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Social media as a shield: Facebook buffers acute stress

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ABSTRACT

Facebook remains the most widely used social media platform. Research suggests that Facebook may both enhance and undermine psychosocial constructs related to well-being, and that it may impair physiological stress recovery. However, little is known about its influence on stress reactivity. Using novel experimental methods, this study examined how Facebook influences reactivity to an acute social stressor. Facebook users (n = 104, 53 males, mean age 19.50, SD = 1.73) were randomly assigned to use their own Facebook account or sit quietly with the option of reading electronic magazines before experiencing an acute social stressor. All participants showed significant changes in subjective and physiological stress markers in response to the stressor. However, participants who used Facebook experienced lower levels of psychosocial stress, physiological stress, and rated the stressor as less threatening (p's < 0.05) when controlling for gender and emotional investment in the website compared to controls. Results suggest that Facebook use may *buffer* stress—in particular psychosocial stress—if used before experiencing an acute social stressor. This study is among the first to incorporate both objective and subjective measures in investigating the complex relationship between Facebook use and well-being.

1. Introduction

As social media continues evolving, understanding its influence on well-being is becoming more important. Facebook remains the most popular social media platform, with over 1 billion worldwide users [16] and 71% of online U.S. adults naming it as their preferred platform [12]. Conflicting research suggests that Facebook may both enhance *and* undermine subjective psychosocial well-being (e.g., [6–8,27,30]). Limited research has taken an objective look at Facebook use and well-being [28,29,32]; and these studies suggest that Facebook can influence physiological outcomes, notably in the context of stress.

In an exploratory study, Rus and Tiemensma [32] found that Facebook use delayed physiological stress recovery after experiencing an acute social stressor. The authors proposed the social self-preservation theory [10] as an explanation for the sustained levels of elevated salivary cortisol output seen during Facebook use. The theory posits that the social self-preservation system activates cortisol release and an increase in negative self-related cognitions and emotions (e.g., embarrassment, shame) when a threat to the social self or social esteem is present. Participants in Rus and Tiemensma [32] who used Facebook while recovering from an acute stressor (i.e., a threat to the social self) showed higher levels of cortisol compared to a control condition. Considering that Facebook use has been associated with constructs such as greater distress [6], induction of negative social comparison [7], and lower self-esteem in addicted and problematic users [5], Rus and Tiemensma [32] proposed that Facebook itself may be a threat to the social self. That is, Facebook *and* the laboratory stressor were perceived as threats, causing participants who experienced both to show a prolonged stress response.

As markers of the body's physiological stress response, both salivary cortisol output and salivary alpha-amylase (sAA) output can aid our understanding of Facebook's impact on stress. The hypothalamic-pituitary-adrenocortical (HPA) axis and the sympathetic-adrenomedullary (SAM) system work together to manage stressful events, and biomarkers of each component of the body's stress system, in particular cortisol (HPA), sAA, blood pressure, and heart rate (SAM), can be easily and non-invasively measured [17,18,21,31,38]. Research has shown that the Trier Social Stress Test (TSST; [39]) can reliably activate both of these components of the body's stress system [4,31]. Given the evidence of Facebook's effect on acute stress *recovery*, this study aimed to assess how Facebook influences the acute stress response.

To assess the effect of Facebook on the stress response, participants in the current study came into the lab believing they would be taking a survey on their Facebook use habits and providing physiological samples (i.e., saliva, blood pressure, heart rate) to assess well-being. Participants were randomly assigned to either use their own Facebook account (experimental condition) or use optional online reading materials (control condition) for 20 min before undergoing the TSST.

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Using the social self-preservation theory as framework, along with the results of Rus and Tiemensma [32], we hypothesized that Facebook would be a stressor itself (i.e., a threat to social self-preservation), and compared to the control condition, use would intensify response to an acute social stressor in terms of both physiological and psychosocial markers (i.e., elevated and sustained salivary cortisol output, sAA output, blood pressure, and heart rate, as well as subjective stress measures).

2. Materials and method

2.1. Participants

Facebook users (n = 111 undergraduates) were recruited from a campus-wide participant pool system. Seven participants quit the study before or during the acute stress induction (see Procedure). Participants who reported current use of prescription medication containing cortisol, cortisone, or hydrocortisone (n = 2) or current use of anti-anxiety or anti-depressant medication (n = 2) were excluded from cortisol and sAA analyses. Participants identified as outliers (raw score > 3 SDs above the mean) at each time point for cortisol or sAA were excluded from analyses for that given time point (i.e., their data was removed only for that measure). For cortisol, two participants were dropped from baseline, two from onset, three at the + 20 marker, five at + 45, and 7 at + 60. For sAA, two participants were dropped at baseline, two at − 13, one at onset, two at + 8, and one at + 20 (see Fig. 1 for study timeline).

Average weekly alcohol consumption within normal range was permitted; however, the majority of participants (75%) reported zero consumption. Twelve participants reported current use of recreational drugs while one reported current use of tobacco products. Twenty-five percent of female participants (n = 13; 3 control, 10 Facebook use) reported current use of hormonal contraceptives. No participants reported current diagnosis of post-traumatic stress disorder or current use of anabolic steroids. None of the above participants showed extreme scores on any outcome measure, nor did their stress response patterns widely diverge from the rest of the sample. Thus, all were retained in analyses.

The final sample of participants (n = 104; 51 females, mean age = 19.50 years, SD = 1.72, BMI = 23.10, SD = 4.95; and n = 53 males; mean age = 19.45, SD = 1.48, BMI = 25.26, SD = 7.04) identified as being Hispanic/Latino (46%), Asian/Pacific Islander (24%), Caucasian (15%), biracial (7%), African American/Black (4%), or Native American/American Indian (1%). The majority of the sample (66%) identified as first-generation college students.

All participants had an active Facebook account, provided informed consent, and were given course credit in exchange for participation. The University Institutional Review Board approved this study and all data collection complied with current APA ethical standards.

2.2. Procedure

Participants were assigned to either the Facebook use (n = 72) or control condition (n = 32) using gender-stratified random assignment. Conditions were intentionally skewed to allow for sub-analyses within the Facebook use group if necessary. We planned to assess how passive (i.e., consuming content) versus active (i.e., producing content) activities during Facebook use may have differently affected stress reactivity. However, all participants in the Facebook use group engaged in more passive than active activities during use (see results), so comparisons were not possible.

The study consisted of each participant completing all procedures in a single, 120-minute laboratory session. All session occurred within the same laboratory room where only the individual participant and the experiment leader were present (with the exception of the portion involving the TSST committee, see below). The experiment leader (a male or female student not involved in the TSST) introduced the study and explained that it aimed to examine how social media use influenced well-being. Participants were told they would be providing measures of heart rate and blood pressure along with saliva samples, as well as answering questions about their Facebook use habits. When enrolling in the study, participants were told they would need to know their Facebook login information in order to participate. Participants randomly assigned to the Facebook use condition did not know they would be using Facebook during the study until the experiment leader asked them to log into their own account (approximately 20 min into the study). Control participants did not use their login information during the study. All participants were unaware that the study included an acute stressor until the TSST was presented. During debriefing, participants were told the true goal of the study was to assess the effect of Facebook use on stress, which required them to temporarily feel stressed. We explained that the TSST is a laboratory protocol commonly used to induce temporary stress. We also asked if they had heard of it or experienced it before. All but one had never heard of it; none had ever experienced it.

Once the study was explained and informed consent collected, all participants completed baseline physiological and psychosocial stress measures as well as measures of Facebook use habits and items assessing threat to social self (see below for description of all measures). Following, participants randomly assigned to the Facebook use condition (n = 72) logged into their own Facebook account on the same laboratory laptop used to complete baseline and follow-up measures.

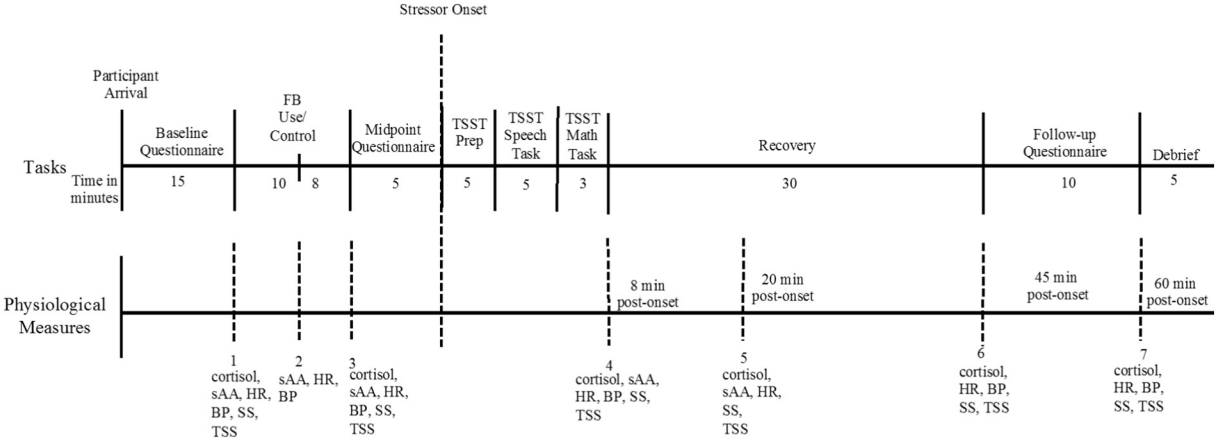

Fig. 1. Timeline for procedural tasks, psychosocial, physiological, and threat to social-self measurements. TSST = Trier Social Stress Test. sAA = salivary alpha-amylase. HR = heart rate. BP = blood pressure. SS = subjective stress. TSS = threat to social self.

They were given 20 min to use Facebook as they wished with the exception of disclosing information about currently participating in the study. Control participants (n = 32) were provided optional reading materials via a digital magazine app on the same laboratory laptop. Available reading options were selected to be engaging but thematically neutral (e.g., gardening, popular science, travel, etc.). The experiment leader remained in the room with each participant to collect physiological samples and subjective stress measures; however, participants were asked not to speak to the experiment leader during this time. Following 20 min of Facebook use/control, participants completed a midpoint questionnaire assessing their activity during that time. Next, the experiment leader left the room and the committee (see below) entered to conduct the TSST. The experiment leader returned, excused the committee, and instructed participants on how to proceed. During 30 min of recovery, all participants had access to the digital reading materials provided during the control condition. Again, the experiment leader remained in the room with participants to collect measures; however, participants were instructed not to interact with them.

Salivary cortisol output, sAA output, heart rate, blood pressure, subjective stress, and threat to social self were assessed at baseline, approximately 5 min before stressor onset, eight minute post-stressor onset, and 20 minute post-stressor onset. Additional sAA, heart rate, and blood pressure measures were collected 10 min into Facebook use/control (approximately 13 min before stressor onset). Additional cortisol, heart rate, blood pressure, subjective stress, and threat to social-self measures were collected at 45 and 60 minute post-stressor onset (see Fig. 1 for study timeline). Following completion of the follow-up questionnaire and final saliva collection, all participants were debriefed about the study's true purpose.

2.2.1. Stress induction and physiological measures

The TSST is known to reliably induce acute stress in the majority of participants in numerous studies [4]. Specifically, it reliably induces an increase in cortisol and in negative self-related cognitions and emotions as well as induces threat to social esteem [10,11]. In the current study, after 20 min of Facebook use/control, participants were instructed to spend 5 min preparing a speech that could be used in an interview for their ideal job. Then, they spent 5 min performing their speech in front of a disapproving committee of three presumed experts in a small laboratory room. Next, participants counted backwards from 1687 by intervals of 13 for 3 min. Each time a mistake was made, participants were told to start again. Participants were also video and audio recorded during the speech and math tasks. In addition, committee members wore white lab coats and held clipboards to enhance the illusion of being experts. The committee always consisted of mixed-gender, student members (i.e., two females and one male, or two males and one female). The committee was only present in the laboratory room for the duration of the stress task.

2.2.1.1. Saliva samples. All data were collected between 12:45 PM and 5:15 PM (i.e., each participant arrived for their 120-minute session at either 12:45 PM or 3:15 PM) in order to control for cortisol fluctuations during the day [25,33]. To avoid temporary elevation of cortisol levels and ensure quality of saliva samples [33], participants were instructed to refrain from eating, smoking, consuming caffeine, drinking beverages other than water, brushing their teeth, or vigorously exercising in the 30 minute before arriving for the study.[1] All samples were collected using salivette collection tubes (Sarstedt Co., Nümbretch, Germany). Participants placed a cotton roll under their tongue for 2 min of collection. To account for changes in cortisol and sAA concentration in response to acute stress [15,31], saliva was collected at baseline, -13 minute stressor onset, -5 minute stressor onset, and eight, 20, 45, and 60 minutes post-stressor onset. All saliva samples were immediately placed in a -20°C freezer and immunoassayed at a later date. For cortisol, thawed samples were centrifuged and assayed in duplicate with a test volume of 25 μL. A commercially available enzyme immunoassay kit was used without modifications to the manufacturer's recommended protocol (Salimetrics; State College, PA). Sensitivity ranged from 0.007 to 3.0 μg/dL. Intra-assay and inter-assay coefficients of variation were < 15%. Salivary alpha-amylase was determined by kinetic assay (Salimetrics; State College, PA). Samples were run in duplicate, and diluted 1:200. Intra-assay and inter-assay coefficients of variation were < 15%.

2.2.1.2. Blood pressure and heart rate. Blood pressure and heart rate were simultaneously measured with an Omron 10 Series digital blood pressure monitor cuff placed around the non-dominant upper arm at baseline, -13 minute stressor onset, -5 minute stressor onset, and 8, 20, 45, and 60 minute post-stressor onset.

2.2.2. Psychosocial measures

2.2.2.1. Facebook use. The Facebook Intensity Scale (FBI) measures integration of site use into the lives of users and emotional connectedness to the site [14]. All participants completed the FBI at baseline. The nine-item scale asks participants to rate statements such as, “I feel that I am part of the Facebook community,” on a five-point scale from 1 (strongly disagree) to 5 (strongly agree). The scale also measures number of Facebook friends as well as average daily time spent actively using Facebook over the past week. Intensity score is computed by averaging all items in the scale, with higher scores indicating higher intensity. Scale validity has not been established; however, the current sample showed moderate reliability (Cronbach's α = 0.68).

The Facebook Activity Survey [23] measures frequency of engaging in specific Facebook activities. Examples include frequency of posting status updates, tagging photos, and sending private messages on a scale of 1 (never) to 5 (very frequently, 100% of the time). All participants reported their normal Facebook use habits at baseline. During the midpoint questionnaire (see Fig. 1), participants in the experimental condition completed an adapted version of the survey regarding their specific use of the site during their 20 min of use. In both cases, frequency of each activity was averaged across participants with higher scores indicating more frequent activity.

During the midpoint questionnaire, participants were also asked which method they most commonly used to access Facebook (i.e., the mobile app, the website from a computer, or both). In addition, participants in the Facebook use condition were asked how using Facebook for 20 min in one sitting compared to their normal use (i.e., they normally use it less, the same, or more), if they did anything during these 20 min that they normally would not do, and if so, what they did.

All questionnaire items assessing Facebook use and stress were asked during the midpoint questionnaire (i.e., *after* participants had both used Facebook if they were in the experimental condition and undergone the acute stressor). This was done in effort not to bias participants towards the study's true purpose.

Participants identified when they were most likely to use Facebook (i.e. when they were lonely, bored, stressed, sad, or anxious) by rating their agreement on a 1 (strongly disagree) to 5 (strongly agree) scale for the item, “I find myself wanting to use Facebook most when feeling X” for each state. Participants also responded to the following statement: “Please rate how stressed using Facebook makes you feel in general,” on a five-point scale ranging from 1 (not at all) to 5 (extremely). In addition, participants rated the following statements on five-point scales ranging from 1 (strongly disagree) to 5 (strongly agree): (1) “In general, I like to use Facebook when I am stressed”, (2) “In general, using Facebook when I am stressed makes me feel *less* stressed”, and (3) “In

[1] Note that the first saliva sample was not collected until approximately 15 min after each participant arrived. Thus, participants had refrained from these activities for at minimum 45 min before saliva collection began.

general, using Facebook when I am stressed makes me feel *more* stressed." Participants in the Facebook use condition were asked to select which statement they agreed with most after using Facebook for 20 min: (1) "Using Facebook made me feel *less* stressed", (2) "Using Facebook made me feel *more* stressed", or (3) "Using Facebook did not change my stress level." Control participants were asked the same set of items regarding the past 20 min (e.g., "Sitting quietly/reading made me feel *less* stressed").

2.2.2.2. Manipulation check. We aimed to have the control condition consist of a neutral, yet stimulating activity that included use of an interactive, electronic device. As a manipulation check, during the midpoint questionnaire (see Fig. 1), control participants were asked what they did during the 20 min they were given to read. They reported how much time they spent viewing photos, viewing advertisements, and reading articles on 1 (none of the time) to 5 (all of the time) scales. They also reported if they read full articles, skipped around among articles, or both (1, "read full"; 2, "skipped"; 3 "both"). Finally, they reported how interesting they found the material they had viewed or read on a 1 (not at all) to 5 (extremely) scale.

2.2.2.3. Psychosocial stress. Subjective stress was assessed after each saliva sample collection (with the exception of the −13 measure) with present-moment ratings of tension, anxiety, insecurity, irritation, nervousness, timidity, fear, well-being, and mood. Each item (e.g., "How anxious are you feeling right now?") was rated from 'not at all' to 'extremely' along a 15-centimeter visual analogue scale. Participants marked their response, and scores were rounded up to the nearest millimeter then converted to a 15-point continuous scale with higher scores indicating greater feelings of each state (adapted from [35]). Mood was also assessed immediately following Facebook use/control with the item "Please indicate which statement you agree with most: (1) Using Facebook/sitting quietly increased my positive mood, (2) Using Facebook/sitting quietly increased my negative mood, or (3) Using Facebook/sitting quietly did not change my mood". Finally, well-being was assessed on a 1 (not at all) to 4 (a lot) scale with the following item: "How much did using Facebook/sitting quietly influence your sense of well-being either positively or negatively?".

2.2.2.4. Threat to social self preservation. State self-esteem was measured with the Social and Performance subscales of the State Self-Esteem Scale (SSES; [19]) at four time points (baseline, -5 minute stressor onset, 8 minute post-stress onset, and follow-up). Participants responded to 14 items for present-moment feelings such as, "I feel confident about my abilities" from 1 (not at all), to 5 (extremely). Lower scores indicate lower state self-esteem. The scale showed high internal consistency across the social (α = 0.85–0.93) and performance subscales (α = 0.82–0.92).

As additional measures to threat to social self preservation, feelings of shame, humiliation, self-consciousness, embarrassment, and self-esteem were assessed at each saliva collection time point (with the exception of -13 minute stressor onset) along the same visual analogue scale as the psychosocial stress items.

2.2.2.5. Task rating. Three items assessed the difficulty, threat, and challenge felt during the acute stress portion of the protocol. All items were rated from 'not at all' to 'extremely' on a visual analogue scale (e.g., "How threatened did you feel during the task you just completed?"). Measurements were taken immediately following completion of the TSST.

2.3. Statistical analyses

Analyses were conducted using SPSS Version 24.0 (SPSS Inc., Chicago, IL, USA). Repeated measures analysis of covariance (ANCOVA) with condition as between-subject and time point as within-subject factors was used to test the effect of Facebook use on acute stress reactivity and recovery. Gender and Facebook Intensity (i.e. emotional connectedness to the site) were included as covariates. Analyses included comparing group means at baseline and each post-stressor time point in separate models for each post-stressor time point (i.e., baseline to +8; baseline to +20, etc.). Simple effects analyses were used to compare group differences within time points when significant Time X Group interactions were found. Cortisol and sAA measures were log-transformed before analyses. Effect sizes are presented as partial η^2 or as Cohen's *d*. Each represent the proportion of explained variance between the predictors and the outcome, with values of 0.01, 0.06, and 0.14, and 0.20, 0.50, and 0.80 indicating small, medium, and large effect sizes, respectively (Cohen, 1988). Significance was set at $p \leq 0.05$. Although all post-stressor time points were tested, only significant results are reported.

3. Results

Sixty-five percent of participants in the Facebook use condition reported using the Facebook mobile app as their most common means of access, while 15.3% reported using the website from a computer, and 19.4% reported using both methods equally. Across conditions, the majority of participants identified wanting to use Facebook most when feeling bored, while a third reported wanting to use it most when stressed (see Table 1). Facebook use and control conditions reported no significant differences on how Facebook use influences stress in general; however, participants in both conditions more strongly agreed that using Facebook when stressed makes them feel *less* stressed compared to more stressed.

3.1. Manipulation check

Immediately following Facebook use or control ("Midpoint Questionnaire" in Fig. 1), control participants reported what they had done for the past 20 min. Seventy-three percent reported spending all or most of the time viewing photos; 75% reported spending most or some of the time reading articles; 56% indicated that they spent most of the time "skipping around" among articles rather than reading full articles; and 56% indicated that the material they viewed was "extremely" or "very" interesting. This suggests that control participants engaged in a similar level of activity compared to Facebook participants.

3.2. The effect of Facebook use on physiological stress

Participants in both conditions experienced physiological stress in response to the stressor, with increases in heart rate and blood pressure followed by decreases in each measure (see Fig. 2). Repeated measures ANCOVA showed a significant Time X Group interaction for systolic blood pressure, $F(1, 94) = 4.76$, $p = 0.032$, $\eta^2 = 0.048$, 95% CI [0.02, 0.09]. Simple effects analyses showed that participants who used Facebook showed less of an increase in systolic blood pressure from baseline to 8 minute post-stressor onset (see Table 2 for estimated marginal means and standard errors). While visually it appears that the Facebook use participants recovered faster than control participants in terms of heart rate, group differences were not significant (see Fig. 2). There were no significant condition differences for diastolic blood pressure.

The majority of participants showed increases in salivary cortisol and sAA concentration in response to the stressor (see Fig. 2); however, there were no significant condition effects for either marker.[2]

[2] Controlling for BMI and use of hormonal contraceptives did not change these results.

Table 1
Full sample and condition values for baseline and facebook use measures.

	Full sample	Control condition	FB condition
n	104	32	72
Females (*n*)	51	15	36
Age	19.50 (1.73)	19.41 (1.43)	19.54 (1.85)
FB activity			
FB friends	≤ 200	≤ 300	≤ 200
Years with FB account	≤ 6	≤ 6	≤ 6
Daily use (minutes)	≤ 30	≤ 30	≤ 30
FBI	3.53 (0.79)	3.76 (0.74)	3.43 (0.79)
Most common activities:	View videos, view photos, follow links	View videos, view photos, use FB Messenger	View videos, view photos, following links
I find myself wanting to use FB most when feeling			
Lonely	40.4%	34.4%	43%
Bored	95.2%	93.8%	95.8%
Stressed	28.8%	28.2%	29.2%
Sad	18.2%	15.7%	19.4%
Anxious	21.2%	18.8%	22.3%
In general, how stressed does using FB make you feel?	1.36 (0.54)	1.44 (0.50)	1.32 (0.55)
In general, I like to use FB when I'm stressed	2.96 (1.08)	3.13 (0.94)	2.89 (1.14)
In general, using FB when stressed makes me feel *less* stressed	3.21 (0.96)	3.22 (0.87)	3.21 (1.01)
In general, using FB when stressed makes me feel *more* stressed	2.29 (0.86)	2.25 (0.84)	2.31 (0.87)
Psychosocial stress			
Tension	2.97 (3.12)	**4.21 (3.24)**	**2.41 (2.92)**
Anxiety	3.53 (3.60)	4.46 (3.83)	3.11 (3.43)
Well-being	10.53 (2.56)	9.86 (2.37)	10.82 (2.61)
Mood	9.92 (2.39)	9.35 (2.33)	10.17 (2.39)
Insecurity	3.19 (3.44)	3.53 (2.99)	3.03 (3.63)
Irritation	1.58 (2.44)	2.11 (2.98)	1.34 (2.15)
Nervousness	2.83 (3.18)	3.52 (3.67)	2.52 (2.92)
Timidity	2.69 (3.03)	3.34 (3.39)	2.41 (2.84)
Fear	1.47 (2.22)	1.87 (2.32)	1.29 (2.17)
Physiological stress			
Systolic blood pressure	110.69 (13.62)	111.00 (11.85)	110.56 (14.42)
Diastolic blood pressure	72.61 (10.27)	72.59 (8.97)	72.62 (10.86)
Heart rate	73.20 (13.07)	73.25 (15.87)	73.18 (11.71)
Cortisol	0.17 (0.12)	0.20 (0.14)	0.16 (0.12)
sAA	55.61 (53.78)	61.59 (55.29)	52.93 (53.29)
Threat to social self			
State self-esteem	52.60 (9.59)	51.15 (9.31)	53.25 (9.71)
Shame	1.57 (2.46)	2.13 (2.90)	1.32 (2.21)
Humiliation	1.98 (7.86)	1.33 (1.92)	2.27 (9.38)
Self-consciousness	3.90 (4.22)	4.90 (4.28)	3.45 (4.13)
Embarrassment	2.80 (3.60)	3.44 (3.92)	2.52 (3.44)
Self-esteem	9.54 (2.80)	**8.29 (2.86)**	**10.10 (2.61)**

Note. Reported values reflect $n = 104$. FB = Facebook. FBI = Facebook Intensity Scale. Participants responded to number of FB Friends, Years with Facebook account, and Daily use as closed-ended questions. For these items, values represent the number, years, and time in minutes that correspond to the median responses from ordinal 1-to-5 scales. Most common activities were determined based on frequency of participants reporting that they did the activity at least once per week. Percentages for each state (lonely, bored, etc.) represent percentage of participants who agreed or strongly agreed with each statement. All other values represent baseline condition means and standard deviations. Cortisol and sAA values represent raw salivary cortisol concentration in μg/dL and sAA concentration in U/mL. Bolded values indicate a significant difference between conditions at $p \leq 0.05$.

3.3. Effect of Facebook use on psychosocial stress

When asked what they did during their 20 min of use, participants in the Facebook use condition reported spending most time scrolling newsfeed without clicking anything, viewing videos, and viewing photos. Half of the participants in the Facebook use condition reported normally spending < 20 min using Facebook in one sitting. However, 87.5% of participants reported that using Facebook for 20 min in one sitting did not cause them to engage in activities they normally would not. Those who reported doing something they normally would not ($n = 9$) described a range of activities including watching videos and passively scrolling newsfeed. When asked about the effect of Facebook use on mood, 59.7% reported no effect, while 34.7% reported a positive change and 5.6% reported a negative change. In addition, 40.3% reported no change in stress level as a result of Facebook use, while 48.6% reported feeling less stressed, and 11.1% reported feeling more stressed. Sixty-five percent of participants reported that using Facebook changed their sense of well-being during use. By comparison, control participants reported the following after reading/sitting quietly for 20 min: 50% reported no change in mood, 43.8% positive mood change, and 6.3% negative mood change; 34.4% reported no change in stress, 53.1% reported less stress, and 9.4% reported more stress; 65.6% reported a change in well-being.

Participants in both conditions experienced similar changes in psychosocial stress in response to the stressor, with increases in tension, anxiety, insecurity, irritation, nervousness, timidity, and fear, and decreases in mood and well-being (see Fig. 3). There were no significant differences at any time point for tension, anxiety, nervousness, timidity, or fear.). Repeated measures ANCOVAs showed significant Time X Group interactions for mood. At 20 minute post-stressor onset, $F(1, 99) = 5.72$, $p = 0.019$, $\eta^2 = 0.055$, 95% CI [0.028, 0.102], and at 45 minute post-stressor onset $F(1, 98) = 4.26$, $p = 0.042$, $\eta^2 = 0.042$, 95% CI [0.021, 0.078], simple effects analyses showed that Facebook use participants reported less decrease in positive mood from baseline to each post-stressor onset time point compared to control. A significant Time X Group interaction for well-being at 45 minute post-stressor onset $F(1, 100) = 4.17$, $p = 0.044$, $\eta^2 = 0.040$, 95% CI [0.020, 0.075] followed by a simple effects analyses showed that Facebook use participants reported less decrease in well-being from baseline to 45 minute post-stressor onset.

Significant Time X Group interactions for insecurity at 20 minute post-stressor onset, $F(1, 94) = 4.20$, $p = 0.043$, $\eta^2 = 0.043$, 95% CI [0.021, 0.081] and 45 minute post-stressor onset $F(1, 96) = 5.34$, $p = 0.023$, $\eta^2 = 0.053$, 95% CI [0.027, 0.098] followed by simple effects analyses showed that Facebook use participants reported decreases in insecurity while control participants reported increases. Significant Time X Group interactions for irritation at 20 min $F(1, 100) = 5.06$, $p = 0.027$, $\eta^2 = 0.048$, 95% CI [0.024, 0.090]; and at 60 minute post-stressor onset, $F(1, 100) = 4.65$, $p = 0.033$, $\eta^2 = 0.044$, 95% CI [0.022, 0.084] followed by simple effects analyses indicated that control participants reported greater increase in irritation compared to Facebook use participants.

3.4. Effect of Facebook use on threat to social self

Participants in both conditions experienced similar changes in state self-esteem, with increases from baseline to stressor onset, decrease in response to the stressor, and increase during recovery. A significant Time X Group interaction for state self-esteem (as measured by the SSES), $F(1, 100) = 4.55$, $p = 0.035$, $\eta^2 = 0.044$, 95% CI [0.022, 0.082] followed by simple effects analyses showed that Facebook participants reported greater increase in state self-esteem compared to control at eight minutes post-stressor onset. Significant Time X Group interactions for shame, $F(1, 99) = 4.17$, $p = 0.044$, $\eta^2 = 0.04$, 95% CI [0.020, 0.076], and humiliation $F(1, 100) = 4.45$, $p = 0.042$, $\eta^2 = 0.041$, 95% CI [0.021, 0.080] followed by simple effects analyses showed that

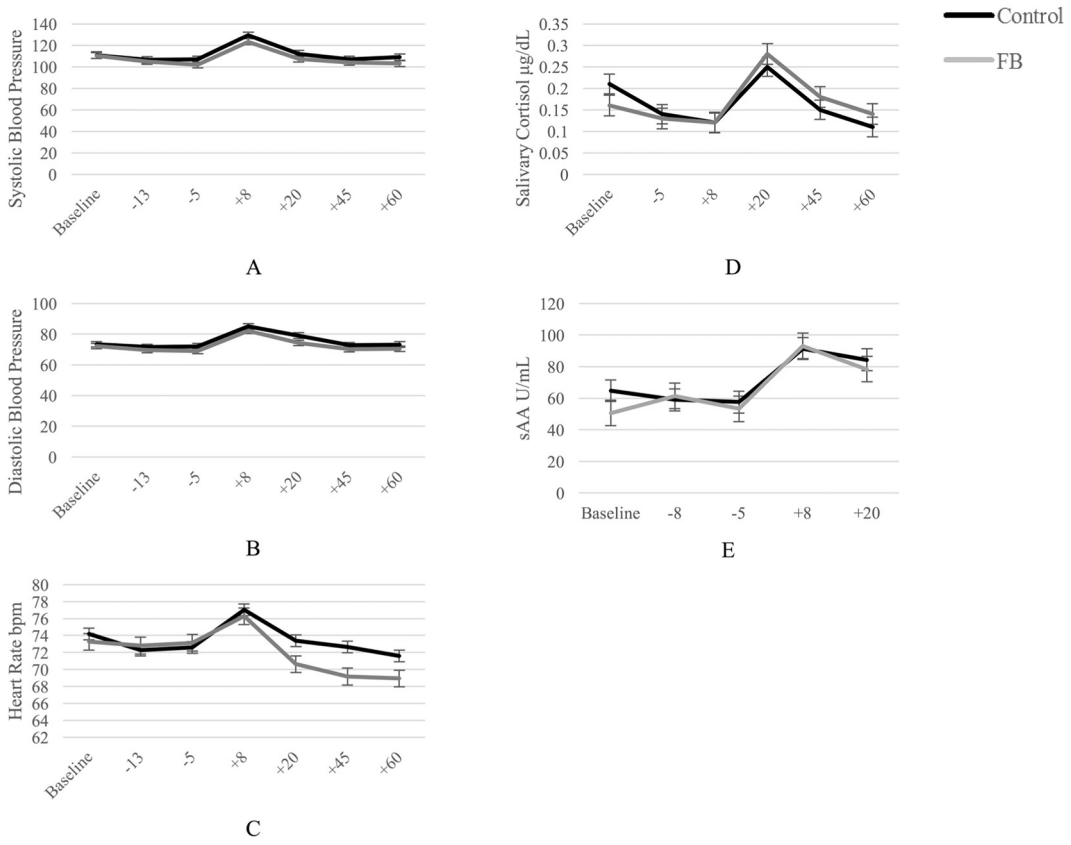

Fig. 2. Physiological stress markers for Facebook and Control conditions. X-axes represent minutes post-stressor onset. Bars represent standard errors. Cortisol and sAA values represent raw salivary cortisol concentration in µg/dL and sAA concentration in U/m; log-transformed values were used for analyses. Conditions showed significant differences for systolic blood pressure at $p \leq 0.05$.

Table 2
Estimated marginal means and standard errors for simple effects.

	Time point	*n*	Control		Facebook	
Physiological stress			EMM	SE	EMM	SE
SBP	Baseline	100	110.94	2.09	110.67	1.37
	+ 8		129.57	2.96	123.13	1.92
Psychosocial stress						
Mood	Baseline	101	9.48	0.43	10.12	0.28
	+ 20		6.28	0.58	8.54	0.38
	Baseline	100	9.49	0.43	10.13	0.28
	+ 45		7.4	0.54	9.36	0.36
Well-being	Baseline	102	10.05	0.45	10.75	0.29
	+ 45		7.68	0.62	9.85	0.41
Insecure	Baseline	96	3.4	0.61	3.19	0.40
	+ 20		5.11	0.67	3.16	0.44
	Baseline	98	3.26	0.58	3.21	0.39
	+ 45		3.53	0.49	1.91	0.34
Irritated	Baseline	102	1.94	0.43	1.42	0.28
	+ 60		3.58	0.54	1.77	0.36
Threat to social self						
Shame	Baseline	101	1.89	0.42	1.42	0.28
	+ 20		4.57	0.64	2.67	0.43
Humiliation	Baseline	102	0.79	1.38	2.51	0.91
	+ 20		5.24	0.74	3.11	0.49
SSES	Baseline	102	51.38	1.73	53.15	1.15
	+ 8		55.28	1.69	57.33	1.12

Note. EMM = estimated marginal mean. SE = standard error. SBP = systolic blood pressure. SSES = State Self-esteem Scale. Variables and time points represent those included in significant Time × Group interactions. Discrepancies in *n*'s are due to missing data.

control participants reported greater increases in both measures compared to Facebook at 20 minute post-stressor onset. See Fig. 4 for condition change over time.

3.5. Task rating

Compared to the Facebook use condition, participants in the control condition rated the TSST as more threatening, challenging, and difficult, with a significant difference for threat, $t(101) = 2.83$, 95% CI [0.78, 4.47], $p = 0.006$, $d = 0.58$.

4. Discussion

The present study builds on our understanding of how Facebook may affect the stress response. Participants experienced changes in subjective and physiological stress in response to an acute laboratory stressor; however, contrary to hypotheses, Facebook appeared to *buffer* stress. Specifically, participants who used Facebook before experiencing acute stress reported lower levels of psychosocial stress (insecurity, irritation; higher well-being and positive mood), lower levels of threat to social self-preservation (shame, humiliation; higher state self-esteem), and lower levels of physiological stress (systolic blood pressure) in reaction to the stressor and during recovery. In addition, participants who used Facebook before the stressor rated the stressor itself as less threatening. Condition differences on many of these variables showed medium effect sizes, suggesting that Facebook use before stress may have a considerable impact on limiting the experience of stress.

The social self-preservation theory [10] posits that threats to social self-preservation trigger both a neuroendocrine and psychosocial stress response. Based on the findings of Rus and Tiemensma [32], we hypothesized that participants in the Facebook use condition would show

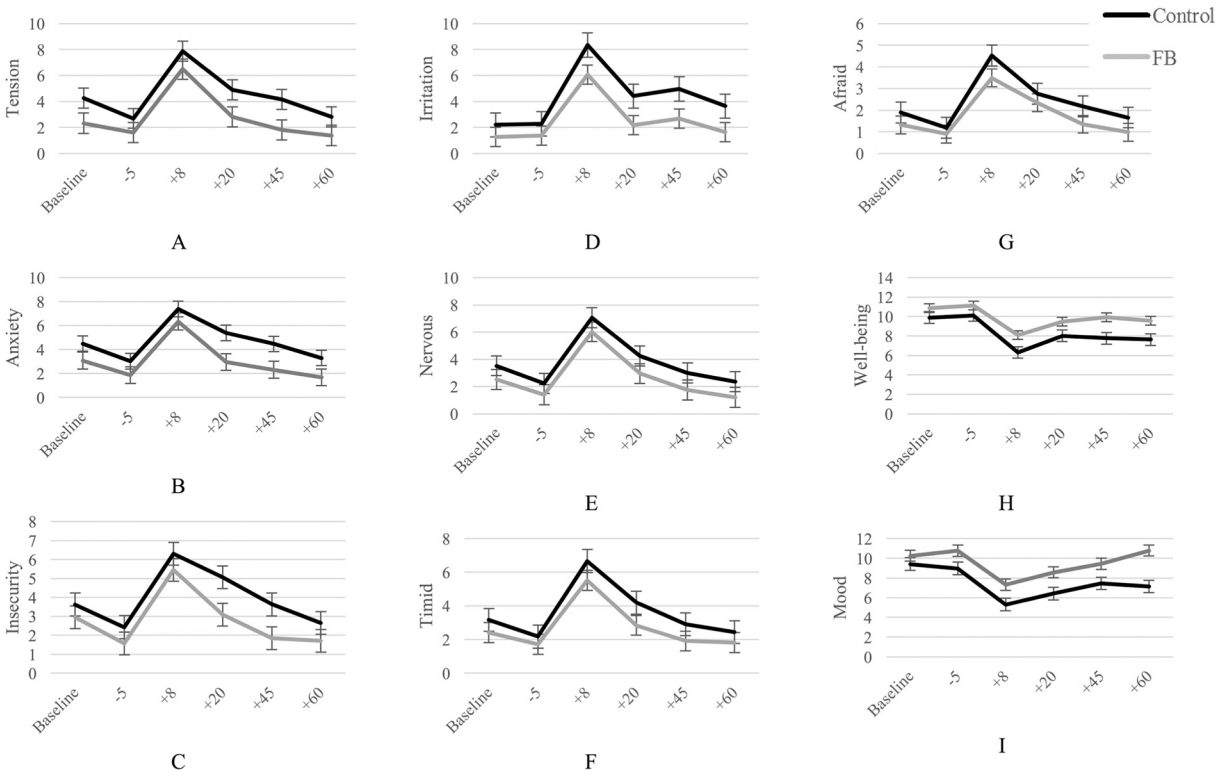

Fig. 3. Psychosocial stress markers for Facebook and Control conditions. X-axes represent minutes post-stressor onset. Bars represent standard errors. Conditions showed significant differences for measures of mood, anxiety, insecurity, irritation, tension, and well-being at $p \leq 0.05$.

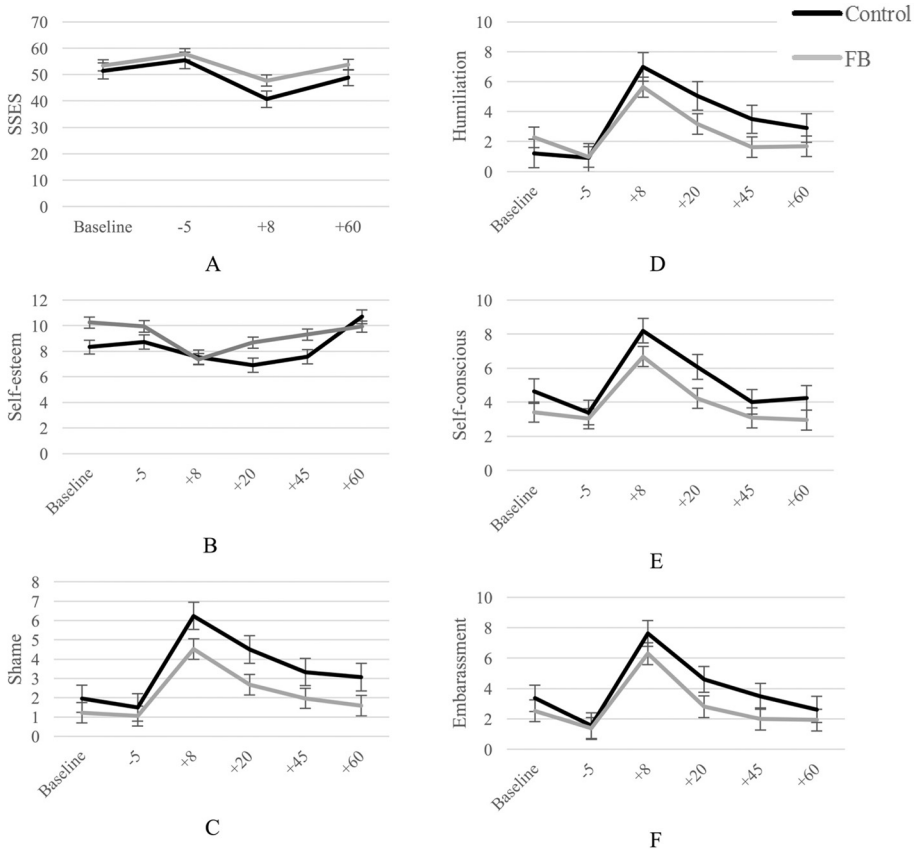

Fig. 4. Threat to social-self markers for Facebook and Control conditions. X-axes represent minutes post-stressor onset. Bars represent standard errors. SSES = State Self-esteem Scale. Conditions showed significant differences on measures of SSES, embarrassment, shame, and humiliation at $p \leq 0.05$.

an intensified reaction to the TSST in terms of psychosocial and physiological stress markers given the additive effect of both Facebook and the TSST being threats to the social self. Given that we found the opposite (i.e., a buffering effect for Facebook use), several explanations must be explored.

Facebook use has been associated with feelings of increased self-esteem [2], enhanced social support [3,27], general well-being [24], and overall life satisfaction [30,36]. Laboratory research has also shown that specific mechanisms such as self-compassion [1], affirmation of personal values [9], and providing support to others [22] can reduce both physiological and psychosocial reactivity to acute stress. Although the current study did not directly assess if participants engaged in any of these specific activities during Facebook use, given what is known about Facebook (e.g., it is a source for social support and is associated with self-esteem; [2,27]), it is possible that such mechanisms facilitated the observed buffering effect. Future work may wish to include more specific measures assessing these potential underlying mechanisms.

Comparing these results to Rus and Tiemensma [32] suggests that the timing and context of Facebook use influence its relationship with stress. That is, users who interact with Facebook in a neutral context (i.e., the current study) may reap psychosocial benefits from the platform's affordances, whereas interacting with Facebook in a stressful context [32] may turn the same content threatening. It is possible that activating the stress response before Facebook use primes users to feel stressed by their Facebook activity when they otherwise would not. Previous cross-sectional work has not accounted for context (e.g., emotional arousal or valence during use), which may in part account for conflicting findings concerning associations between Facebook use and well-being (e.g., [6,24]). Considering that in the current study, using Facebook before stress appeared to provide a boost to social self-preservation rather than a threat, manipulating emotional arousal or valence surrounding use could further clarify the relationship between stress and Facebook use.

Participants who used Facebook reported engaging in mostly passive activity (i.e., they consumed content rather than actively created it). Previous work has linked passive Facebook activity to negative well-being outcomes [34,37]. The current study suggests that passive use may in fact protect against negative outcomes. Similar to how social support buffers acute stress (e.g., [20]), perhaps passive Facebook use served as a simple reminder of one's social network being available for support despite users not actively engaging with members of their network. This begs the question of how different social media platforms may affect acute stress; in particular, ones in which users more commonly engage outside of their social network (e.g., Twitter). Future work will benefit from manipulating active versus passive Facebook use, as well as considering various platforms to better understand the interplay between use and well-being.

Although Facebook buffered some measures of psychosocial stress, threat to social self, task threat, and systolic blood pressure, there was no effect for cortisol, sAA, heart rate, or diastolic blood pressure. Those who used Facebook experienced the same amount of physiological stress as control participants in terms of these markers. This dissociation between psychosocial and physiological stress is consistent with previous findings (e.g, [13,22,26,32]).

Studies looking at buffering laboratory stress have found mixed results for effect on cortisol. Specifically, affirming personal values buffers cortisol response [9] while giving support to others does not [22]. As previously discussed, we did not collect data on participants engaging in these specific activities while using Facebook. However, it is possible that such behaviors negated a condition effect for cortisol. While Rus and Tiemensma [32] found that Facebook affected HPA activity (cortisol) but not SAM activity (blood pressure and heart rate), the current study found the opposite. This discrepancy further suggests that Facebook may differently affect these two components of the stress system, and further work is needed to understand how. That only systolic blood pressure showed an effect for SAM system activity highlights the complicated relationship among physiological markers and the need for future research.

Despite these novel findings, limitations must be addressed. The control condition involved a stimulating, yet neutral activity in effort to provide some level of arousal for all participants. It is possible that control participants interacted with material that influenced stress. Future work may benefit from including a third condition involving complete rest. In addition, we did not collect specific information related to content viewed during Facebook use. Some content (e.g., emotionally arousing images or stories) may have differently affected arousal and bolstered the buffering effect. Future work may wish to control for valence of content (e.g., positive or negative), particularly in light of the observed buffering effect. Finally, it is possible that these effects are specific to Facebook, and other social media platforms (e.g., Twitter, Instagram) may influence stress in different ways. Future studies could focus on comparing platform-specific features (e.g., text- versus image-based messages) to assess if it is social media in general buffering stress, or perhaps select features.

5. Conclusions

The present study adds to the growing literature on Facebook use and well-being. In particular, it is one of the few studies to take an objective look at the relationship between a pervasively popular activity and both psychosocial *and* physiological outcomes. We showed that using Facebook before an acute social stressor buffers stress in terms of psychosocial and physiological measures. That is, using Facebook before stress can limit the experience of stress.

Declaration of conflicting interests

The authors declare that they have no conflict of interest.

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Author contributions

H. M. Rus developed the study concept. Both authors contributed to the study design. Testing and data collection were performed by H.M. Rus. Immunoassay, data analyses, and interpretation were performed by H.M. Rus under the supervision of J. Tiemensma. H. M. Rus drafted the manuscript, and J. Tiemensma provided critical revisions. Both authors approved the final version of the manuscript for submission.

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