebook. While this is perhaps unsurprising because it is reasonable to expect that individual social anxiety would be borne out across a range of contexts, it does reflect positively on the Facebook-Social Interaction Anxiety Scale that was developed by McCord et al. (2014), which has been used subsequently by other researchers both in whole (Mackson et al., 2019) and with modification (Lee & Jang, 2019), and which demonstrated very good internal consistency in our samples.

Greater Facebook-centric social anxiety, but *lower* general social anxiety, both predicted people's less frequent usage of socially-interactive Facebook features in the regression analyses of McCord et al.'s work and our Study 2, but this association was not invariantly apparent across all of the various correlations and regressions where it was assessed. If this finding is robust, it is easy to understand why our measure of Facebook-centric social anxiety (sample item: "I have difficulty commenting on someone's status or other post") should co-occur with our measure of usage of Facebook features (sample item: "I post comments on friends' status updates, pictures, etc"). In addition, the association between greater social anxiety and greater Facebook usage is consistent with the social compensation hypothesis (see Introduction); people who struggle with in-person social activities (sample item in our measure: "I have difficulty talking with other people") might make up for this by interacting via Facebook. Further, these findings distinguish between Facebook-centric and general social anxiety in terms of their implications for Facebook behaviour, demonstrating that different types of social anxiety do not manifest themselves identically in interactive behaviour.

Neither Study 1 nor Study 2 replicated McCord et al.'s key finding that among more socially anxious people, those who used socially-interactive Facebook features the most frequently were also particularly anxious about using those features. In contrast, among less socially anxious people, there was little difference in usage frequency between those who did or did not experience high levels of anxiety about using socially-interactive Facebook features. Our mini-meta-analysis indicated no good evidence overall for this effect. Various explanations are possible for this pattern of findings. First, it should be noted that these findings do not contradict each other, in the sense that the confidence intervals overlap across all of the studies. If there is a genuine difference in sample behaviour to explain, then perhaps in McCord's sample, some portion of the 'low Facebook usage' subgroup used it insufficiently to fully realise and report how anxious it made them feel - someone cannot report feeling nervous or uncomfortable writing on a Facebook wall, or posting on the wall of a Facebook group, (two of the items), if they never do this.

Finally, McCord et al. (2014) reported an interaction between Facebook-centric social anxiety, and usage frequency of socially-interactive Facebook features, in

predicting general social anxiety. This interaction was supported in our mini-meta-analysis. Specifically, among people with the highest Facebook-centric social anxiety, usage frequency of socially-interactive Facebook features was especially predictive of social anxiety (with high usage rate predicting high social anxiety); in contrast, among people with the lowest Facebook-centric social anxiety, Facebook usage was no longer so predictive of social anxiety. In the same way, among the most frequent users of the socially-interactive Facebook features, Facebook-centric social anxiety predicted general social anxiety more strongly than among the least frequent users of the Facebook features. Perhaps this result was driven by participants who simply did not use the socially-interactive Facebook features regularly enough to have much insight into how anxious they might feel about using them, and so were unable to report the relationship that we might expect, between Facebook-centric social anxiety and general social anxiety.

Our simulation illustrated that the detection of interaction effects via regression modelling requires large sample sizes to detect small to moderate effects (n > 350). This is in line with other studies arguing that interaction effects in multiple regression typically suffer from low statistical power (e.g., McClelland & Judd, 1993; Gelman, Hill, & Vehtari, 2020; Jaccard & Turrisi, 2003). Our simulations specifically modelling McCord et al. 's (2014) scenario further corroborated these claims that large sample sizes are required to reliably detect interaction effects. Low statistical power, and a failure to consistently replicate at least one interaction effect across two studies, leads us to conclude that without ample statistical power, or replication, interaction effects such as those reported in McCord et al. (2014) warrant scrutiny.

Apart from issues relating to statistical power, it is also worth pointing out that some measurement issues potentially affect the conclusions drawn by McCord et al. (2014). First, the same three variables are used to formulate two interaction models, which is somewhat unusual. Obviously, correlational data, such as used here, cannot be used to make causal inferences (Pearl, 2009), and accordingly, it is not clear what the two interaction models with the same three variables seek to achieve. Future work might benefit from a clearer assignment of whether any given variable acts as an independent or dependent variable. Second, general social anxiety and Facebook-centric social anxiety were correlated at .64 in the original study and .77 and .64 in our studies. Given that the overlap in these measures is quite substantial, it can be difficult to disentangle whether the effects are driven by 'general' social anxiety or social anxiety specifically related to Facebook. Confounding can occur where predictors correlate, and both confounding (e.g., Greenland, 2009) and measurement error in the predictors (e.g., Jaccard & Turrisi, 2003; Muff & Keller, 2015; Whisman & McClelland, 2005) could lead to significant interaction effects in regression models. Future studies would benefit from better measurement (i.e. avoiding measures which overlap substantially, and/or causal modelling to separate out effects of 'general' social anxiety and social anxiety relating specifically to a medium such as Facebook).

Social media platforms evolve rapidly, and we have seen changes in the social functionality of Facebook since McCord et al.'s 2014 publication, with the release of Facebook Messenger for example. Indeed, the receipt of targeted communication such as messages from strong network ties has been associated with improved

well-being (Burke & Kraut, 2016; see also e.g., Dienlin, Masur, & Trepte, 2017). It might be that the measure of social Facebook use of our replication studies no longer well reflects the range of socially interactive Facebook features most widely used. The ongoing technological changes to SNSs combined with the difficulties of developing robust measurement tools that keep pace with these changes make comparisons of any kind challenging, and researchers continue to refine scales for measuring social media anxiety (e.g. Alkis, Kadirhan, & Sat, 2017). More broadly, we can question the reliability and validity of self-reported behaviours on the internet (Ellis, Davidson, Shaw, & Geyer, 2019; Scharkow, 2016), and more work is necessary to validate how self-reported Facebook use corresponds to *actual* user behaviour. In this context, it is also worth noting that the focus on correlational studies, and dearth of experimental studies, means that we have limited grounds to establish mechanisms (Dobrean & Păsărelu, 2016). Future longitudinal studies, further qualitative work to understand more complex relationships between social anxiety and Facebook use, and consideration of older users based upon the noted effects of age in relation to social media use and anxiety (Hardy & Castonguay, 2018; Prizant-Passal et al., 2016), may all prove beneficial.

In conclusion, we have seen how general social anxiety and Facebook-centric social anxiety co-occur, unsurprisingly. However, these two variables are not identical, and appear to have somewhat different implications: lower Facebook-centric social anxiety, but *greater* general social anxiety, both predicted people's more frequent usage of socially-interactive Facebook features. Together, these findings speak gently to the social compensation hypothesis: Facebook may provide a space where some people with high social anxiety might find some reprieve, and be able to interact more freely with others, even if ultimately this does not improve their quality of life (Weidman et al., 2012). Although our study focussed primarily on British people with a mean age in their 30s, we anticipate that these findings would generalise much more broadly, given the universal importance of social interactions, and the ubiquity of Facebook usage.

Acknowledgments

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