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RESEARCH ARTICLE

The burden of online friends: The effects of giving up Facebook on stress and well-being

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ABSTRACT

People occasionally choose to cut themselves off from their online social network by taking extended breaks from Facebook. This study investigated whether abstaining from Facebook reduces stress but also reduces subjective well-being because of the resulting social disconnection. Participants (138 active Facebook users) were assigned to either a condition in which they were instructed to give up Facebook for 5 days or continue to use Facebook as normal. Perceived stress and well-being, as well as salivary cortisol, were measured before and after the test period. Relative to those in the Facebook Normal condition, those in the No Facebook condition experienced lower levels of cortisol and life satisfaction. Our results suggest that the typical Facebook user may occasionally find the large amount of social information available to be taxing, and Facebook vacations could ameliorate this stress—at least in the short term.

"I deleted it [my Facebook account] when I was 15, because I think it [Facebook] was just too much for me with all the gossip and all the cliques and how it was so important to be—have so many friends—I was just like it's too stressful to have a Facebook, if that's what it has to take to stay in contact with just a little people. It was just too strong, so I just deleted it. And I've been great ever since" (16-year-old girl, Pew Internet & American Life Project, 2013).

Online social networks in daily life are ubiquitous. In most parts of the world, people have found their way onto Facebook, the largest online social network, with over 1.37 billion daily active users (Facebook, 2017). Facebook provides a set of tools for communicating and keeping up-to-date with a large number of people—tools that are relatively effortless, omnipresent, and rich in information. As Facebook use has grown, researchers in psychology and related fields have reported hundreds of studies about how and why people use Facebook, as well as the impact that Facebook has on people and their relationships (Ryan, Chester, Reece, & Xenos, 2014; Wilson, Gosling, & Graham, 2012). It is clear that Facebook provides many benefits that keep its users at the site for many hours each month. For example, Facebook users use it for maintenance of their existing offline relationships (Smock, Ellison, Lampe, & Wohn, 2011). They will also use Facebook to ask their online friends for a ride to the airport, make a recommendation for a restaurant, share music discoveries, or provide validation for an opinion or action (Burke, Kraut, & Marlow, 2011; Ellison, Gray, Vitak, Lampe, & Fiore, 2013; Krause, North, & Heritage, 2014). Facebook messages can also influence information seeking and voting behavior during elections (Bond et al., 2012).

Yet, despite the benefits afforded by Facebook, it is also clear that being an active user can be onerous, as exemplified by the teenager's quote above. Indeed, in one survey of online adults (Rainie,

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Smith, & Duggan, 2013), 61% of current Facebook users reported having taken a "Facebook vacation," in which they voluntarily stopped using Facebook for several weeks or more. Moreover, 20% of adults reported once using Facebook but no longer did so. Excessive use of Facebook appears to be too much of a good thing. Consistent with this conclusion, Kross et al. (2013) reported that the more participants used Facebook over a 2-week period, the more their life satisfaction levels declined. This decline in general well-being was not moderated by loneliness, self-esteem, motivations for using Facebook, or even the perceived supportiveness of their social network. Similarly, Sagioglou and Greitemeyer (2014) found that the longer participants used Facebook in a single session, the more negative was their mood afterwards. In that study, the relationship between Facebook use and mood was mediated by participants' feelings of having wasted time while on Facebook. Verduyn et al. (2015) found similar negative outcomes associated with Facebook use, particularly when people used it passively (i.e., just reading other people's posts). Indeed, in a recent review of the literature on subjective well-being and social network sites (SNS) more generally, Verduyn, Ybarra, Résibois, Jonides, and Kross (2017) concluded that subjective well-being is (robustly) negatively associated with passive SNS use, but they also found some evidence that it may be positively associated with active SNS use.

Given these outcomes, it is clear then that taking a break from Facebook could have both positive and negative consequences. One way to understand people's use of Facebook is to consider it as an activity fraught with feelings of ambivalence. That is, sometimes a person's needs to belong, connect, etc. are strong enough to drive one to engage Facebook, whereas at other times the need to minimize the stress associated with too much social cognition drives one to disengage from it. As such, the typical active user probably feels a great deal of ambivalence about his or her time on Facebook. Giving it up may reduce stress, but it comes with the cost of making one feel disconnected from others and therefore less satisfied (Sheldon, Abad, & Hinsch, 2011), and thus eventually leading to a resumption of Facebook use.

Research question and hypotheses

We used an experimental manipulation to investigate our central research question: Does a break from Facebook elicit changes in stress and well-being?[1] The interview data from the Pew Project (2013), as well as work of Kross et al. (2013) suggested that changes in stress, measured here with both self-report and physiological measures, and well-being are the main consequences of taking a break from Facebook, and perhaps are why people are motivated to take such breaks on their own. Therefore, active Facebook users were recruited for the study with the knowledge that they might be asked to give up Facebook for a few days. They were then randomly assigned to a condition in which they were instructed either to completely give up Facebook for 5 days or to continue to use Facebook as normal. From informal discussions with other active Facebook users, we decided on 5 days because (1) it seemed to be a sufficient amount of time for an active Facebook user to feel "cut off," and (2) it allowed us to test multiple groups of participants at the same time of day each week (i.e., a 7-day interval would mean Session 2 participants would have come to the lab just as we were presenting Session 1 to new participants). To measure stress, we used self-report measures, but we also measured salivary cortisol because of its well-established relationship to both acute and chronic stress (Kirschbaum & Hellhammer, 2000). When activated, the hypothalamic-pituitary-adrenocortical (HPA) axis releases the cortisol hormone into the bloodstream, which has a number of effects on bodily systems, particularly during the stress response. Short-term stressors (e.g., receiving negative feedback about a Facebook post) and long-term stress (e.g., engaging in frequent threatening social status comparisons) are typically associated with elevated cortisol, whether measured in plasma or saliva (Blascovich, Vanman, Mendes, & Dickerson, 2011; Dickerson & Kemeny, 2004).

In addition, we used self-report measures of well-being and mood. Compared to the Facebook-as-normal control group, we predicted that giving up Facebook would lead to a decrease in stress, but that these same participants would also report feeling unhappy about being disconnected from their

Facebook social network and therefore exhibit a decline in subjective well-being as well. We reasoned that abstaining from Facebook would lower life satisfaction because it normally makes us feel connected to others, which meets a fundamental need (Sheldon et al., 2011; Tobin, Vanman, Verreynne, & Sari, 2015). We also thought the break would reduce stress because people often report feeling overwhelmed with the information, social comparisons, and other threats to their social status that are part of the everyday Facebook experience. These two predictions might appear to be at odds with the findings of Kross et al. (2013), who found increased Facebook usage was negatively related with well-being. Our interpretation of the "Facebook vacation" phenomenon, however, suggested that the vacation ends when people start feeling sufficiently socially disconnected and unhappy, which is possibly a different motivational dynamic from what occurs during regular Facebook usage that was observed by Kross et al., who did not examine what happened when participants are cut off from Facebook.

Exploratory questions

We included other measures for exploratory analyses. With participants in the no Facebook condition having reduced online social contact, we explored whether this would cause more of those people to seek out actual contact on a weekend day. We also examined whether the number of Facebook friends moderated any of the effects of the experimental manipulation. Humans likely have a limited capacity in keeping track of information about other people in their social groups. Indeed, the social brain hypothesis (Dunbar, 1992) posits that humans are constrained in the number of relationships they can maintain due to cognitive limitations imposed by the structure of the neocortex. Based on an analysis of the relationship between the relative neocortex size and the size of various ape social groups, Dunbar (1992, 2011) estimated that evolution has led to a "natural" community size of humans of around 150 people. Maintaining relationships much greater than this number should be increasingly difficult. With Facebook allowing up to 5000 "friendships," many Facebook users might find it too stressful to keep up with such a large network (Maier, Laumer, Eckhardt, & Weitzel, 2014). Thus, we explored whether "Dunbar's number" of Facebook friends served as a limit for the effects of Facebook use on well-being and stress. Interestingly, Kross et al. (2013) found no relationship between the number of Facebook friends and the decline in well-being associated with greater Facebook active use, which suggests that Dunbar's number of 150 is not critical to understanding why people take periodic breaks from Facebook. In contrast, Maier et al. (2014) found that the number of relationships predicted feelings of social overload (i.e., Facebook exhaustion due to perceptions of too many social support requests), but this finding was moderated by factors such as age and Facebook usage. Larger Facebook networks may reflect relatively weak quality social relationships (Dunbar, 2012) or individual differences in structure (e.g., grey matter density) in brain regions associated with social cognition (Kanai, Bahrami, Roylance, & Rees, 2012).

Method

Below we report how we determined our sample size, all data exclusions, all manipulations, and all measured used in this study. The complete data file and questions used are permanently archived at https://osf.io/grh8s/.

Participants

Participants were 138 active Facebook users (51 men, 87 women, M_{age} = 22.43, range 18–40 years). Our initial aim was to collect data from at least 120 participants based on an a priori estimate, assuming medium effect sizes and 80% power (Bakker, Hartgerink, Wicherts, & van der Maas, 2016). However, we continued to collect past this point until our source of potential research participants was exhausted at the end of the academic year. They were recruited through psychology research

participant pools, advertisements on Facebook, and online bulletin boards. Participants received either credit for a course requirement or were paid AU$20 for participating in both sessions. Seventy-eight participants were randomly assigned to the Facebook as normal condition, and 60 were assigned to the No Facebook condition.[2] Of these participants, 123 (89.1%) completed both study sessions.

Materials

Questionnaires were administered online in a computer laboratory. These included measurements of Facebook activity as well as measures of stress and well-being.

Facebook use

Participants were asked to indicate the number of Facebook friends they had. In addition, two items measured their overall use of Facebook: "How often do you log on to Facebook?" and "In a typical day, what is the total time in hours you spend on Facebook?" To assess different ways participants used Facebook, seven items assessed various Facebook activities. Each item used an 8-point response scale ranging from "never" to "multiple times a day." Based on prior research (Burke, Marlow, & Lento, 2010), we classified five of these items as measures of active use: clicking like on friends' posts, posting status updates, commenting on friends' posts, posting on friends' walls, and posting photos. Passive use was defined as the frequency of logging into Facebook without making any posts or comments.

Stress and well-being

We used four measures of stress and well-being, and provide psychometric information from the original reports of those measures here. The 5-item Satisfaction with Life Scale (SWLS, Diener, Emmons, Larsen, & Griffin, 1985) was used to measure current subjective well-being. It includes items such as "In most ways my life is close to my ideal" and "I am satisfied with my life" (Cronbach's α = .87, and two-month test-retest r = .82). It has multi-method convergence with other well-being constructs (Pavot & Diener, 1993), and it has already been demonstrated to be associated with Facebook usage (Kross et al., 2013). The Perceived Stress Scale (PSS, Cohen, Kamarck, & Mermelstein, 1983), a 10-item scale, assessed the frequency (0 = *never* to 4 = *very often*) of various experiences of stress within the last three days (e.g., "In the last three days, how often have you felt that things were going your way" and "In the last three days, how often have you been able to control irritations in your life" (Cronbach's α = .85, two weeks test-retest, r = .85). The Positive and Negative Affect Schedule (PANAS, Watson, Clark, & Tellegen, 1988), a 20-item measure of positive and negative affect, assessed the participant's affective state in the last three days (e.g., "Indicate to what extent you have felt this way in the past three days: hostile, where 1 = *very slightly or not at all* to 5 = *extremely*; Cronbach's α ranged from .86 to .89, one-week test-rest, r = .80). Finally, we included the short form of the Social and Emotional Loneliness Scale for Adults (SELSA-S, DiTommaso, Brannen, & Best, 2004), a 15-item measure comprised of three subscales of current social (e.g., "I feel part of a group of friends"), romantic (e.g., "I wish I had a more satisfying romantic relationship"), and family loneliness (e.g., "I feel alone when I am with my family"), rated on a 7-point Likert scale that ranged from 1 = *strongly disagree* to 7 = *strongly agree*, where Cronbach's α ranged from .87 to .90.

A single item measuring face-to-face contact was included in the second survey only and asked participants to indicate in hours how much time they had spent socializing face-to-face with others on the Sunday during the testing period. Given that this was a day off from university classes, we thought this one day, common to all participants regardless which day they started the study, would be fairly representative of their typical face-to-face social life.

Procedure

To avoid cortisol fluctuations due to time of day, all sessions were run in the afternoon between 2:00 and 5:00 p.m. when cortisol levels are less variable (Blascovich et al., 2011). Participants were instructed not to eat, have caffeine, or exercise for at least half an hour before the sessions. The first session occurred on a Thursday or Friday, with the second session occurring five days later.

Participants first completed the questionnaire items regarding demographic information and measures of stress and well-being (the SWLS, PANAS, PSS, and SELSA-S). These were completed prior to their knowledge of their Facebook condition assignment. After completing these measures, participants then provided the first saliva sample, which served as the baseline cortisol measure. Participants gently chewed a cotton salivette for 2 minutes and then placed the salivette into a vial.

When the participant returned to the computer to complete the survey, the program randomly assigned them to their Facebook condition for the remainder of the study. They were either instructed to not use Facebook until the next session or to use Facebook as normal. Participants were also instructed not to tell the researcher which condition they had been assigned to. The last part of the first survey included all the Facebook use items. Finally, participants were given five minutes to write a brief description of how they believed the next five days would be. These descriptions were later analyzed using the Linguistic Inquiry and Word Count 2007 (LIWC) software package (Pennebaker, Chung, Ireland, Gonzales, & Booth, 2007) to count words based on their emotional content (Tausczik & Pennebaker, 2012). Upon completion of the questionnaire participants again provided a saliva sample, which was approximately 20 minutes after the first sample was provided.

At Session 2, participants completed a second survey. It included the same Facebook activity items that had been used in session one, but referred specifically to the time period since session one. Participants then completed the SWLS, PANAS, PSS, and SELSA-S with respect to the last three days. After completing the survey, participants provided the final saliva sample.

Saliva samples were stored in a − 20°C freezer until study completion. A professional reference laboratory at the Technical University of Dresden, Germany then assayed them for cortisol. Sampling tubes were centrifuged for 5 min, and hormone concentrations were measured by commercially available chemiluminescence-immuno-assays with high sensitivity (IBL International, Hamburg, Germany). Intra- and interassay coefficients of variations were below 10%.

Results

Note that in all analyses reported below, alpha was set at .05. Effect sizes are reported using Cohen's *d*. In addition, gender was initially examined as an additional factor in each analysis, but no differences were found in those analyses, so the final analyses reported below did not include gender as a factor.

Attrition and compliance

Fifteen participants did not complete the study. More participants in the Facebook Normal condition ($n = 12$) than participants in the No Facebook condition ($n = 3$) failed to reappear at Session 2, but this difference was not significant, χ^2 (1, $n = 138$) = 3.78, $p = .052$. Participants did not differ between the two conditions in their number of Facebook friends or reported typical use of Facebook at Session 1. For the overall sample, the mean number of Facebook friends was 506.11 (range: 3–4031; median = 420). Given the positive skew of this variable, it was log transformed for the analyses below. The mean frequency of logging in to Facebook was 7.62 (where 8 = "multiple times per day"; range; 2–8), and the mean number of hours of daily Facebook use was 2.85 (range: 0.1–13). At Session 2, however, consistent with their assignment to conditions, participants in the No

Facebook group (M = 0.38, SD = 0.92) reported a lower number of daily hours of Facebook use during the manipulation period than did those in the Normal Facebook group (M = 2.38, SD = 2.38), $t(122)$ = 6.18, p < .001, d = 1.12.

Subjective well-being and perceived stress

Due to a programming error, the PSS was not presented to 55 participants at Session 1, but was presented to all participants at Session 2. Scores on the SWLS, PSS, PANAS, and SELSA-S did not differ between the two experimental groups at Session 1. Scale reliabilities and zero-order correlations between each of the key self-report measures are presented in Table 1. Having more Facebook friends was associated with more daily hours on Facebook, greater active Facebook use, greater PANAS positive affect, and less SELSA-S family loneliness. More Facebook Logins was associated with more active and passive Facebook use, but also greater perceived stress. Greater active Facebook use (e.g., posting status updates) was associated with higher SWLS, lower SELSA-S social loneliness, and lower SELSA-S family loneliness. Greater passive Facebook use (i.r., was associated with greater perceived stress. SELSA-S romantic loneliness was not associated with any Facebook usage measures.

At Session 1 we also examined how participants felt about the condition to which they were assigned. LIWC analyses of the essay written just after assignment to condition focused on the number of positive and negative affect words used by the participants. Although the manipulation had no effect on the number of positive words, the conditions differed in the number of negative words used, $t(124)$ = −3.22, p = .002, d = 0.58, with those in the No Facebook group using more negative words (M = 1.91, SD = 1.90) than those in the Facebook Normal group (M = 0.95, SD = 1.44). Subsequent exploratory analyses found that the number of negative words was unrelated to other measures in the experiment (e.g., cortisol levels, SWLS).

As depicted in Figure 1, experimental condition affected life satisfaction (SWLS) over time, such that the Facebook Normal group had a greater (positive) change (i.e., the 95% CI did not contain 0) from Session 1 to Session 2 (M = 1.85, SD = 4.97) than did the No Facebook group (M = −0.93, SD = 5.61), $t(125)$ = 3.01, p = .003, d = 0.54. Both groups reported a decline in perceived stress from Session 1 to Session 2 (M = −0.88, SD = 3.84), but this difference was not affected by condition. Additional analyses found none of the Facebook usage variables moderated the effects of experimental condition on the PANAS and SELSA measures.

Table 1. Bivariate correlations among Session 1 self-report measures of Facebook use, well-being, and stress.

	2	3	4	5	6	7	8	9	10	11	12
1. FB Friends	.14	.25**	.34**	.02	.11	.00	.18*	−.03	−.15	−.26**	.11
2. FB Logins		.26**	.48**	.52**	.05	.31**	−.05	.13	−.10	−.10	.04
3. Daily Hrs on FB			.43**	.11	−.07	.05	.13	.17	−.09	.00	.05
4. Active FB Use			**.83**	.33**	.21*	.13	.16	.00	−.32**	−.24**	.05
5. Passive FB Use					.06	.31**	.04	−.12	−.11	−.01	.11
6. SWLS					**.86**	−.07	.39**	−.33**	−.45**	−.42**	−.24**
7. PSS						**.82**	.11	.34**	.11	.12	.06
8. PANAS-Positive							**.90**	−.08	−.29**	−.26**	−.03
9. PANAS-Neg								**.89**	.25**	.32**	−.08
10. SELSA-Social									**.86**	.50**	.04
11. SELSA- Fam										**.86**	−.05
12. SELSA-Rom											**.86**

Note. N = 138, except for correlations involving PSS, where n = 72. Values in bold on the diagonal are Cronbach alpha values for scales with two or more items.
*p < .05. **p < .01.
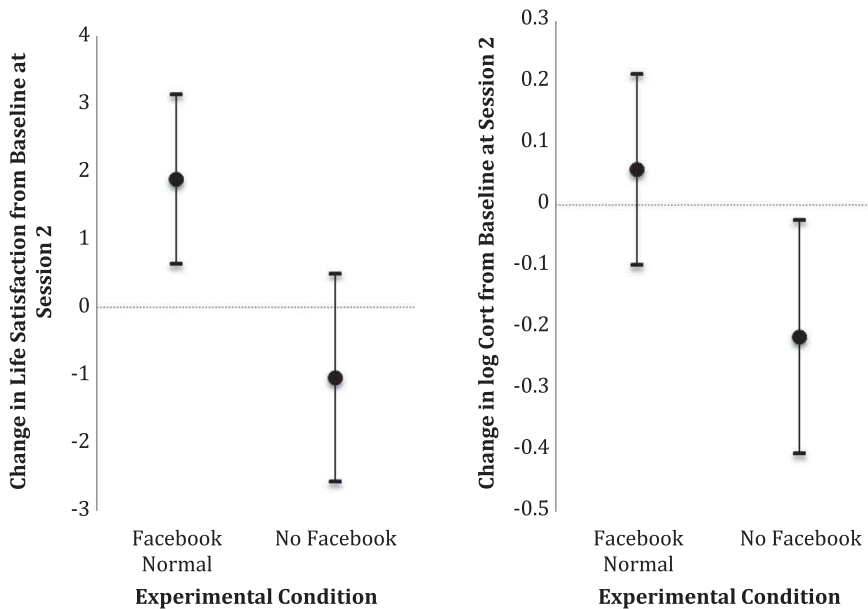
Figure 1. Mean life satisfaction (SWLS) and cortisol changes at Session 2 as a function of experimental condition. Error bars represent 95% confidence intervals.

Cortisol

Low and high values for cortisol were 1.38 and 31.17 ng/ml, respectively. Thus, the values were within the normal range for our participant sample (IBL International, Hamburg, Germany). Cortisol was not adequately sampled (i.e., not enough saliva was collected) for seven participants, leaving 133 and 120 having complete cortisol samples in Sessions 1 and 2, respectively. For the analyses reported below, cortisol concentrations were natural log-transformed to normalize the distributions. Cortisol levels did not differ between the two experimental groups at baseline. Cortisol at baseline was also not associated with any of the social network, Facebook use, or well-being measures.

Change scores from baseline were computed for the cortisol samples collected at the end of Session 1 and at Session 2. No differences were observed between the groups at Session 1 after assignment of condition. However, as can be seen in Figure 1, at Session 2 the two Facebook conditions differed, $t(118) = 2.24$, $p = .027$, $d = 0.41$, with the No Facebook group (M = −0.22, SD = 0.70) showing a decline in cortisol from baseline (i.e., the 95% CI did not contain 0), whereas the Facebook group remained relatively unchanged ($M = 0.06$, $SD = 0.63$). Across conditions, a decline in cortisol was associated with less perceived stress, $r = .18$, $p = .05$, and lower SELSA-S social loneliness, $r = .20$, $p = .036$. When examined separately by experimental condition, however, these relationships were not significant for either group alone, including the relationship between life satisfaction and cortisol level. That is, cortisol was not correlated with perceived stress in the Facebook condition, $r = .023$, $p = .857$, or in the No Facebook condition, $r = .243$, $p = .072$. Similarly, life satisfaction was not correlated with cortisol level in the Facebook condition, $r = -.133$, $p = .292$, or in the no Facebook condition, $r = .228$, $p = .088$. None of the Facebook usage variables moderated the effects of experimental condition on cortisol changes.

Number of facebook friends

We examined whether the number of Facebook friends moderated any of the main results reported above. First, we split the participants into two groups based on Dunbar's number of 150—those who

reported having fewer than or exactly 150 Facebook friends (n = 21) and those with more than 150 friends (n = 99). Analyses revealed that those with the smaller number of friends showed a greater decrease in cortisol at Session 2, (M = −0.39, SD = 0.63) than those with over 150 friends (M = 0.01, SD = 0.67), $F(1, 116)$ = 5.41, p = .022, d = 0.43, but this did not interact with experimental condition, nor was this grouping related to any of the other outcome variables. We also explored whether using a grouping based on a median split or a continuous measure of the log transformed number of friends interacted with experimental condition to predict any of the main outcome variables, but none of these analyses revealed any such effects.

Face-to-face contact

Participants in the No Facebook condition reported spending more hours in face-to-face contact on Sunday (M = 6.81, SD = 4.67) than did participants in the Facebook Normal condition (M = 4.76, SD = 3.38), $t(122)$ = −2.83, p = .005, d = 0.51. More face-to-face contact on Sunday was also associated with less SELSA-S romantic loneliness, r = -.26, p = .004, and increased PANAS positive affect, r = .24, p = .008, at the second session.

Additional post hoc analyses

Verduyn et al.'s (2017) review of the SNS literature suggested another important moderator that we did not consider in our original hypotheses—active Facebook usage. At the suggestion of an anonymous reviewer, we examined whether our measures of active and passive Facebook use moderated the effects of the Facebook manipulation on either changes in cortisol or life satisfaction. These analyses failed to demonstrate any interactions on life satisfaction, but on cortisol change, the manipulation yielded a greater difference in condition means for those low in passive use ($M_{facebook}$ = 0.06, $SD_{facebook}$ = 0.69 vs. $M_{no\ facebook}$ = −0.50, $SD_{no\ facebook}$ = 0.63) than the difference in condition means for those high in passive Facebook use ($M_{facebook}$ = 0.05, $SD_{facebook}$ = 0.63 vs. $M_{no\ facebook}$ = .06, $SD_{no\ facebook}$ = 0.67), $F(1, 116)$ = 5.61, p = .020, d = 0.44. The analysis on active Facebook use as a moderator did not yield a significant interaction effect on cortisol, $F(1, 116)$ = 3.30, p = .072, d = 0.34.

Discussion

This study investigated the effect of short-term abstention from Facebook on stress and well-being. Using an experimental design, we found that taking a break from Facebook led to lower cortisol levels after just five days. However, this hormonal change was also accompanied by differences in subjective well-being. Participants who gave up Facebook reported lower scores on the SWLS than those who maintained normal Facebook usage. Thus, participants appeared to show an improvement in physiological stress by giving up Facebook, but they also reported lower subjective well-being compared to the control group. As we theorized in the introduction, however, these effects are consistent with the general ambivalent feelings that may typify most active users about Facebook. It has become an essential social tool for millions of users, and it obviously provides many benefits. Yet, perhaps because it conveys so much social information about a large network of people, it can also be taxing (Maier et al., 2014), which is why the occasional Facebook break may happen naturally.

At first glance, our findings appear to contradict those of Kross et al. (2013), who reported that, the more that young adults used Facebook over a two-week period, the more their subjective well-being, as measured by the SWLS, declined. In contrast, the participants using Facebook as normal in our study reported an increase of their well-being on this measure. Moreover, we found that SWLS at the first session was positively correlated with typical active Facebook usage. More recently, after we had completed the data collection and analyses for this study, Tromholt (2016) reported that

participants who were assigned to a no-Facebook condition for 7 days showed increases in well-being, albeit on a single item of life satisfaction. This effect was more profound for people who were the heaviest consumers of Facebook.

Why is there an apparent discrepancy between our results and those of Kross et al. (2013) and Tromholt (2016)? First, it is important to note that our study was conducted over just 5 days, so it is possible that people in the Facebook Normal group would have eventually shown a decline in well-being after 2 weeks of regular use. Moreover, our study was conducted over a weekend, and it is reasonable to assume that most participants' well-being would normally increase during a short break from normal university life. What is more striking, however, is that participants in No Facebook condition had lower levels of life satisfaction than the control group. In everyday life, people may regularly take breaks from Facebook when it becomes taxing, but participants in our study were randomly assigned to give up Facebook, so many of them may have not been "ready" to take such a break. Although their physiological stress dropped, their perceptions of their well-being may have centered on being "cut off" from their Facebook friends—likely the prime reason why they joined Facebook in the first place. This threat to their need to stay connected was evident as soon as they were assigned to the experimental condition, such that participants in the No Facebook condition used more negative words as they imagined their break from Facebook. For example, one participant speculated that, "I will probably feel…upset as my social life will be totally stopped if I cannot use Facebook and cannot find my friends in Facebook, I will also feel like left behind as I will not be able to know what has happened with my Facebook friends in the coming five days."

Although we observed changes in cortisol levels, self-reports of stress were not affected by the experimental manipulation. Across conditions, participants who showed a decline in cortisol did report lower stress at the second session, but this was not significant when the relationship was examined by condition. We suspect that the subjective measure of stress used here (the PSS) either may be insensitive to the small changes in stress perceived by participants, or that their perceptions about being cut off from Facebook (e.g., "I'm disconnected!") in the No Facebook condition influenced their responses on this measure. Indeed, with a slight increase in power, we may have very well found a significant relationship between stress and cortisol for the No Facebook group. Discrepancies between salivary cortisol responses and subjective measures of stress are common in studies of stress (e.g., Brant, Wetherell, Lightman, Crown, & Vedhara, 2010; Chida & Steptoe, 2009; Simpson et al., 2008), and thus may reflect methodological issues that go beyond this study.

As noted, Verduyn et al.'s (2017) review of the SNS literature suggested that the amount of active Facebook could be a potential moderator of the effects we observed here. That is, if one's Facebook use is more passive, well-being tends to be lower, probably due to increased social comparisons (Appel, Crusius, & Gerlach, 2015; Haferkamp & Krämer, 2011; Verduyn et al., 2015; Vogel, Rosen, Okdie, Eckles, & Franz, 2015). One could therefore hypothesize that those participants engaged in more passive Facebook use would should greater life satisfaction when giving up Facebook, as well as lower cortisol. We therefore conducted a post hoc analyses to test this hypothesis for both cortisol and life satisfaction. We did not find support for this line of reasoning. Although these analyses failed to yield any interaction effects for life satisfaction, participants who engaged in less passive Facebook use showed a greater effect of the experimental manipulation, such they were more likely to show a reduction in cortisol when assigned to the No Facebook condition. Interestingly, active Facebook use was not a significant moderator, but the effect size for the interaction on cortisol was $d = 0.34$, which suggests that a higher-powered replication of our study would find stronger support for that variable as well. In addition, our study was not designed to test these particular hypotheses, so future research might be able to test them with more precise measures. It is also important to note that the zero-order correlations at the first session indicated that perceived stress was positively related to passive Facebook use, whereas life satisfaction was positively related to active Facebook use, which is contrary to the conclusions of Verduyn et al. (2017).

We also investigated whether the number of Facebook friends moderated any of the observed changes in stress and well-being. Overall, we found no evidence that the number of Facebook friends moderated the effects of our experimental manipulation. In fact, we did find that when participants

were divided on the basis of Dunbar's number, that those with 150 or fewer friends showed a decline in cortisol, independent of the experimental condition. It is important to note, however, that the small number of participants who actually had fewer than 150 friends prevented us from having sufficient power to fully test its effects. Nevertheless, we did not find evidence that the number of Facebook friends is related to any of the positive or negative effects of Facebook use. The quality of Facebook social networks may be relatively weak (Dunbar, 2012)—the consequence of a tradeoff of increased social information and the limitations of human social cognition. We also did not assess perceptions of requests for social support, as did Maier et al. (2014) in their study, which found that increasing numbers of friends led to more Facebook exhaustion.

A limitation of our study is that participant recruitment depended on a willingness to give up Facebook for five days. That is, participants who opted not to participate in the study may not have shown the same effects of the manipulation because they did not want to face a possible interruption of their use of Facebook. By contrast, participants in our study might have been looking for a good reason to have a Facebook vacation because they felt overburdened by it already, and thus were more likely to show a decline in cortisol in the No Facebook condition. We cannot rule out this explanation entirely, but it is worthwhile to consider again how negatively participants perceived being assigned to this condition. Only a handful of participants in that condition, for instance, reported that they believed the next five days would be a pleasant experience. In fact, in a post-experimental debriefing, many participants (unprompted) expressed happiness that they could get back onto Facebook again because they felt so cut off. If we had studied naturally occurring Facebook vacations instead, we may have found less distress after such a short break. Importantly, the increased face-to-face contact with others that the No Facebook participants experienced on Sunday, which was nearly two hours longer than those in the Normal Facebook condition, apparently was not sufficient in making up for the lost time on Facebook.

This is the first study to demonstrate the effects of Facebook use on a physiological measure associated with health outcomes. Tromholt (2016) also concluded that breaks from Facebook could be particularly beneficial for people who heavily use the platform or experience too much social comparison and envy that harm their well-being. Another key difference in our research is that, once they had learned which experimental condition they had been assigned to, we asked participants to imagine what the next few days would be like. It is possible that this writing task caused our participants to have more negative expectations, which, in turn, led them to have those negative experiences—although this would not explain the lower cortisol at the second session for those in the No Facebook condition. Our findings also suggest several interesting questions that require further investigation, such as what happens when people are disconnected from Facebook for much longer periods (e.g., months), what are the mechanisms that underlie the changes in cortisol when people do give up Facebook, and do people actually show a cyclical pattern of Facebook activity in which stress builds to a point where they disconnect for a while and then they resume their use of Facebook when their needs for affiliation are too great?

Our cortisol findings in particular suggest that Facebook use can have measurable effects on HPA functioning and the body's responses to stress. Taking short breaks from Facebook could be beneficial to one's health, as any prolonged stress could contribute to mental and physical disorders (McEwen, Nasca, & Gray, 2016). Precisely how long the breaks should be, how often they should occur, and when they might become too long, are questions that could not be addressed by our research. However, given that it is already known that "too much" Facebook can reduce one's feelings of well-being (Kross et al., 2013; Tromholt, 2016) and increase negative mood via social comparison (Sagioglou & Greitemeyer, 2014), the added knowledge that taking a break can reduce one's physiological stress might cause the typical Facebook user to consider whether he or she might indeed benefit from a Facebook vacation, even though it risks feelings of being socially disconnected. As Facebook has quickly become a permanent fixture in everyday social life, addressing questions about people's use of such online platforms should help us more fully understand how our evolutionary "old" brains are coping with such rapidly developing social networks.

Notes

1. After this study was completed, and while we were preparing the manuscript, Tromholt (2016) published a similar experimental study, in which participants were randomly assigned to a control or no Facebook group for one week. We address this study in the Discussion.
2. The unequal numbers of the two conditions was simply due to true random assignment.

Funding

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Data availability statement

The data described in this article are openly available in the Open Science Framework at https://osf.io/grh8s/

Open Scholarship

This article has earned the Center for Open science badges for Open Data and Open Materials through Open Practices Disclosure. The data and materials are openly accessible at https://osf.io/grh8s/

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