Psychophysiological Effects of Social Feedback During Social Media Use

Major Qualifying Project (MQP)

WPI

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Abstract

In recent years, rates of depression, anxiety, and other indices of poor mental health have increased dramatically among adolescents and young adults. Some research suggests that social media use has contributed to this mental health crisis, but few studies have examined psychological mechanisms that may underlie effects of social media on mental health, especially effects on anxiety levels tied to social evaluation on social media. Thus, the aim of the present study was to test whether there is a psychophysiological stress response to social feedback, as experienced on a social media platform. College aged students in the WPI community were recruited to participate in a two-part study in which they were first prompted to create captions for various images and memes that would later be used as mock social media posts—as part of a presumably new social media platform designed for WPI students (Part 1). Next, for Part 2, participants came into the lab and completed a PsychoPy task in which they were exposed to positive and negative feedback on the mock posts and captions they provided in Part 1, while having their heart rate and heart rate variability measured via an armband heart monitoring device. Throughout the task participants also reported how positively or negatively they felt after receiving different kinds of feedback. Findings revealed that the valence of the feedback mattered most when it came to participants' affect ratings, with individuals scoring high on Need to Belong (NTB), approval-related Contingent Self-Worth on Instagram (IGCSW), and Social Anxiety (SA) most sensitive to positive/negative feedback. Moreover, there was a psychophysiological stress response marked by lower heart rate variability when participants high on IGCSW received low likes and negative feedback. These findings suggest that interactions on social media can begin to be considered a social evaluative threat. Replication studies should be conducted to confirm validity of results.

Introduction

I. Social Media and Youth Mental Health

Social media has become increasingly prevalent in everyday life for many, as an effect of continuous technological advancement. Various social media platforms have gained more popularity throughout the years, especially amongst younger generations. Research suggests 259 million new users have joined social media platforms from April of 2023 to April of 2024, equating to an annualized growth of 5.4% (DataReportal, retrieved in April, 2024; see Figure 1).

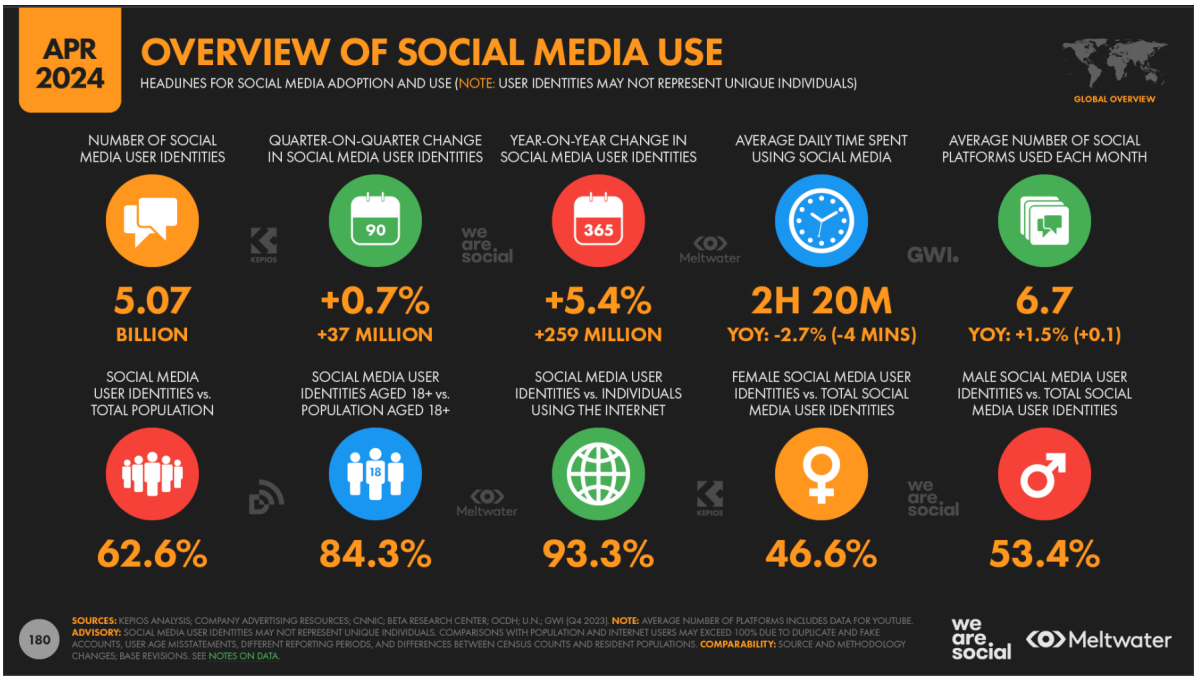

Figure 1: Image demonstrating statistics on social media popularity and growth, exemplifying data representing the amount of users relative to various populations (DataReportal, retrieved in April, 2024).

These platforms allow for users to easily connect with local peers as well as communities around the globe p Not only has social media increased the possibilities of social interactions, but they are also primarily used to post and consume content, whether that be pictures, videos, experiences, political views, and so on. The possibilities for social connection through a wide range of user content has become seemingly limitless. As demonstrated in Figure 2 below,

recent studies have shown that out of the 5.07 billion social media users, the most popular social media platforms consist of Youtube, Whatsapp, Facebook, and Instagram (DataReportal, retrieved in April, 2024).

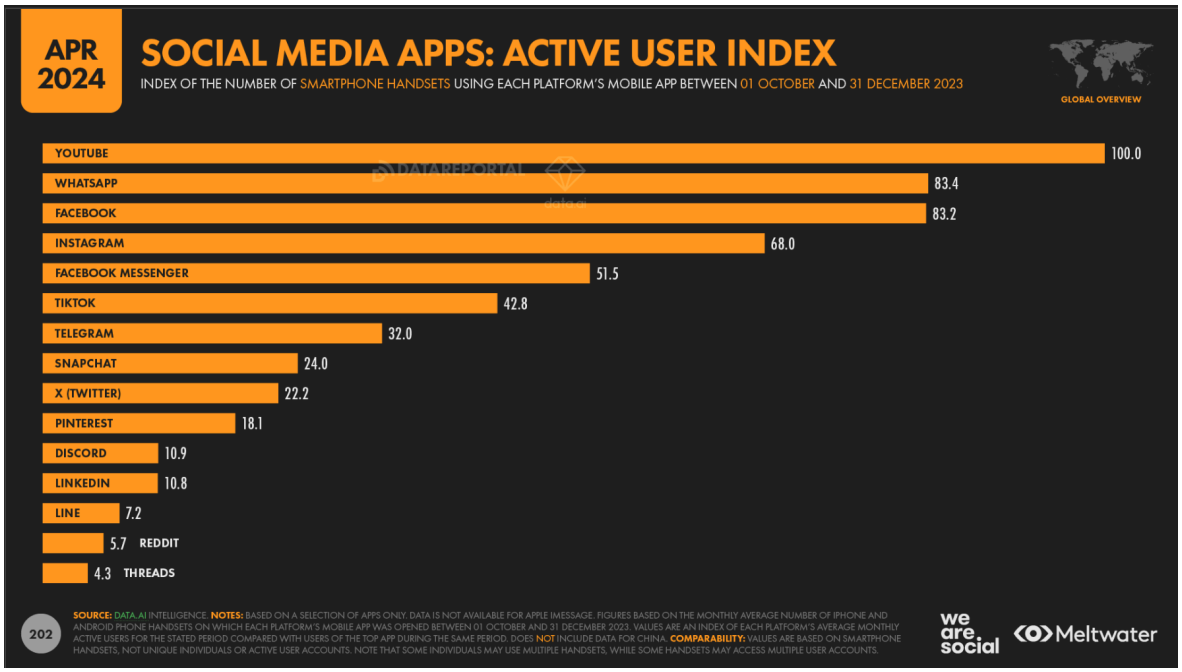

Figure 2: Image demonstrating number (in millions) of users utilizing each social media platform between the dates October 1 and December 31 of the year 2023 (DataReportal, retrieved in April, 2024).

However, there have been many negative effects from the increasing use of social media. Misinformation and disinformation have spread at a much faster and greater rate than ever before, considering how easy it has become to post content on different platforms. A study conducted by Gizem Caylen and colleagues suggests that the frequency and quantity of misinformation being shared on social media platforms is associated with how habitually individuals use certain social media platforms (Ceylan et al., 2023). From her study, she assessed how the small group of more habitual Facebook users were responsible for 37% of the false headlines being shared, due to the reward system framed by social media platforms. Active users are rewarded for sharing any kind of content through likes, comments, and reactions, which

continues to reinforce the cycle of misinformation spreading (Ceylan et al., 2023). This reward framework experienced on social media is the primary reason why these online platforms are so vastly overused and misused. Not only receiving "Likes" but also giving that feedback on an online post has been proven to activate the ventral striatum and vmPFC, brain regions associated with reward processing (Sherman et al., 2018).

Additionally, unrealistic beauty standards or even life standards have been pushed on young users, especially young women. Research has suggested that increased social media use has strong correlations with feelings of depression and low self-esteem, especially in young adults, adolescent women in particular (Kelly et al. 2018; Sherlock & Wagstaff, 2019). Along with increased rates of depression and poor self-esteem, anxiety symptoms have also increased among heavy social media users, which can be due to many different reasons.

Younger generations have been exposed to social media platforms starting early in life, which has been proven to cause significant effects not only on their self-esteem, but on their sense of identity and belonging as well. On average, children and adolescents are creating and using social media accounts as young as 12.6 years old (Howard, 2018), and currently 95 percent of teenagers use at least one social media platform (Hill et al., 2016). This is extremely relevant, especially considering how the formative years that make up adolescence are characterized by an increased need to belong, and social comparison, given it's a sensitive period in which adolescents are 'uniquely attuned to the complexities of interpersonal relationships' (Sherman et al., 2016). Earlier exposure to social media platforms have also been associated with higher levels of anxiety and depression in addition to negative health outcomes related to weight and sleep (Hill et al., 2016). Research also suggests that social media use can be associated with increased acceptance of "risky" behavior. In a study conducted by Sherman and colleagues, the

researchers found that the amount of likes and comments a photo received online significantly impacted how their adolescent participants perceived the image. If a photo received a higher number of likes, participants were more likely to like the post themselves, even if the image portrayed "risky" behaviors such as underage drinking and marijuana use (Sherman et al., 2016). Recent literature has even shown that those individuals with higher social anxiety tended to have higher contingent self-worth, as experienced on Instagram (Lopez & Poletta, 2021).

Early exposure to social media has been an important factor on individuals' mental well-being, but research has also proven that just as importantly, the manner in which one engages with social media is also extremely influential in their mental and physical health indices (Hill et al., 2016). Active social media usage consists of users engaging with content through liking, commenting or sharing posts, and actively posting content themselves. Passive social media use on the other hand, is characterized by solely consuming content without interacting with it, i.e. doom scrolling, which has become increasingly popular in the most recent years. Research has shown that all types of Instagram use have a correlation to increased social comparison behaviors. It has also been proven that there is a significant correlation between passive Instagram use and sense of self-worth (Turk, 2021).

II. Background Information

A. Social Evaluative Threat and Physiological Responses

Social Evaluative Threat (SET) is defined by Dickerson, Gruenewald, and Kemeny as "situations that provide the potential for a loss of social esteem, social status, or social acceptance". They go on to explain "prototypical threats to the social self are conditions in which an important aspect of the self-identity is, or could be, negatively judged by others" (Dickerson,

Gruenewald, & Kemeny, 2004). Social evaluative stressors have been proven to elicit salivary cortisol responses through the activation of the HPA axis, as well as cardiovascular reactivity demonstrated through increases in heart rate and blood pressure (Smith & Jordan, 2015; Woody, Hooker, Zoccola, & Dickerson, 2018). Usually, a SET physiological response is induced through the use of a Trier Social Stress Test (TSST), which does so by requiring research participants to prepare an interview-style presentation, and afterwards complete a surprise mental arithmetic test, in front of confederates who do not provide either feedback or encouragement (Allen et al. 2016). A meta-analysis done by Dickerson and Kemeny in 2004, proved that "tasks containing both uncontrollable and social-evaluative elements were associated with the largest cortisol and adrenocorticotropin hormone changes and the longest times to recovery". When inducing SET through TSSTs, researchers often analyze the effects of both acceptance stressors and status stressors in evoking psychophysiological responses. However, as Smith and Jordan (2015) point out, "it is often unclear which specific aspects of social threat influence these responses. That is, the relative importance of acceptance and status stressors as distinct determinants of physiological response is not yet clearly established" (Smith & Jordan, 2015).

Social evaluative threat has proven to be a great source of psychological stress to many individuals, and is an extremely important measure when analyzing social interactions and relationships, as well as cultural trends and practices.

B. Approval-Related Contingent Self-Worth

Contingent self-worth is considered to be a separate construct from self-esteem and it consists of the actions one takes, or how one presents themselves in order to attain external approval from their peers and surroundings (Crocker & Knight, 2003). The construct of contingent self-worth has become increasingly popular regarding social media studies, due to the

culture of social comparison and need to belong so prevalent in social media platforms. Many social media users, especially younger individuals, have suffered from low self-esteem as a result of receiving negative feedback, or not as much positive feedback as their peers, on their respective social media accounts. This allows researchers to assume young social media users associate their self-worth to the feedback they receive from social interactions on online platforms.

In their study, Lopez and Polletta adapted the Contingencies of Self-Worth Scale from Crocker, Luhtanen, Cooper and Bouvrette (2003), to create the Approval-Related Contingent Self-Worth scale. Participants were asked to report their agreement with the items using a 5-point Likert scale. The statements participants reported on were as follows: "(1) When I get a lot of likes and new followers on my Instagram, my self-esteem increases. (2) I feel worthwhile when others like or comment on my Instagram posts. (3) When my Instagram posts or comments go unnoticed, I feel badly about myself. And (4) My self-esteem depends on how popular and active my Instagram profile is" (Lopez & Polletta, 2021). What the researchers found from this study was that individuals who demonstrated high levels of social anxiety tended to engage with Instagram differently, and tied their self-worth to feedback they would receive from their posts. Interestingly, the researchers also found that people with high levels of social anxiety curated their posts' content to adhere to what would be more "socially acceptable" in their context, and what would generate greater and more positive feedback (Lopez & Polletta, 2021).

This in turn creates a vicious cycle among social media users, especially those who began using online platforms at such a young age. Children are growing up being exposed to unrealistic beauty standards and ever-changing fashion trends, and in turn they begin to believe they must portray themselves in the same manner to achieve social status and acceptance.

III. Investigative Questions and Aims

In the present study, social media platforms (namely Instagram and Threads) were investigated to determine whether they served as a context for potential social evaluative threat, as evidenced by a psychophysiological response comprised of cardiovascular reactivity and self-reported affect. Specifically, researchers assessed whether experimental manipulation of the number of likes and valence of positive and negative feedback received on social media could elicit a psychophysiological stress response.. Researchers also aimed to assess whether individual differences quantified through mental health measures and psychological questionnaires interacted with likes and feedback to alter the psychophysiological stress response. Ultimately, by determining which aspects of social media make it a characteristic SET, this study aims to guide future interventions that aim to improve health and well-being in daily life.

IV. Study Overview

This present study will aim to determine whether a common, naturalistic stressor (i.e., feedback one receives based on social media posts), can reliably elicit psychophysiological effects, and whether there are individual differences in this stress response. In order to do so, this study will screen participants for various mental health indices such as Generalized Anxiety Disorder (GAD), Depression, Instagram Contingent Self-Worth, Need to Belong, and Social Anxiety. The Online Social Evaluative Stressor (OSES) task will aim to measure the effects of two primary kinds of feedback someone can receive on social media platforms when they share a post, namely: the amount of likes and comments, and the emotional valence of the feedback in

response to the post. The task will be operationalized through the use of two parts: a primary online task, and a secondary in person online social evaluative stress task. During the in person online stressor task, participants will be measured on their cardiovascular reactivity through various heart rate (HR) measures including average HR, as well as heart rate variability metrics, such as RMSSD values and lnRMSSD values. It is hypothesized that social feedback received from interactions online can be considered a social evaluative stressor, due to the prevalence of social comparison in social media platforms (especially among younger populations). Furthermore, it is expected that negative feedback will elicit the most significant physiological stress response, as represented through negative affect ratings, increased average heart rate, and decreased heart rate variability.

Methods

I. Study Sample

The target population for this study were college students currently enrolled at Worcester Polytechnic Institute (WPI) in Worcester, MA who have been previously exposed to social media platforms and/or use them on a regular basis. The age group our team of researchers looked into in this experiment were young adults, who have most likely grown up using social media platforms to either consume content, or post content themselves. There was no exclusion criteria for participant recruitment in this study. Participants were recruited through WPI SONA systems, and were compensated by receiving course credit for their participation. The study sample consisted of 31 WPI students (20 Female; 8 Male; 3 Non-Binary), with an average age of 20 years old (SD_{age}=1.58 years).

II. Methods

A. Study Design and Procedure

This Online Social Evaluative Stressor Task measured the effects of two primary kinds of feedback one could receive on social media platforms after sharing a post, namely: the amount of likes, and the emotional valence of feedback in response to the post. The task was operationalized through the use of two parts: a primary online task, and a secondary in person online social evaluative stress task.

Part 1 of the study consisted of data collection through the completion of Qualtrics surveys on WPI SONA Systems. In the surveys, after being presented with the informed consent document and the cover story verbiage (see Appendix B), participants were asked to complete a series of demographic questions as well as various questionnaires assessing their current mental

health state and their relationship with social media, explicitly the platform Instagram. Following the completion of these questionnaires, participants were presented with 24 different images, commonly used as ‘memes’ on social media, and were prompted to create funny and/or relatable captions for the respective images related to the WPI student and/or social life. The captions uploaded from each participant were then used to generate mock posts, which served as stimuli in the stressor task in Part 2 of the study, where participants received faux social feedback manipulated to be either positive or negative in an online context.

Part 2 of the study consisted of an in-person task following a 2-by-2, within-subjects block design, with number of likes and comments (high vs. low) as one factor, and the valence of the feedback (positive vs. negative) as the other factor. Participants were exposed to four variations of each mock post containing their own captions along with the corresponding images, which were previously submitted in Part 1. Following the within-subjects block design used in the study by Chen et al. (2020) (see References), participants were exposed to 24 trials for each cell of the design, resulting in 96 total trials (e.g., 24 trials in which they're exposed to their mock post with few/no likes and a negative feedback response, 24 trials with few/no likes and a positive response, etc.).

Table 1: Experimental 2x2 within-subjects design

2x2 design	Positive feedback	Negative feedback
High # of likes (range: 100-250)	Positive High (PH 1-24)	Negative High (NH 1-24)
Low # of likes (range: 0-20)	Positive Low (PL 1-24)	Negative Low (NL 1-24)

The OSES task was coded on PsychoPy, allowing for each participant to be exposed to every variation of their own mock posts for five seconds, followed by an image containing the social feedback to their posts, which was displayed for eight seconds. Stimuli were presented to

participants in four separate blocks, each containing 24 individual variations of the participant's mock posts and 24 different feedback responses. The blocks were categorized following the model presented in **Table 1** with Block 1 containing all negative comments and low amount of likes, named Negative Low (NL); Block 2 containing all negative comments and high amount of likes, named Negative High (NH); Block 3 containing all positive comments and low amount of likes, named Positive Low (PL); and finally, Block 4 containing all positive comments ad high amount of likes, named Positive High (PH). During the exposure to each condition, participant's Heart Rate (HR) and Heart Rate Variability (HRV) were measured through the use of a *Rhythm 24™ Waterproof Armband Heart Rate Monitor* produced by *Scosche Industries*. Following each block of the stressor task described above, participants were prompted to complete a short affect self-assessment on their emotional state after each block, rating how positively or negatively they feel in the moment on a scale of 1 to 7. Participants were also prompted to respond to questions about the mock posts' aesthetics ('look and feel') to increase the cover story's validity. The flow of the PsychoPy task is demonstrated in **Figure 3** below.

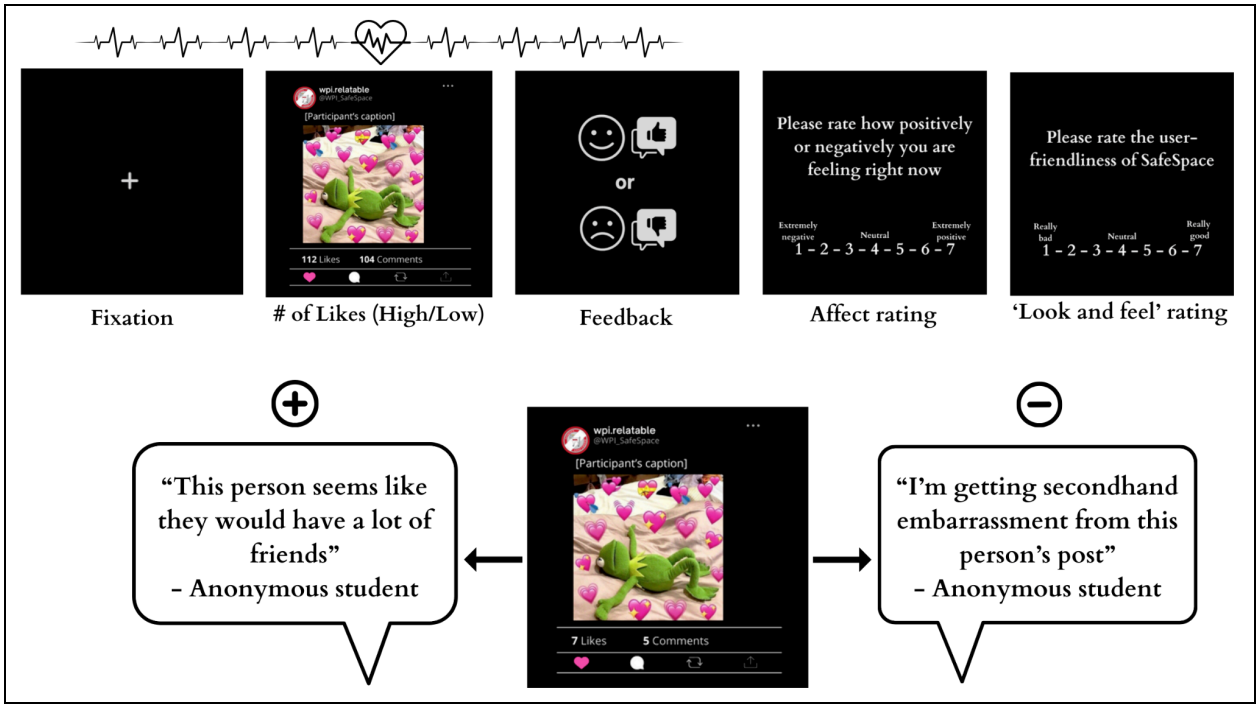

Figure 3: Schematic representation of social stressor task coded on PsychoPy, which comprised Part 2 of the study.

Immediately after the stressor task, participants received a full debriefing explaining the true purpose of the study, and reassuring that all stimuli had been falsely articulated for the purpose of the study.

B. Materials

For the execution of this study, the materials utilized were as listed below:

1. Mock posts made through Canva website (see Appendix D for examples)
2. Surveys powered through Qualtrics
3. Stressor task powered through PsychoPy
4. Rhythm 24™ Waterproof Armband Heart Rate Monitor fabricated by Scosche
5. Cover story video (see Appendix B for cover story verbiage)
6. Debriefing form (see Appendix C for debriefing verbiage)
7. Mental health and social media use questionnaires (see Appendix A and Measures section A for references)

III. Measures

A. Questionnaires

During Part 1 of the study, participants were prompted to respond to the following questionnaires assessing their mental health and social media use: the Generalized Anxiety Disorder 7 scale (Spitzer et al. 2006), the Personal Health Questionnaire Depression Scale (Kroenke et al. 2009), the Need to Belong scale (Leary 2013), the Social Anxiety scale (NIMH, 2023), and the Instagram Contingent Self-Worth scale (Lopez & Polletta, 2021).

During Part 2 of the study, prior to the stressor block-trial task, participants were asked to honestly complete questionnaires assessing their social media use and motives (Lopez & Polletta, 2021), and their screen time. After each trial in the social evaluative stressor task, participants were also prompted to report on their affect, by answering the question "How positively or negatively do you feel right now?" on a scale of 1 (very negatively) to 7 (very positively) and 4 being a neutral value. Participants were also required to report on each stimuli's aesthetics in order to increase cover story validity, and to add a buffer period in between stressor trials within blocks.

B. Heart Rate (HR)/ Heart Rate Variability (HRV)

Participants had their Heart Rate (HR) and Heart Rate Variability (HRV) measured using a pulse-measuring device, the *Rhythm 24™ Waterproof Armband Heart Rate Monitor* fabricated by *Scosche*, on their left wrist. All the data captured from the heart rate monitor and transferred via bluetooth to the *EliteHRV* appfor storage and subsequent analysis. *EliteHRV* automatically computes HR and HRV metrics. Average HR, as well as two indicators of HRV (RMSSD values and log-transformed RMSSD values) were the HR/HRV measures of interest for this study.

IV. Data Management and Analysis

All data were stored securely in the cloud (encrypted Qualtrics servers) and password-protected computers with encrypted hard drives. In the interest of open and reproducible science, anonymized data from this study will be included in the finalized MQP report, as well as on the Open Science Framework.

For the purpose of this study, all data from each block trial was analyzed through a Mixed Model analysis in *Jamovi,*a statistical analysis software, in order to assess the relationship between the social feedback received online and various heart rate variables. The statistical test was conducted once for each dependent variable of interest, with the primary ones being affect ratings, the average HR/HRV scores, and the lnRMSSD values.

Results

All data analyses were conducted using the Mixed Model analysis tool on *Jamovi*, a statistical analysis software (jamovi, version 2.5). Data were analyzed from 31 participants (20 Female; 8 Male; 3 Non-Binary; M_{age}=20; SD_{age}=1.58) out of the 38 individuals who completed Part 2 of the study. Seven participants were excluded from the data analyses due to methodological changes in the protocol during the data collection period.

I. Psychological Variables from Survey Data

The study sample was found to be split relatively equally between the mental health and social media use measures, with an exception to Depression and Generalized Anxiety measures where the majority of participants scored lower on those respective scales (PHQ-8 & GAD-7), meaning they experienced fewer anxiety and depression symptoms.

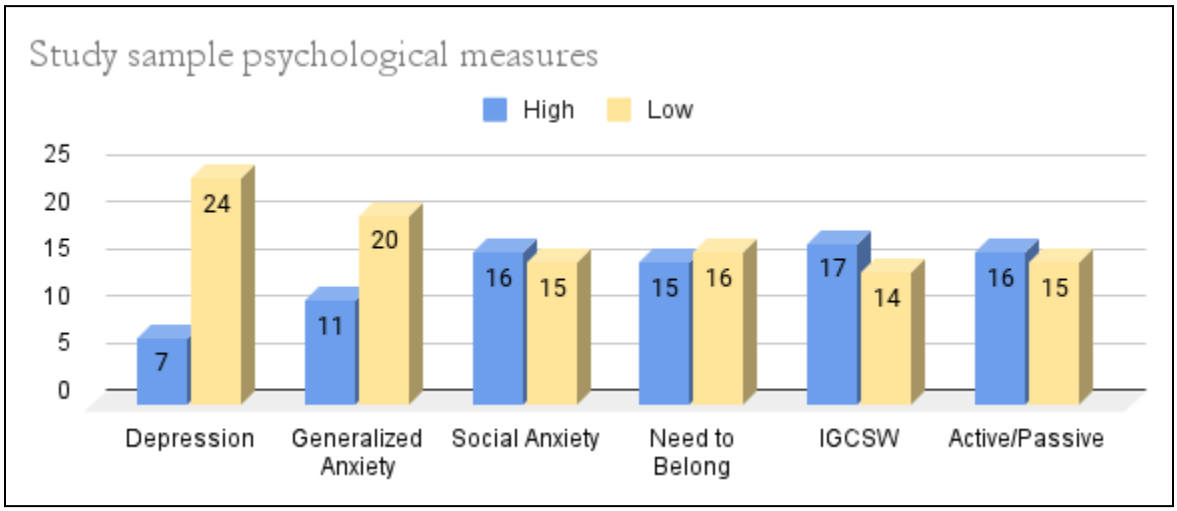

Figure 4: Split of study sample exhibiting high or low depression, generalized anxiety, social anxiety, need to belong, IGCSW, & active or passive social media usage

II. Affect Rating Analyses:

A. What Types of Social Feedback Elicited Positive and Negative Affect?

Using a Linear Mixed Model analysis tool on *Jamovi*, it was found that participants' affect was significantly moderated by the type of feedback they received, either positively or negatively-valenced comments. As demonstrated in **Figure 5**, the amount of likes (either high or low) did not impact participants' affect ratings independent of the valence of feedback they were paired with. There was no significant main effect of likes $F(1, 82.5)=0.10$, $p=0.751$, nor a significant interaction effect $F(1, 82.5)=0.26$, $p=0.62$. Because there was no effect of likes on affect ratings ($p=0.751$), all additional findings below come from streamlined models with valence as the experimental factor, given there was a significant main effect of valence $F(1, 82.5)=41.27$, $p<.001$.

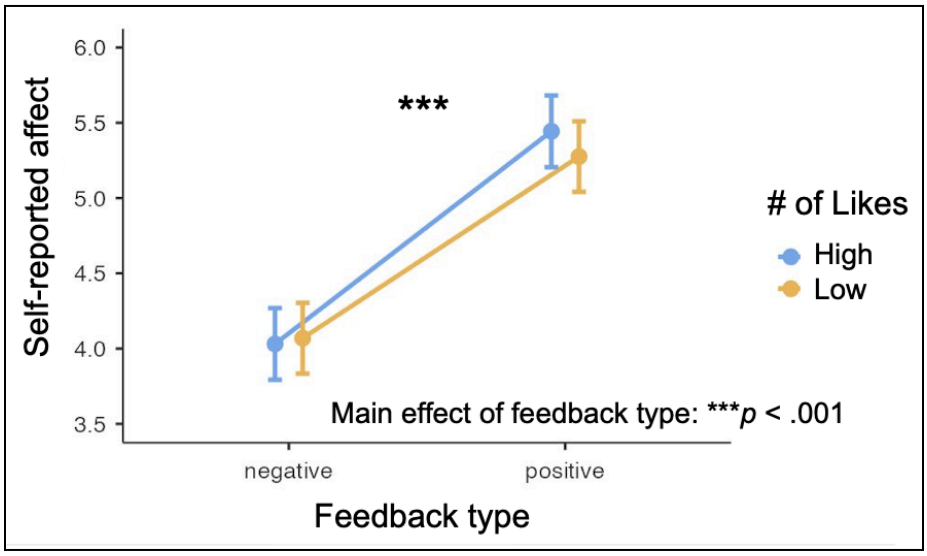

Figure 5: Plot of effects of feedback valence on affect ratings with number of likes as a moderator

In order to examine individual differences in Need to Belong, Approval-Related Contingent Self-Worth on Instagram, and Social Anxiety and their potential influence on the outcomes of interest, scores from these scales were included in additional models.

B. Need to Belong (NTB) and Feedback Valence Interactions

In the model predicting affect with valence and NTB as predictors, there was a significant interaction effect $F(1, 79.7)=9.58$, $p=0.003$, such that those with low NTB scores were less susceptible to negative feedback, while those with high NTB scores were significantly more affected by negative feedback $F(1, 80.1)=47.80$, $p<.001$, thus resulting in lower affect ratings.

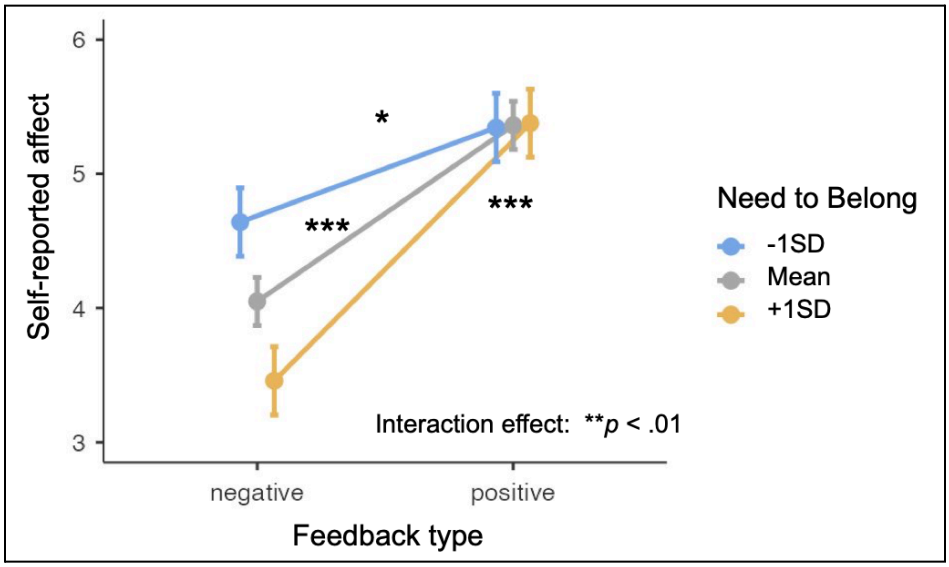

Figure 6: Plot of interaction effect of feedback valence and NTB scores on affect ratings

C. Approval-Related Contingent Self-Worth on Instagram (IGCSW) and Feedback Valence Interactions

In the model predicting affect with valence and IGCSW as predictors, there was a significant interaction effect $F(1, 79.5)=4.72$, $p=0.033$, such that those with low IGCSW scores were less susceptible to negative feedback, while those with high IGCSW scores were significantly more affected by negative feedback $F(1, 80.0)=37.62$, $p<.001$, thus resulting in lower affect ratings.

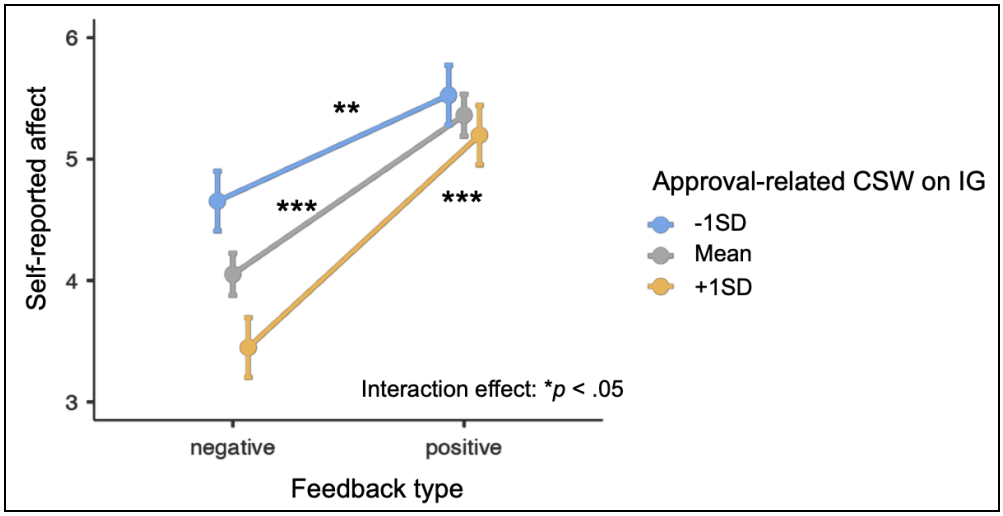

Figure 7: Plot of interaction effect of feedback valence and IGCSW scores on affect ratings

D. Social Anxiety (SA) and Feedback Valence Interactions

In the model predicting affect with valence and SA as predictors, there was a significant interaction effect $F(1, 79.9)=8.19$, $p=0.005$, such that those with low SA scores were less susceptible to negative feedback, while those with high SA scores were significantly more affected by negative feedback $F(1, 80.2)=44.88$, $p<.001$, thus resulting in lower affect ratings.

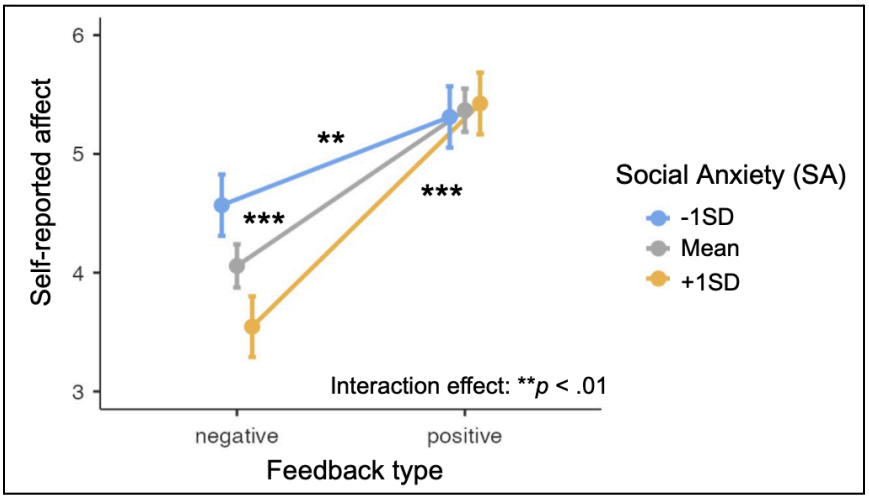

Figure 8: Plot of interaction effect of feedback valence and SA scores on affect ratings

III. Heart Rate & Heart Rate Variability Analyses

A. Feedback Types and Average Heart Rate

Using a Mixed Model analysis tool on *Jamovi*, it was found that participants' average heart rate was not significantly moderated by the type of feedback they received. As demonstrated in **Figure 9**, neither the valence of the feedback nor the amount of likes had any significant effects on average heart rate measures. There was no significant main effect of likes $F(1, 72.0)=0.004$, $p=0.949$, nor a significant main effect of valence $F(1, 72.0)=0.01$, $p=0.920$. There was also no significant interaction effect $F(1, 72.1)=2.06$, $p=0.156$.

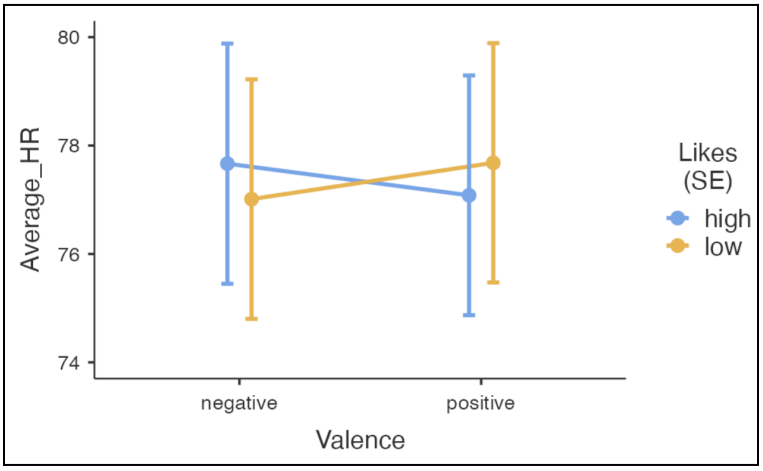

Figure 9: Plot of effects of feedback valence on average heart rate with number of likes as a moderator

Interestingly however, when analyzing lnRMSSD values (a measure of heart rate variability) as the dependent variable, significant interaction effects were found. In order to examine individual differences in Generalized Anxiety Disorder, Depression, and Approval-Related Contingent Self-Worth on Instagram and their potential influence on lnRMSSD values (a heart rate variability measure), scores from these scales were included in additional models.

B. Generalized Anxiety Disorder (GAD) and Feedback Valence Interactions

In the model predicting lnRMSSD values with valence and GAD-7 scores as predictors, there was a significant interaction effect $F(1, 69.2)=5.00$, $p=0.029$, such that those with high GAD-7 scores were significantly more affected by negative feedback $F(1, 69.1)=4.48$, $p=0.038$, thus resulting in lower lnRMSSD values, translating to lower heart rate variability. There was no significant interaction effect for those who had lower GAD-7 scores $F(1, 69.3)=1.14$, $p=0.289$.

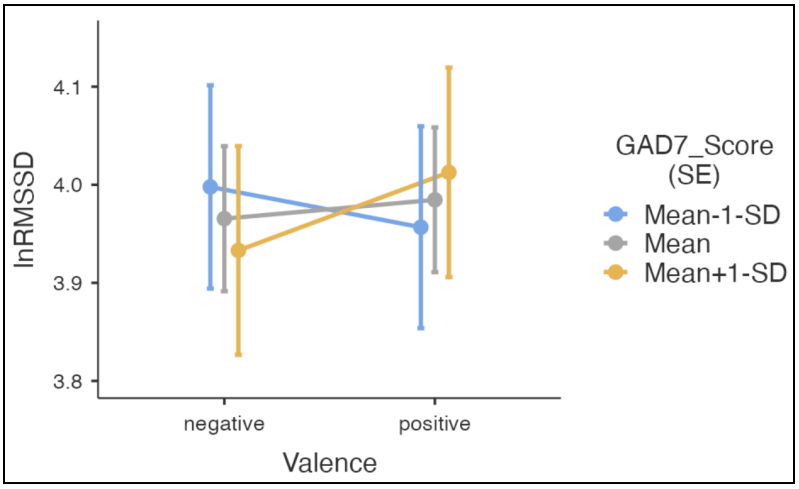

Figure 10: Plot of interaction between GAD-7 scores and feedback type on lnRMSSD values

C. Depression (PHQ-8) and Feedback Valence Interactions

In the model predicting lnRMSSD values with valence and PHQ-8 scores as predictors, there was a significant interaction effect $F(1, 69.2)=6.02$, $p=0.017$, such that those with high PHQ-8 scores were significantly more affected by negative feedback $F(1, 69.1)=5.17$, $p=0.026$, thus resulting in lower lnRMSSD values, translating to lower heart rate variability. There was no significant interaction effect for those who had lower PHQ-8 scores $F(1, 69.3)=1.49$, $p=0.226$.

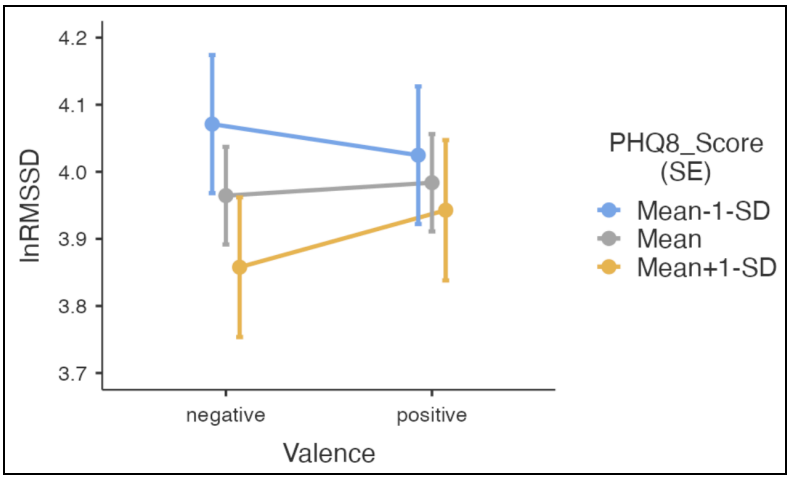

Figure 11: Plot of interaction between PHQ-8 scores and feedback type on lnRMSSD values

D. Approval-Related Contingent Self-Worth on Instagram (IGCSW), Feedback Valence & Number of Likes Interactions

In the model predicting lnRMSSD values with valence, number of likes, and IGCSW scores as predictors, there were no significant main effects of likes or valence, but there was a significant 3-way interaction effect $F(1, 70.6)=6.20$, $p=0.015$, such that when the likes were in a low range, those with high IGCSW scores were significantly more affected by negatively valenced feedback, thus resulting in lower lnRMSSD values, translating to lower heart rate variability, $b=.11$, $t(69.4)=2.075$, $p=.042$; this interaction is demonstrated by the regression of the slope represented by the yellow line in **Figure 12**. In contrast, for those who had relatively lower IGCSW scores, the pattern reversed, such that there was a marginal difference with relatively higher lnRMSSD values in the negative (vs. positive) feedback condition, $b= -0.09$, $t(69.4)= -1.746$, $p=.085$.

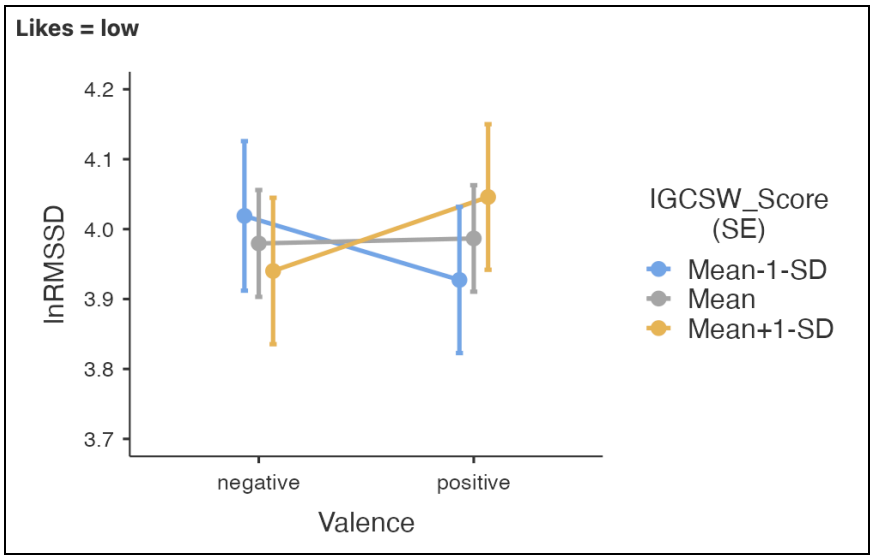

Figure 12: Plot of interaction between IGCSW scores and feedback type when number of likes are low on lnRMSSD values

Discussion

I. Important Findings

We hypothesized that a combination between the amount of likes and the valence of social feedback to participants' mock posts would elicit a more robust physiological stress response. The combination we expected to elicit the most stress would be a low amount of likes and comments in conjunction with negative feedback. However, contrary to my hypotheses, the number of likes did not impact affect ratings or average HR/HRV measures, as demonstrated by both Figures 5 and 9 (see **Results** sections II-A, and III-A respectively), showing the correlation between affect ratings/ average HR reading and valence with number of likes as a moderator. The factor that drove significant correlations was the type of feedback (either positive or negative) participants were exposed to following the visual task of viewing the engagement their own posts received on the mock platform 'SafeSpace'.

It is then inferred that one negative interaction online is just as capable of eliciting negative affect as multiple negative interactions. This interaction effect was exacerbated when taking into account the covariates Need to Belong (NTB), Approval-Related Contingent Self-Worth on Instagram (IGCSW), and Social Anxiety (SA). The scores participants received from their responses to the scales above, influenced how susceptible to negative affect following negative social feedback they were. Participants who obtained higher scores on said scales, were significantly more impacted from the negative feedback than their peers who scored lower on the scales. Interestingly, the same interaction effect was not seen in participants who rated higher on both the PHQ-8 and GAD-7 scale, which fails to confirm findings from previous literature regarding social media use and effects on psychological measures. The finding that NTB, IGCSW, and SA moderate positive and negative affect, confirms our initial hypothesis that

individual differences play a huge role on the amount of evaluation social media users are susceptible to when engaging with such platforms.

Another implication is that NTB, SA, and IGCSW drive how people engage with social media platforms and their usage of different platforms. If people have higher NTB, it is implied that they would use social media to create more connections, or engage with the same content their peers and their communities are engaging with. Individuals with a high need to belong would want to know about all the latest trends, to feel a greater sense of belonging within their friend groups. Furthermore, it is implied they would approach social media platforms in a similar way to their peers. For example, if their peers are active social media users and are constantly engaging with content online rather than just consuming content, individuals with high need to belong would also be active social media users. Following the same train of thought, for participants who rated higher on IGCSW it would be logical to assume they are also more active social media users. If their self worth is tied to the feedback and approval they receive on social media platforms, it is implied they would post more content of themselves and things they value and enjoy in order to continue to receive that approval. As for social anxiety, it would be interesting to assess more in depth the relationship between high social anxiety and social media use. It is logical to assume people with higher social anxiety would be more passive social media users out of fear of being rejected and avoidance for social interactions, for consuming content offers lower stakes and fewer to no opportunities to receive any negative feedback.

We also hypothesized significant cardiovascular reactivity to different types of feedback, with a focus on negative feedback. Our hypothesis was confirmed through significant interaction effects between PHQ-8 and GAD-7 scores with feedback valence on lnRMSSD values. From these significant interaction effects, it is inferred that individuals with higher levels of

generalized anxiety and depression are physiologically affected by negative feedback, despite not having self-reported this effect during affect ratings. Additionally, consistent with previous literature, it was determined through our sample that individuals with higher levels of depression have higher heart rate readings in general (Lutin et al., 2022), no matter the experimental condition, as demonstrated in **Figure 19** (see Appendix G).

II. Limitations

This study encountered various limiting factors. Due to the high-speed nature of semesters at Worcester Polytechnic Institute (WPI), we had less than 14 weeks to pilot the study and implement changes and improvements to the protocol while simultaneously running participants. Because the study required two parts, the first entirely online and the second in person and in the Social Neuroscience of Affective Processes (SNAP) Lab, many participants only completed Part 1 of the study and never signed up for Part 2. Although the team of research assistants constantly reached out to individuals who had completed Part 1, and constantly attempted to recruit additional participants, the discrepancy between the number of sign-ups for Part 1 and Part 2 remained significant.

Even though there were no significant main effects of likes or valence on the physiological stress measures of interest (i.e., HR and lnRMSSD), there were significant interaction effects observed with IGCSW, GAD7 and PHQ8 scores. The lack of an overall main effect could be due to many reasons, namely the fact that as part of the cover story, participants were told their captions along with the corresponding images would be posted anonymously. Therefore participants knew their posts could not and would not be traced back to them even when exposed to the negative responses. Additionally, creating the WPI-related memes was not an accurate depiction of themselves. In order for participants to feel threatened by the negative

feedback to their posts, they would have to value the trait of being funny to begin with, and want to pursue that characteristic and be perceived as funny to others. Now, if participants either did not consider themselves funny, or did not care about being perceived as funny, negative feedback to their memes would not elicit a significant stress response or negative affect.

Another factor that could have influenced participants' stress responses and affect ratings was whether or not they believed in the cover story. The cover story was extremely thorough, however WPI has a small campus compared to other colleges and universities, therefore if participants hadn't previously heard of the new social media platform the team of researchers was trying to promote, it is likely that they correctly assumed the study involved deception, and the visual task consisted of faux feedback.

Despite having created the feedback with accurate depictions of what was prevalent on social media platforms such as TikTok and Instagram, many participants reported having not believed all the social feedback they received was ecologically valid. This could be due to many reasons, partly because social media trends change so rapidly, therefore even though the feedback was consistent with trends during protocol development, by the time participants were exposed to the feedback trends could have already been significantly different. Another justification is that the WPI student body is very unique through the high indices of neurodivergent students. Autism Spectrum Disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD) significantly impact social interactions and how neurodivergent individuals communicate, therefore the way in which the social feedback for this study was written, may not be fully representative of the WPI student body. It is also a consideration that the social feedback was not written very intensely in order to provoke a heightened sense of threat or appraisal, which would elicit a more robust physiological response.

Additionally, the *Scosche Rhythm 24* armband may not provide as reliable and accurate data as other heart rate monitoring devices on the market (e.g. Polar H10 chest band).

III. Future Directions

The present study is considered a pilot study for the SNAP Lab. In order to continue this line of research, repeating this study with a more representative sample is necessary to determine the accuracy of the equipment and protocol and the reliability of the results. Furthermore, lengthening the study protocol (i.e. creating more stimuli to result in longer blocks), would be essential in assessing heart rate changes and spikes over a longer period of time and to be able to compare the results more effectively between different conditions. Through lengthening the protocol, future research assistants could implement cortisol collection in addition to measuring HR, given the necessary 20-minute intervals in between cortisol samples. Cortisol is very reactive to social evaluative threat, therefore it is extremely relevant to address whether social media interactions elicit cortisol spikes. It is also recommended to utilize a chest band heart monitoring device as opposed to an armband in order to decrease the amount of lagging during readings and improve signal quality overall.

More importantly, it is necessary to repeat this study using pictures the participants themselves took or have on their phones, as stimuli and content in order to provide an accurate depiction of who they are and what they value. In doing so, the ecological validity of the study would significantly increase. Simultaneously, the psychophysiological stress responses would be very similar to what participants normally experience every day while using different social media platforms.

Finally, it would be very interesting to implement fNIRS data collection in the study protocol to assess what cortical regions experience higher activation depending on the type of

feedback participants receive. It would be interesting to determine if different types of feedback elicit different brain region activation, or different levels of cortical region activation. It would also be relevant to assess the role of expectations and social pain as a predictor of brain activation, further investigating participants' engagement with social media platforms.

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Appendices:

Appendix A: Questionnaires

Personal Health Questionnaire Depression Scale (PHQ-8)

How often during the past 2 weeks were you bothered by…	**Not at all**	**Several days**	**More than half the days**	**Nearly every day**
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed, or hopeless	0	1	2	3
3. Trouble falling or staying asleep, or sleeping too much	0	1	2	3
4. Feeling tired or having little energy	0	1	2	3
5. Poor appetite or overeating	0	1	2	3
6. Feeling bad about yourself, or that you are a failure, or have let yourself or your family down	0	1	2	3
7. Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
8. Moving or speaking so slowly that other people could have noticed. Or the opposite- being so fidgety or restless that you have been moving around a lot more than usual	0	1	2	3

Kroenke, K., Strine, T. W., Spitzer, R. L., Williams, J. B., Berry, J. T., & Mokdad, A. H. (2009). The PHQ-8 as a measure of current depression in the general population. *Journal of affective disorders*, *114*(1-3), 163–173. https://doi.org/10.1016/j.jad.2008.06.026

Generalized Anxiety Disorder 7 scale (GAD-7)

Over the <u>last 2 weeks</u>, how often have you been bothered by the following problems?	**Not at all**	**Several days**	**More than half the days**	**Nearly every day**
1. Feeling nervous, anxious, or on edge	0	1	2	3
2. Not being able to stop or control worrying	0	1	2	3
3. Worrying too much about different things	0	1	2	3
4. Trouble relaxing	0	1	2	3
5. Being so restless that it is hard to sit still	0	1	2	3
6. Becoming easily annoyed or irritable	0	1	2	3
7. Feeling afraid as if something awful might happen	0	1	2	3

Spitzer, R. L., Kroenke, K., Williams, J. B. W., & Löwe, B. (2006). *Generalized Anxiety Disorder 7 (GAD-7)* [Database record]. APA PsycTests. https://doi.org/10.1037/t02591-000

Need to Belong Scale

Please indicate the extent to which each statement is true or characteristic of you	**Not at all**	**Slightly**	**Moderately**	**Very**	**Extremely**
1. If other people don't seem to accept me, I don't let it bother me	1	2	3	4	5
2. I try hard not to do things that will make other people avoid or reject me	1	2	3	4	5
3. I seldom worry about whether other people care about me	1	2	3	4	5
4. I need to feel that there are people I can turn to	1	2	3	4	5

in times of need					
5. I want other people to accept me	1	2	3	4	5
6. I do not like being alone	1	2	3	4	5
7. Being apart from my friends for long periods of time does not bother me	1	2	3	4	5
8. I have a strong "need to belong"	1	2	3	4	5
9. It bothers me a great deal when I am not included in other people's plans	1	2	3	4	5
10. My feelings are easily hurt when I feel that others do not accept me	1	2	3	4	5

Leary, M. R. (2013). Need to belong scale. *Journal of Personality Assessment.*

Instagram Contingent Self-Worth

Please indicate the extent to which you agree with the following statements.	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
1. When I get a lot of likes and new followers on Instagram, my self-esteem increases.	1	2	3	4	5
2. I feel worthwhile when I have others like or comment on my Instagram posts.	1	2	3	4	5
3. When my Instagram posts comments go unnoticed, I feel badly about myself	1	2	3	4	5
4. My self-esteem depends on how popular and active my Instagram profile is.	1	2	3	4	5

Lopez, R. B., & Polletta, I. (2021). Regulating Self-Image on Instagram: Links Between Social Anxiety, Instagram Contingent Self-Worth, and Content Control Behaviors. *Frontiers in Psychology*, *12*. 10.3389/fpsyg.2021.711447

Social Anxiety Scale

Below are a series of social interactions that may or may not cause you UNEASE, STRESS, or NERVOUSNESS. Please select the number next to each social situation that best reflects your reaction, where "1" represents NO unease, stress, or nervousness and "5" represents VERY HIGH or EXTREME unease, stress, or nervousness.
If you have never experienced the situation described, please IMAGINE what your level of UNEASE, STRESS or NERVOUSNESS might be if you were in that situation, and rate how you imagine you would feel by selecting a number on the corresponding scale.

Please rate all of the items and do so HONESTLY; do not worry about your answer because there are no right or wrong ones.	**Not at all or very slight (1)**	**Slight (2)**	**Moderate (3)**	**High (4)**	**Very high or extremely high (5)**
1. Greeting someone and being ignored					
2. Having to ask a neighbor to stop making noise					
3. Speaking in public					
4. Asking someone attractive of the opposite sex for a date					
5. Complaining to the waiter about my food					
6. Feeling watched by people of the opposite sex					
7. Participating in a meeting with people in authority					
8. Talking to someone who isn't paying attention to what I am saying					
9. Refusing when asked to do something I don't like doing					
10. Being mugged or robbed					

by an armed gang					
11. Making new friends					
12. Telling someone that they have hurt my feelings					
13. Having to speak in class, at work, or in a meeting					
14. Maintaining a conversation with someone I've just met					

(continuation)	**Not at all or very slight (1)**	**Slight (2)**	**Moderate (3)**	**High (4)**	**Very high or extremely high (5)**
15. Expressing my annoyance to someone that is picking on me					
16. Greeting each person at a social meeting when I don't know most of them					
17. Being teased in public					
18. Talking to people I don't know at a party or a meeting					
19. Being asked a question in class by the teacher or by a superior in a meeting					
20. Looking into the eyes of someone have just met while we are talking					
21. Being asked out by a person I am attracted to					
22. Making a mistake in front of other people					

23. Attending a social event where I know only one person					
24. Starting a conversation with someone of the opposite sex that I like					
25. Being reprimanded about something I have done wrong					
26. While having dinner with colleagues, classmates or workmates, being asked to speak on behalf of the entire group					
27. One of my parents getting seriously ill					
28. Telling someone that their behavior bothers me and asking them to stop					
29. Asking someone I find attractive to dance					
30. Being criticized					
31. Talking to a superior or a person in authority					
32. Telling someone I am attracted to that I would like to get to know them better					

Caballo, V. E., Salazar, I. C., Irurtia, M. J., Arias, B., & Hofmann, S. G. (2012). The multidimensional nature and multicultural validity of a new measure of social anxiety: The social anxiety questionnaire for adults. *Behavior Therapy*, *43*(2), 313–328. https://doi.org/10.1016/j.beth.2011.07.001

Screen Time Questionnaires

For IPhone users:

Go to your iPhone Settings and select Screen Time (hourglass icon), then select See All Activity.

Next:

1) *Swipe right once to reveal your screen time data for last week.*
2) *Please indicate the time indicated for Last Week's Average, in hours and minutes,*

respectively, using the two slider bars below (e.g., 2h 15 mins would be entered as 2 hours in the first slider, 15 minutes in the second slider).

3) *Next, please indicate the % change in screen time from the previous week (e.g., enter 28% if your phone says "up 28% from last week")*
4) *Next, indicate the 3 most used apps under the screen time bar graph:*
    a) *Most used app:*
    b) *Second most used app:*
    c) *Third most used app:*

For Android users:

1. Go to Settings > Battery > Battery Usage
2. Scroll down to System Usage / Battery Usage since last full charge
3. Report the total time under "Screen" in hours and minutes, respectively, using the two slider bars below (e.g., 1h 10 mins would be entered as 1 hour in the first slider, 10 minutes in the second slider).

Instagram-use Questionnaires

Instagram Comparison Scale:

In the past month, how often did you...	Not at all (1)	A little (2)	Somewhat (3)	Quite a bit (4)	Very often (5)
Look at photos of other Instagram users whose lives may be worse off than you?					
Compare yourself with other Instagram users who may be worse off than you?					
Look at photos of other Instagram users whose lives may be better off than you?					
Compare yourself with other Instagram users who may be better off than you?					

Instagram Distract vs. Recharge Scale:

Here are two statements that may or may not apply to you. There are no right or wrong answers, so just answer honestly, considering how you compare to most people.	Not at all like me (1)	Not much like me (2)	Somewhat like me (3)	Mostly like me (4)	Very much like me (5)
When I don't feel like working, I usually distract myself on Instagram					
I feel recharged/energized after going on/ using Instagram					

Active vs. Passive Social Media Use Scale:

Please rank each item below between [Never] to [Very Frequently] to show how often you do the following on Instagram	Never (1)	Sometimes (2)	About half the time (3)	Somewhat frequently (4)	Very frequently (5)
Only scroll through my newsfeed or explore page without interacting with content					
Only look at other users' posts without interacting with the posts or users					
Contact friends via DM (direct message)					
Comment on other users' posts					
Like other users' posts					
Post my own content (posts or stories)					

Only click on profiles that you don't follow and view their posts but do not interact with the content or user					

Note: *Items 3, 4, 5, & 6 are reverse scored.*

Appendix B: Cover Story Verbiage

As part of this study, we are working with another MQP group in the Computer Science department on developing a social media platform meant for students. This platform is meant to spread positivity in contrast to a large amount of hate, arguments, and doom-scrolling online. Mental health issues related to poor social media use are on the rise, especially among young adults and teenagers. This new social media is meant to create a pleasant experience for self expression, increase mental wellbeing, and support positive online interactions, following a Twitter/ Threads format. As part of Part 1 of this study, we would like you to upload funny captions for the given images, as you would see in versions of Twitter/ Tumblr/ Reddit, by responding to [Qualtrics survey]. The ‘captions’ should be consistent and relatable to your humor and WPI experience, whether that be related to classes or social life on campus.

Appendix C: Debriefing Verbiage

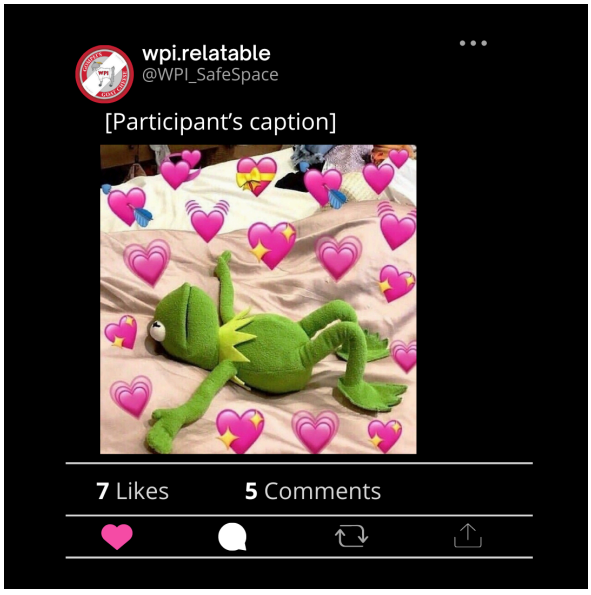
Thank you for your participation. At this point, you can learn a bit more about the study you just participated in. Sometimes in conducting research, it is necessary to withhold the true purpose of the study until after responses were collected. This study was actually about whether social media interactions can elicit a physiological stress response, and whether the valence of the interactions has an effect on the psychophysiological stress response. We aimed to confirm whether online interactions have the same physical effects social evaluative stressors do. We

hope this research will help further studies in understanding not only the effects social media has on mental health, but also physical health, especially in young users who have been exposed to social media starting at a young age. If you have any further questions about the purpose of the study or the questions you just answered, please don't hesitate to contact the investigators at rlopez1@wpi.edu or lsnunes@wpi.edu.

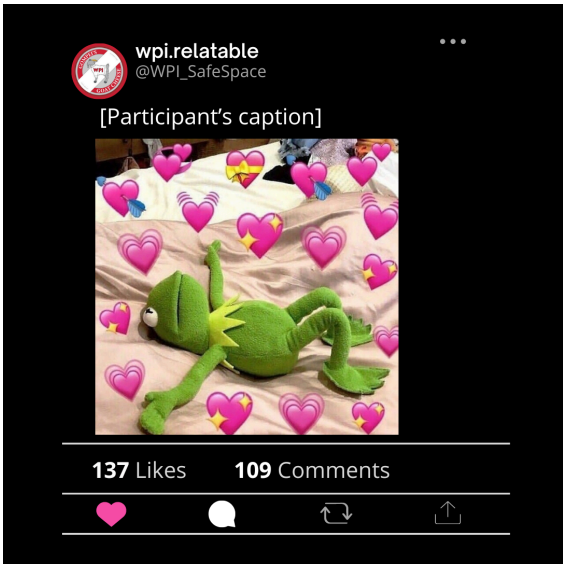
Now that you are fully informed of the purpose of the study, you may wish that we do not include your results and responses in the study data. You have already earned credit for participation in this study and will not lose that credit if you choose to remove your data from the study. Please contact the investigators if you wish to have your data removed or if you have any further questions.

Appendix D: Canva Mock Posts

1) Example of mock post with low amount of likes and comments (range: 0-20)

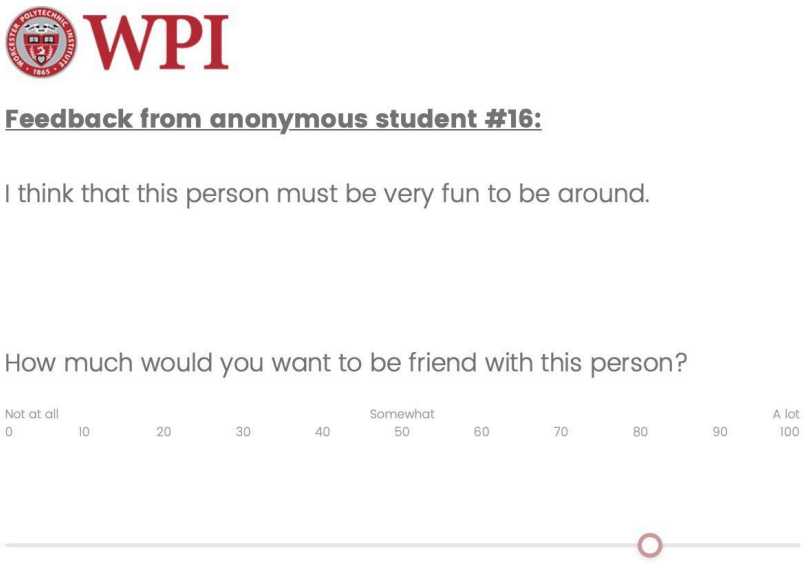


2) Example of mock post with high amount of likes and comments (range: 100-250)

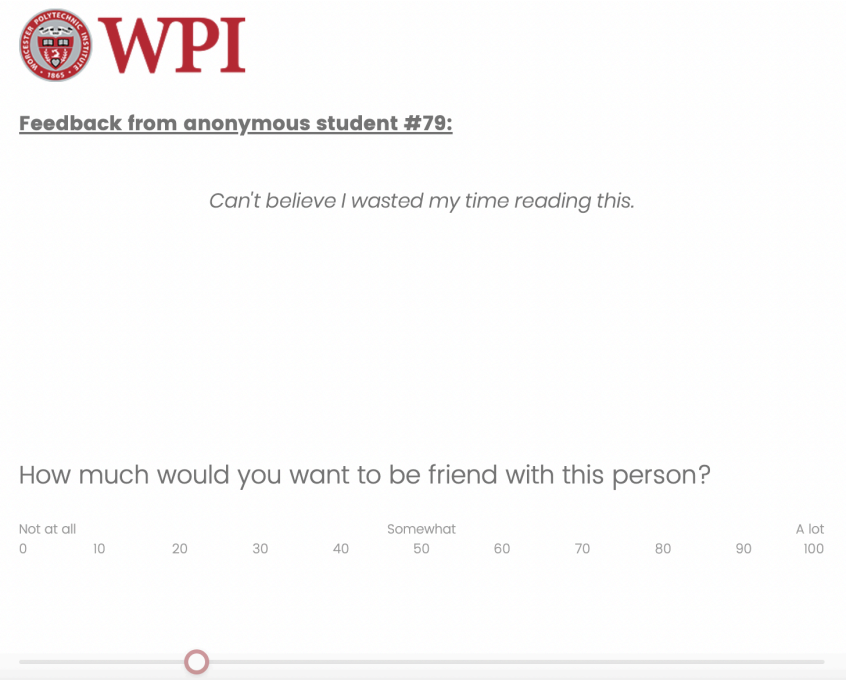


Appendix E: Online Social Feedback

1) Example of positive social feedback



2) Example of negative social feedback



Appendix F: Protocol Script

OSES Script:
Legend: ____ what you read out loud ____*running instructions*

Please read through the entire script before running your participant so you know the sequence of events and what to expect!!!!!

Before the participant arrives, make sure the Qualtrics for L2 Part 2 screen is open and ready to go. Also make sure the Rhythm wristband is fully charged and the PsychoPy task is ready to go with the participant's stimuli.

Welcome student into the SNAP Lab and have them sit at the computer workstation- guide them to the booth and allow them to settle in before you start reading the script.

Hi, my name is _____, and I am the researcher who will be working with you today. First, I just need to go over a few guidelines for your participation. During your time here today, you will first complete some online questionnaires , and then afterwards you will complete a task related to the data you provided in part 1 of the survey. In addition to this task, we will be measuring some physiological variables using this wristband. We recently bought this wristband for the lab and we wanted to include it in this study to make sure it works properly and we can use it in future research.

Show them the Rhythm 24 band

As a reminder, for this MQP study we are working with another MQP team in the Computer Science department on developing a social media platform meant for WPI students.
This platform is meant to spread positivity on campus in contrast to a large amount of hate, arguments, and doom-scrolling online. Mental health issues related to poor social media use are on the rise, especially among young adults and teenagers.
This new social media platform, which we're tentatively calling SafeSpace, is intended to create a pleasant experience for self expression, increase mental wellbeing, and support positive online interactions, following a Twitter/ Threads format.
Your captions have been posted anonymously on SafeSpace, where other WPI students have provided some feedback on your posts as well as some overall feedback.

I will guide you every step of the way, do you have any questions that I can answer right now?
Answer any questions participants may have.

Okay then! You may now begin with the surveys, if you have any questions feel free to call me over, otherwise I will give you privacy to complete the questionnaires. Please notify me when you have finished completing all questionnaires.

Wait for participant in the main table in SNAP Lab. Feel free to assign them their research credit on SONA during this time so that you don't forget later on.
Make sure wristband is fully charged and maybe even do a test trial on yourself to make sure it is reliably reading HR/HRV.

Once participant is done completing the survey, politely ask them to step away from the booth for just a moment and pull up and start the PsychoPy task. Once the initial instructions are on the screen, call the participant into the booth again.

Okay, now you will be viewing a video we prepared for you! While you focus on the short video, I will be taking an initial reading of your Heart Rate to make sure the signal from the wristband reading is good.
Instruct the participant to place the wristband on their forearm, below the elbow, and on the 'meatiest' part of their forearm. The wristband should be pretty snug, but not cutting off circulation. Once the lights turn any color other than purple or red, start an 'Open HRV reading'.
When selecting 'Open HRV reading': disable the time limitation and breathing pattern. Mark position as 'sitting' and enable the Live Preview. Press 'Take Test'. Once the Live Preview starts,

press begin reading and let it run for about 40secs-1min. Once it's done running, BEFORE you save the data, select 'View All Data'. If the signal is 'Good', save the data and restart the process. DO NOT START READING until instructed. If signal is 'Okay' or 'Poor', instruct participant to either tighten the wristband or move it around and take another test reading sample, do as many as you need until you get a 'Good' signal.
Once the video is up, stop the reading and check the signal. If the signal is good, instruct them on starting the PsychoPy task.

Now you will be starting the visual task. Please read the instructions on the screen in front of you carefully and thoroughly.
Allow participant to read the instructions.

Before you begin the visual task, we will be taking a resting heart rate reading. You should not engage with any other external factors at this moment. The reading will last for five minutes and it is intended for you to do absolutely nothing, so that we can get an accurate measure of your resting state.
Perform the 5 minute reading, once this block is done read the following:

To reiterate what you read before, now we will be showing you some screenshots from the developing platform SafeSpace, and we were able to get this feedback in 2 different ways:
1) we were able to incorporate your captions along with the corresponding images, and we took screenshots from the app and you will be viewing the engagement your posts had on the platform.
2) We also asked WPI students to provide impressions on you and ratings of how likely they would be to befriend you based on the memes you created. Every rating you will see is from a different individual at WPI.
You will then be asked to provide 2 different ratings, 1 psychological rating and 1 rating on the apparent user friendliness of the app.
Do you have any questions about this?
Please call me over when you are instructed to do so on the screen in front of you.
Otherwise, I will give you privacy to complete the task.

Once the wristband is set up for the Block reading, make sure to press for the Elite App to start reading AT THE SAME TIME you press the 'space' key for the task to begin. Instruct them to not use the arm of the wristband and to keep it as straight as possible and resting on the desk.

Leave the participant in the booth and sit at the table behind it with your phone recording HR/HRV.

Press 'Stop Reading' once you see the affect rating pop up on the participant's screen. Wait for them to call you over to restart the HR reading for the following block. Repeat this whole process 4 times.

At the end of the fourth block, thank the participant and read them the Debriefing form printed out on the main table.
Alright, you are all done. Thank you so much for participating. Before you go, I want to tell you a bit more about the study you just participated in.

Read them the Debriefing form.

Thank them for participating and wait for them to leave to start cleaning up. If the wristband needs charging, plug it in the charger! Exit out of Qualtrics and PsychoPy and make sure the mouses are all off.

You're all set!! You ran an OSES participant!! Thank you so much -Lorena

Appendix G: Additional Tables and Figures from All Models

Table 2: Simple effects of feedback valence on affect ratings with number of likes as a moderator

Simple effects of Valence : Parameter estimates

Moderator levels				95% Confidence Interval				
Likes	contrast	Estimate	SE	Lower	Upper	df	t	p
high	positive - negative	1.41	0.291	0.833	1.99	82.9	4.85	<.001
low	positive - negative	1.21	0.285	0.639	1.77	82.1	4.23	<.001

Table 3: Simple effects of feedback valence on average heart rate (HR) with number of likes as a moderator

Simple effects of Valence : Parameter estimates

Moderator levels				95% Confidence Interval				
Likes	contrast	Estimate	SE	Lower	Upper	df	t	p
high	positive - negative	-0.584	0.632	-1.843	0.676	72.1	-0.924	0.359
low	positive - negative	0.670	0.590	-0.507	1.847	72.0	1.135	0.260

Table 4: Simple effects of feedback valence on average heart rate variability (HRV) with number of likes as a moderator

Simple effects of Valence : Parameter estimates

Moderator levels				95% Confidence Interval				
Likes	contrast	Estimate	SE	Lower	Upper	df	t	p
high	positive - negative	0.403	0.633	-0.858	1.66	72.5	0.638	0.526
low	positive - negative	0.197	0.591	-0.982	1.38	72.2	0.334	0.740

Table 5: Simple effects of feedback valence on affect ratings with Need to Belong (NTB) scores as a moderator

Simple effects of Valence : Parameter estimates

Moderator levels				95% Confidence Interval				
NTB_Score	contrast	Estimate	SE	Lower	Upper	df	t	p
Mean-1-SD	positive - negative	0.704	0.277	0.154	1.25	79.2	2.55	0.013
Mean	positive - negative	1.312	0.195	0.923	1.70	79.7	6.71	<.001
Mean+1-SD	positive - negative	1.919	0.278	1.367	2.47	80.1	6.91	<.001

Note. Simple effects are estimated setting higher order moderator (if any) in covariates to zero and averaging across moderating factors levels (if any)

Table 6: Simple effects of feedback valence on affect ratings with Approval-Related Contingent Self-Worth on Instagram (IGCSW) scores as a moderator

Simple effects of Valence : Parameter estimates

Moderator levels				95% Confidence Interval				
IGCSW_Score	contrast	Estimate	SE	Lower	Upper	df	t	p
Mean-1-SD	positive - negative	0.873	0.285	0.306	1.44	79.3	3.07	0.003
Mean	positive - negative	1.312	0.201	0.911	1.71	79.7	6.52	<.001
Mean+1-SD	positive - negative	1.751	0.285	1.183	2.32	80.0	6.13	<.001

Note. Simple effects are estimated setting higher order moderator (if any) in covariates to zero and averaging across moderating factors levels (if any)

Table 7: Simple effects of feedback valence on affect ratings with Social Anxiety (SA) scores as a moderator

Simple effects of Valence : Parameter estimates

Moderator levels				95% Confidence Interval				
SA_Score	contrast	Estimate	SE	Lower	Upper	df	t	p
Mean-1-SD	positive - negative	0.743	0.279	0.187	1.30	79.5	2.66	0.009
Mean	positive - negative	1.311	0.197	0.918	1.70	79.8	6.64	<.001
Mean+1-SD	positive - negative	1.879	0.280	1.321	2.44	80.2	6.70	<.001

Note. Simple effects are estimated keeping constant other independent variable(s) in the model

Table 8: Fixed Effects of feedback condition on lnRMSSD values with GAD-7 scores as a moderator

Fixed Effect Omnibus tests

	F	Num df	Den df	p
Likes	0.16626	1	69.2	0.685
Valence	0.51563	1	69.2	0.475
GAD7_Score	9.08e-4	1	27.9	0.976
Likes ✻ Valence	0.06781	1	69.5	0.795
Likes ✻ GAD7_Score	1.71270	1	69.2	0.195
Valence ✻ GAD7_Score	4.99720	1	69.2	0.029
Likes ✻ Valence ✻ GAD7_Score	0.00852	1	69.3	0.927

Note. Satterthwaite method for degrees of freedom

Table 9: Simple effects of feedback type on lnRMSSD values with GAD-7 scores as a moderator

Simple effects of Valence : Omnibus Tests

Moderator levels				
GAD7_Score	F	Num df	Den df	p
Mean-1-SD	1.140	1.00	69.3	0.289
Mean	0.516	1.00	69.2	0.475
Mean+1-SD	4.484	1.00	69.1	0.038

Table 10: Fixed Effects of feedback condition on lnRMSSD values with PHQ-8 scores as a moderator

Fixed Effect Omnibus tests

	F	Num df	Den df	p
Valence	0.5277	1	69.2	0.470
Likes	0.1290	1	69.2	0.721
PHQ8_Score	1.0355	1	27.9	0.318
Valence ✻ Likes	0.0755	1	69.5	0.784
Likes ✻ PHQ8_Score	1.8045	1	69.2	0.184
Valence ✻ PHQ8_Score	6.0208	1	69.2	0.017
Valence ✻ Likes ✻ PHQ8_Score	6.88e-5	1	69.3	0.993

Note. Satterthwaite method for degrees of freedom

Table 11: Simple effects of feedback type on lnRMSSD values with PHQ-8 scores as a moderator

Simple effects of Valence : Omnibus Tests

Moderator levels

PHQ8_Score	F	Num df	Den df	p
Mean-1-SD	1.490	1.00	69.3	0.226
Mean	0.528	1.00	69.2	0.470
Mean+1-SD	5.174	1.00	69.1	0.026

Table 12: Fixed Effects of feedback condition on lnRMSSD values with IGCSW scores as a moderator

Fixed Effect Omnibus tests

	F	Num df	Den df	p
Likes	0.2915	1	69.1	0.591
Valence	0.3881	1	69.2	0.535
IGCSW_Score	0.0998	1	28.3	0.754
Likes ✻ Valence	0.1211	1	69.5	0.729
Valence ✻ IGCSW_Score	0.8664	1	69.4	0.355
Likes ✻ IGCSW_Score	0.7643	1	69.2	0.385
Likes ✻ Valence ✻ IGCSW_Score	6.2004	1	70.6	0.015

Note. Satterthwaite method for degrees of freedom

Table 13: Simple effects of feedback valence on affect ratings with Depression (PHQ-8) scores as a moderator

Simple effects of Valence : Parameter estimates

Moderator levels				95% Confidence Interval				
PHQ8_Score	contrast	Estimate	SE	Lower	Upper	df	t	p
Mean-1-SD	positive - negative	1.42	0.290	0.847	2.00	79.4	4.91	<.001
Mean	positive - negative	1.30	0.205	0.894	1.71	79.6	6.35	<.001
Mean+1-SD	positive - negative	1.18	0.291	0.600	1.76	79.9	4.06	<.001

Note. Simple effects are estimated setting higher order moderator (if any) in covariates to zero and averaging across moderating factors levels (if any)

Table 14: Simple effects of feedback valence on affect ratings with Generalized Anxiety Disorder (GAD-7) scores as a moderator

Simple effects of Valence : Parameter estimates

Moderator levels				95% Confidence Interval				
GAD7_Score	contrast	Estimate	SE	Lower	Upper	df	t	p
Mean-1-SD	positive - negative	1.28	0.289	0.703	1.85	79.4	4.42	<.001
Mean	positive - negative	1.30	0.204	0.893	1.71	79.6	6.36	<.001
Mean+1-SD	positive - negative	1.32	0.290	0.743	1.90	79.8	4.56	<.001

Note. Simple effects are estimated setting higher order moderator (if any) in covariates to zero and averaging across moderating factors levels (if any)

Table 15: Simple effects of feedback valence on affect ratings with Active vs. Passive scores as a moderator

Simple effects of Valence : Parameter estimates

Moderator levels				95% Confidence Interval				
Active_Passive_Score	contrast	Estimate	SE	Lower	Upper	df	t	p
Mean-1-SD	positive - negative	1.58	0.290	1.005	2.16	79.2	5.46	<.001
Mean	positive - negative	1.31	0.205	0.903	1.72	79.5	6.41	<.001
Mean+1-SD	positive - negative	1.04	0.290	0.462	1.62	79.4	3.59	<.001

Note. Simple effects are estimated keeping constant other independent variable(s) in the model

Table 16: Simple effects of feedback valence on average HR with Active vs. Passive scores as a moderator

Simple effects of Valence : Parameter estimates

Moderator levels				95% Confidence Interval				
Active_Passive_Score	contrast	Estimate	SE	Lower	Upper	df	t	p
Mean-1-SD	positive - negative	0.9797	0.606	-0.229	2.189	69.0	1.617	0.111
Mean	positive - negative	0.0942	0.421	-0.746	0.935	69.0	0.224	0.824
Mean+1-SD	positive - negative	-0.7914	0.591	-1.971	0.388	69.0	-1.339	0.185

Note. Simple effects are estimated keeping constant other independent variable(s) in the model

Table 17: Simple effects of feedback valence on average HR with Social Anxiety (SA) scores as a moderator

Simple effects of Valence : Parameter estimates

Moderator levels				95% Confidence Interval				
SA_Score	contrast	Estimate	SE	Lower	Upper	df	t	p
Mean-1-SD	positive - negative	0.2100	0.625	-1.038	1.458	69.1	0.336	0.738
Mean	positive - negative	0.0690	0.434	-0.797	0.935	69.0	0.159	0.874
Mean+1-SD	positive - negative	-0.0720	0.610	-1.289	1.145	69.0	-0.118	0.906

Note. Simple effects are estimated setting higher order moderator (if any) in covariates to zero and averaging across moderating factors levels (if any)

Table 18: Simple effects of feedback valence on average HR with Depression (PHQ-8) scores as a moderator

Simple effects of Valence : Parameter estimates

Moderator levels				95% Confidence Interval				
PHQ8_Score	contrast	Estimate	SE	Lower	Upper	df	t	p
Mean-1-SD	positive - negative	0.5067	0.601	-0.692	1.706	69.0	0.843	0.402
Mean	positive - negative	0.0877	0.419	-0.749	0.924	69.0	0.209	0.835
Mean+1-SD	positive - negative	-0.3314	0.590	-1.508	0.846	69.0	-0.562	0.576

Note. Simple effects are estimated setting higher order moderator (if any) in covariates to zero and averaging across moderating factors levels (if any)

Table 19: Simple effects of feedback valence on average HR with Generalized Anxiety Disorder (GAD-7) scores as a moderator

Simple effects of Valence : Parameter estimates

Moderator levels				95% Confidence Interval				
GAD7_Score	contrast	Estimate	SE	Lower	Upper	df	t	p
Mean-1-SD	positive - negative	0.5265	0.613	-0.697	1.750	69.0	0.858	0.394
Mean	positive - negative	0.0934	0.427	-0.759	0.945	69.0	0.219	0.828
Mean+1-SD	positive - negative	-0.3397	0.599	-1.534	0.855	69.0	-0.567	0.572

Note. Simple effects are estimated keeping constant other independent variable(s) in the model

Table 20: Simple effects of feedback valence on average HR with Need to Belong (NTB) scores as a moderator

Simple effects of Valence : Parameter estimates

Moderator levels				95% Confidence Interval				
NTB_Score	contrast	Estimate	SE	Lower	Upper	df	t	p
Mean-1-SD	positive - negative	-0.5252	0.612	-1.746	0.695	69.0	-0.858	0.394
Mean	positive - negative	0.0440	0.429	-0.813	0.901	69.0	0.102	0.919
Mean+1-SD	positive - negative	0.6132	0.607	-0.597	1.824	69.0	1.011	0.316

Note. Simple effects are estimated keeping constant other independent variable(s) in the model

Table 21: Simple effects of feedback valence on average HR with Approval-Related Contingent Self-Worth on Instagram (IGCSW) scores as a moderator

Simple effects of Valence : Parameter estimates

Moderator levels				95% Confidence Interval				
IGCSW_Score	contrast	Estimate	SE	Lower	Upper	df	t	p
Mean-1-SD	positive - negative	-0.2393	0.614	-1.464	0.986	69.0	-0.390	0.698
Mean	positive - negative	0.0835	0.430	-0.774	0.941	69.0	0.194	0.847
Mean+1-SD	positive - negative	0.4062	0.621	-0.832	1.644	69.1	0.655	0.515

Note. Simple effects are estimated setting higher order moderator (if any) in covariates to zero and averaging across moderating factors levels (if any)

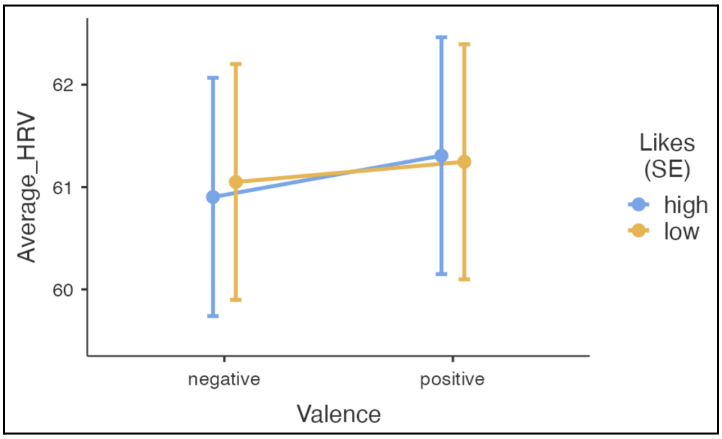


Figure 13: Plot of effects of feedback valence on average heart rate variability with number of likes as a moderator

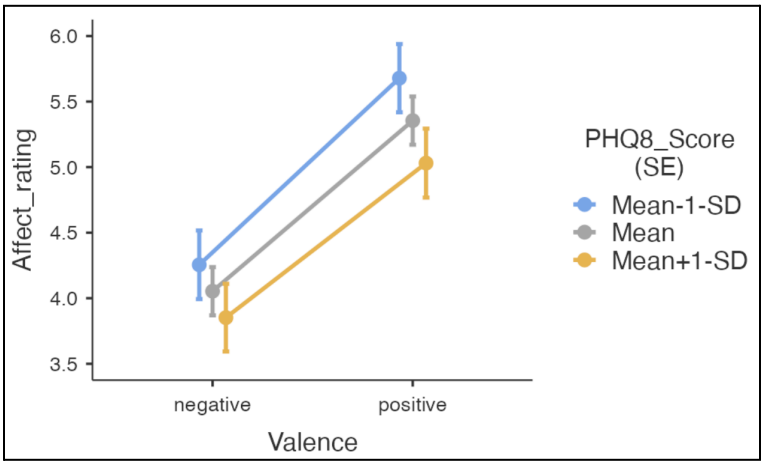


Figure 14: Plot of effects of feedback valence on affect ratings with Depression (PHQ-8) scores as a moderator

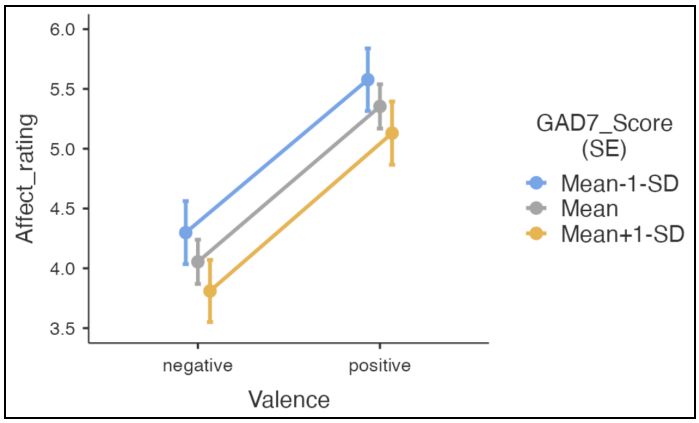


Figure 15: Plot of effects of feedback valence on affect ratings with Generalized Anxiety Disorder (GAD-7) scores as a moderator

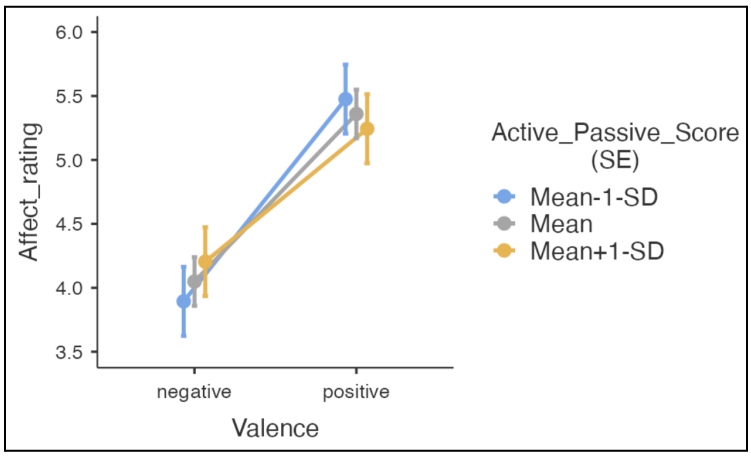


Figure 16: Plot of effects of feedback valence on affect ratings with Active vs. Passive scores as a moderator

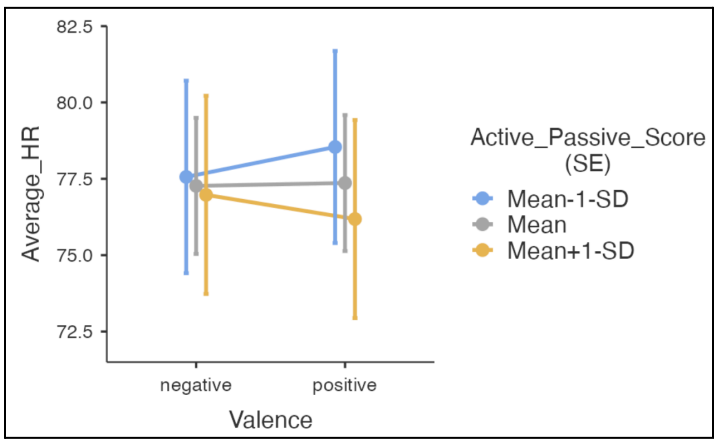


Figure 17: Plot of effects of feedback valence on average HR with Active vs. Passive scores as a moderator

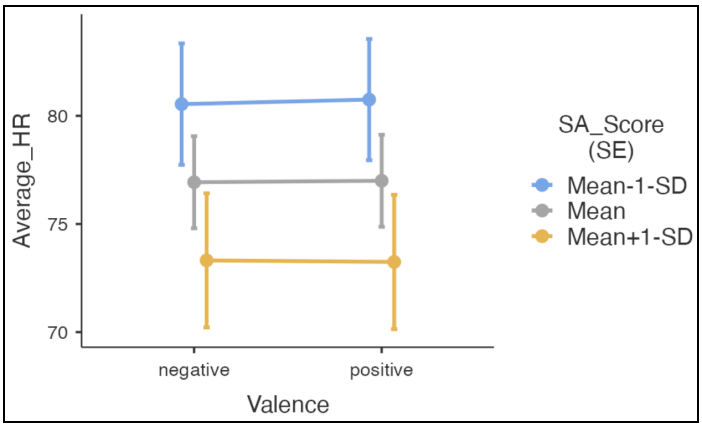


Figure 18: Plot of effects of feedback valence on average HR with Social Anxiety (SA) scores as a moderator

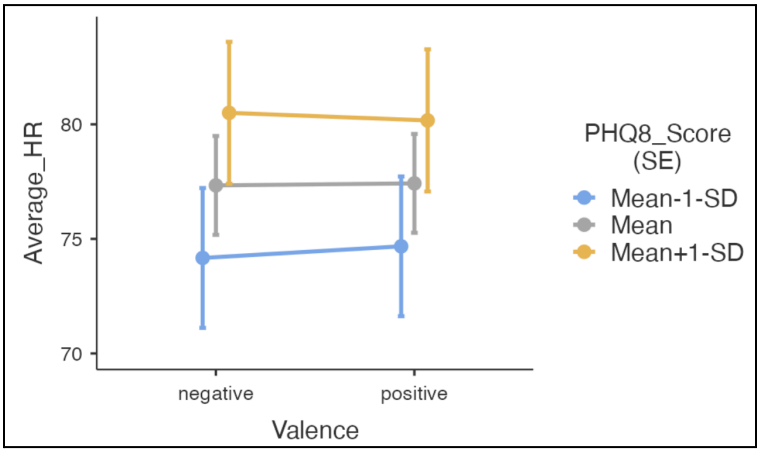


Figure 19: Plot of effects of feedback valence on average HR with Depression (PHQ-8) scores as a moderator

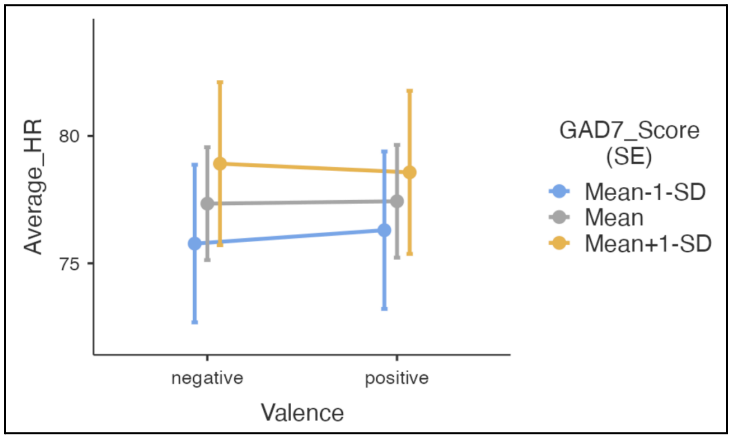


Figure 20: Plot of effects of feedback valence on average HR with Generalized Anxiety Disorder (GAD-7) scores as a moderator

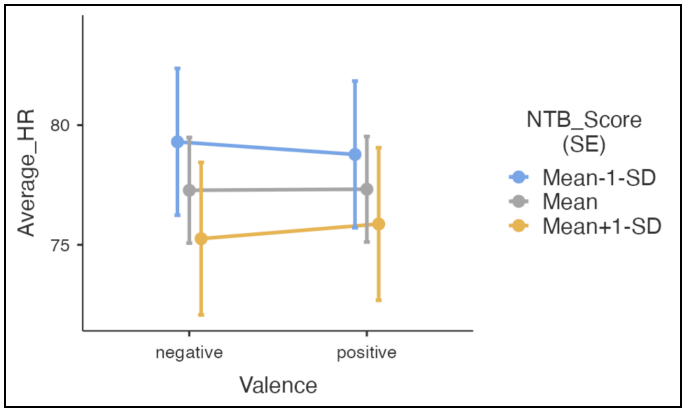


Figure 21: Plot of effects of feedback valence on average HR with Need to Belong (NTB) scores as a moderator

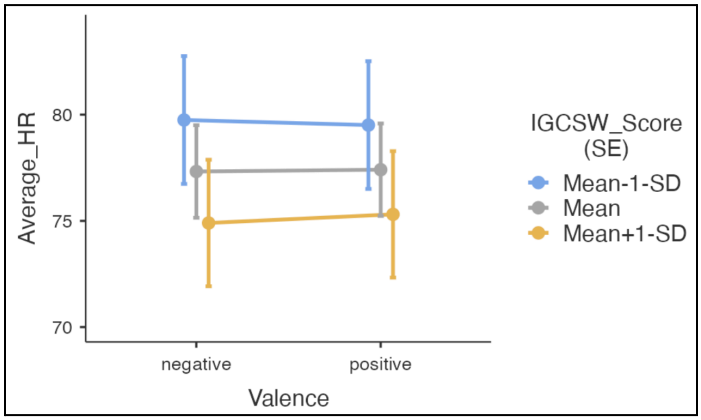


Figure 22: Plot of effects of feedback valence on average HR with Approval-Related Contingent Self-Worth on Instagram (IGCSW) scores as a moderator