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Socializing and Emotional Arousal: An Analysis Using Biological Signals and Self-Reported Surveys

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Socializing and Emotional Arousal:
An Analysis Using Biological Signals and Self-Reported Surveys

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Abstract

Socializing and Emotional Arousal: An Analysis Using Biological Signals and Self-Reported Surveys

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Emotions, and emotional responses, are fundamental to human growth and development. Considering how feeling both positively and negatively can lead to increased risk-taking behavior, it is important to consider the effects of friendship on emotional arousal. This study uses a novel technique of continuously measured electrodermal activity (EDA) signals, a sympathetic nervous system measure of emotional arousal, in conjunction with self-reported survey data to examine how social friendships impact emotional arousal. Furthermore, the study examines how socializing impacts positive and negative affect in self-reported social situations. Results show that socializing, in particular with groups of friends, results in more positive affect and is associated with increased emotional arousal, when compared to not socializing. The association is particularly salient when respondents also report feeling positive. This work makes a contribution to the emerging literature on how biosignal collection can be a way to distinctly measure the effects of social experiences on physical health.

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INTRODUCTION

Emotions are fundamental to human growth and development. Interaction ritual chain theory describes how interactions within interpersonal relationships are cumulative, building on previous moments infused with emotions and past experiences (Collins 2004). Starting in childhood and extending through the life course, feeling both positively and negatively can lead to increased risk-taking behavior — in particular, socializing in adolescence, spurred on by peer pressure and how young people seek pleasure in their interactions, often leads to increased risk-taking behavior (Steinberg 2010). Such risk-taking behavior generally peaks in adolescence, and adolescents are often attracted to friends with similar levels of sensation seeking (Arnett 1992). Although social ties can influence healthy and unhealthy habits and are highly important through the life course as individuals transition between life stages (Umberson, Crosnoe, and Reczek 2010; Thoits 2011), friendships can lead to negative experiences too, and even the most-connected people can still claim feelings of loneliness and social isolation.

Even so, the process of social interaction can buffer against negative emotions and is associated with social resources like social support, in additional to personal resources such as life satisfaction and self-esteem (Livingstone and Srivastava 2012). Accordingly, it is important to study various types of social relationships to learn more about how friendships influence different levels of positive and negative emotional arousal. However, few studies have objectively measured emotional arousal to examine the effects of various types of socializing on health. While researchers of emotion have investigated subjective self-reports and physiological changes (particularly in the field of psychology), such studies rarely employ more than one type of indicator to measure multiple dimensions of emotional arousal, despite the demonstrated need to choose measures carefully (Thoits 1989). Observation and self-reported information can commonly be biased by personal inclinations and social desirability bias, and physiological indicators in particular are highly complex and are not studied in-depth within the social sciences (Thoits 1989).

To address these issues, using data from the StudentHD pilot project (a study conducted on a large predominantly white Midwestern research university campus during the fall of 2016 and the spring of 2017), this study will examine how social friendships impact emotional arousal. using a novel technique of continuously measured electrodermal activity (EDA) signals, a sympathetic nervous system measure of emotional arousal, in conjunction with self-reported survey data of positive and negative affect. Additionally, I examine how socializing impacts positive and negative affect in self-reported social situations. This work will contribute to the literature on interpersonal relationships and emotionality, particularly highlighting the novel use of sensor data in order to analyze how various types of socializing impact emotional arousal, in addition to examining how this socialization impacts positive and negative emotionality. The unique nature of this kind of data collection allows us to assess real-time dynamics using biosignal data, demonstrating for the first time how various types of socializing prompt different measurable biological responses in addition to how these types of socializing correlate with positive and negative affect. Ideally, this research will inform future studies that use advanced technologies to collect biological data to examine the effects of social experiences in sociological research, underscoring how dynamic biological measures of emotional arousal can be used in conjunction with information about social contact.

BACKGROUND

Dual Systems Model

According to social exchange theory, the satisfaction derived from interpersonal interactions is a function of the degree to which the reward costs meet or exceed the comparison level, or the standard that reflects what an individual feels they "deserve" based on prior wants and anticipated desires (Thibaut and Kelley 1959; La Gaipa 1972). Correspondingly, as children get older, they begin to understand emotions as a component of the attributions they have assigned to emotion-evoking situations (Weiner et al. 1982; Hubbard and Coie 1994). Adolescence, the period between childhood and adulthood, is a convoluted part of development that corresponds with social, physical, and psychological growth (Ernst, Pine, and Hardin 2006). As adolescents mature, this growth is often accompanied by suboptimal decision-making that can result in increased incidence of injuries, substance abuse, unintended pregnancy, and sexually transmitted diseases (Casey, Jones, and Hare 2008). Furthermore, adolescence functions as a time of increased emotional reactivity — adolescents' social environments gradually change so that more time is spent with friends of a similar age instead of adults, and this period is often characterized by increased conflict between the adolescent and their parents (Casey, Jones, and Hare 2008). As adolescents age and begin to operate independently of parental influences, they often begin to prioritize forming close friendships while achieving social acceptance and regard, regardless of the potential personal cost (Steinberg and Silk 2002; Klimes-Dougan et al. 2014).

As defined by developmental psychologists, risk-taking behavior in adolescence results from the interaction of changes in two distinct neurobiological systems: the “socioemotional” system, and a “cognitive control” system (Steinberg 2008). According to this dual systems model, adolescent risk-taking results from stimulates rapid increases in dopamine (a neurotransmitter foundational to motivating reward-driven behavior) around puberty, which leads to increases in reward-seeking, risk-taking behavior — the heightened reactivity of the socioemotional system is then discordant with the still-maturing cognitive control system (Steinberg 2010; Strang, Chein, and Steinberg 2013). For example, studies have shown that when in peer groups, participants take more risks, focus more on the benefits rather than the costs of risky behavior, and make riskier decisions than if they were alone. Furthermore, the presence of friends increases risk-taking in adolescents and youths, but not as significantly in adults (Gardner and Steinberg 2005; Chein et al. 2011). As people mature from adolescence into adulthood, their socioemotional systems become less reactive while their cognitive control system strengthens and functions more efficiently — accordingly, these changes that result in an increase in risk-taking during adolescence are followed by a decrease in risk-taking as individuals age (Strang, Chein, and Steinberg 2013). Adolescents who lacked adequate support from peers sometimes experienced difficulty in communicating their emotions, then internalizing negative thoughts in the process of their emotional development over time (Klimes-Dougan et al. 2014).

Accordingly, college students are a valuable sample to analyze, given how they are situated right on the border of adolescence and early adulthood, and are experiencing life outside of the context of direct parental supervision for perhaps the first time. The combination of less vigilant supervision by parents or guardians with the increased availability of sex partners and potential for risk-taking behaviors creates an interesting setting for studying college freshmen as they enter a new environment (Steinberg et al. 2008). Studying students early in their college careers allows us to explore how their new social experiences impact their emotional states.

SOCIOLOGY OF EMOTIONS

Early theorists discussing the sociology of emotions commented on how emotions were phenomena that are difficult to operationalize, with the sampling and analysis of micro-interactions being impractical (Thoits 1989). While theoretical efforts at the micro level discussed how emotional socialization processes are key to development, Thoits and others stressed the need for more descriptive and systematic hypothesis testing, given the reluctance of sociologists and other researchers of emotion to confront measurement issues head-on (Kemper 1980; Collins 1981; Heise 1987; Thoits 1989; Costin and Jones 1992; Underwood 1997; Collins 2004; Fehr and Harasymchuk 2005). However, as technologies evolve, it has become possible (and less cumbersome, through the development of wearable sensors) to collect physiological data to validate lab-based research (Garbarino et al. 2014).

Few researchers have examined emotional responses and the socializing influences of child and adolescent peers. The research that does exist often relies on measures like self-reported data in longitudinal studies (Klimes-Dougan et al. 2014), survey responses (Fehr and Harasymchuk 2005; Livingstone and Srivastava 2012; Chow and Ruhl 2014), and interview responses to visual or hypothetical vignettes in order to assess how children and adolescents anticipate emotional behavior (Foot, Chapman, and Smith 1977; Shipman et al. 2003; Burgess et al. 2006). Retrospective responses can be limited by unreliable autobiographical memory, and data gleaned in a laboratory setting can be impacted by concerns regarding ecological validity (Runyan et al. 2013; Schwarz 2007). Consequently, the development of convenient wearable sensors that can continuously measure dynamic processes in real-time addresses these concerns by providing a way to measure biological processes like emotional arousal in a reliable and valid manner.

SOCIAL RELATIONSHIPS AND EMOTIONS

Individuals differ to the extent that their relationships with others develop differently across time (Collins 2004). In childhood, interactions in relationships are central to development, given how these interactions are the contexts within which basic skills and tools emerge and help a child learn the necessary cognitive and emotional resources to adapt and function in the social world (Costin and Jones 1992). Experiences during childhood, adolescence and early adulthood set the stage for subsequent adaptation through adulthood (Zeman, Cassano, and Adrian 2013). With age, friendships become more valuable to adolescents, satisfying both a need for belonging in addition to serving as a fundamental "glue" for society (Lashbrook 2000). Social epidemiology research has suggested the absence of positive social relationships is a significant risk factor for broad-based morbidity and mortality (Cacioppo and Cacioppo 2014). Humans have long survived by banding together in families, couples, tribes, and groups — from these social ties, people can derive mutual protection and assistance in addition to social trust, cohesiveness, and collective action (Cacioppo and Cacioppo 2014).

Just as physical pain serves as a signal from the body that draws attention to threats or damage to one's physical body, feelings of loneliness and isolation serve as a signal that motivates responses to threats or damage to one's social body (Cacioppo et al. 2013). However, even though researchers have found less socially integrated people have increased morbidity and earlier mortality, the quality of relationships can matter more than the quantity of social ties — people with smaller social networks might not feel lonely, while well-connected individuals may still experience loneliness (House, Landis and Umberson 1988; de Jong Gierveld et al. 2006; Cloutier-Fisher et al. 2011).

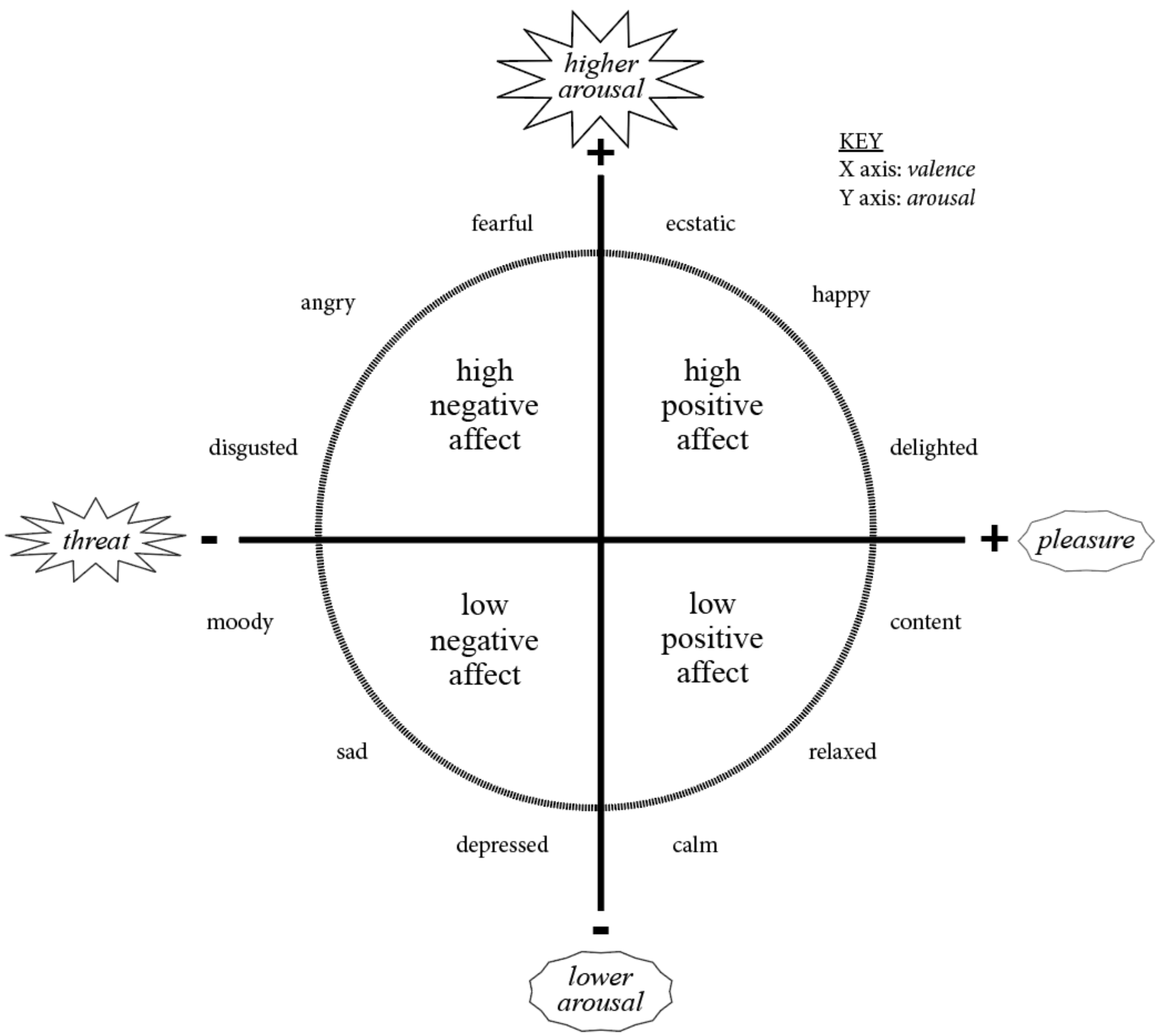
Intense emotions, whether positive or negative, are most commonly experienced within close interpersonal relationships (Fehr and Harasymchuk 2005). Studies of children find that for both withdrawn and aggressive children, friends' involvement during interpersonal challenges helped to alleviate emotions and coping responses (Burgess et al. 2006). One study tested sharing emotional experiences with a friend, with pairs of friends viewing emotional (positive and negative) and neutral pictures either alone or with their friend, who was performing the task in a different room (Wagner et al. 2014). The researchers found that ratings of subjective feelings improved significantly when participants viewed emotional pictures together rather than by themselves, an effect that was corroborated by increased brain activity — this implies that sharing social experiences contributes to the regulation of individual emotions, and such regulation happens due to the existence of a friendship, rather than the physical proximity of another person (Wagner et al. 2014).

To properly examine friendship in the context of emotional arousal, it is therefore important to focus not only on the quantity of social relationships, but also on the composition and relational quality of these social ties (House, Umberson, and Landis 1988). Incorporating daily diary survey data into this study's methodology allows us to assess how various types of socialization can impact emotional arousal and the nature of that arousal, such as whether it is positive or negative.

The Circumplex Model of Emotion

The circumplex model of affect characterizes emotional states along two different axes: one related to valence along a displeasure–pleasure spectrum, and the other to arousal, or the level of alertness (Russell 1980; Anders et al. 2004; Posner, Russell, and Peterson 2005). Accordingly, affective states can be categorized as related to each other in a structural fashion that can be conceptualized as a circle in a two-dimensional bipolar space, with valence on one axis and arousal on the other. Key to this model is the recognition that individuals do not experience emotions as discrete entities — instead, emotions are more often recognized as ambiguous and overlapping, and lacking distinct borders. The two-dimensional circumplex model allows for the representation of emotions as a combination of varying amounts of both valence and arousal (Posner, Russell, and Peterson 2005). Emotions are fundamental to our understanding of society, given how solidarity, conflict, and the stratification of sociological systems is based in emotional reaction (Collins 2004).

Figure 1: Circumplex Model of Emotion.



One way of measuring emotional arousal is through electrodermal activity (EDA) signals. EDA is part of the sympathetic nervous system, which functions to regulate the body's unconscious actions as part of the autonomic nervous system (Critchley and Nagai 2013). The sympathetic nervous system is commonly associated with the body's fight-flight-or-freeze response. Neurons within the sympathetic nervous system control our sweat glands, which are relevant in this study given how small changes in sweating correspond to emotional arousal. Specifically, EDA signals reflect the activity of the sweat glands as skin reacts and becomes a better conductor of electricity due to an emotional, psychological, or cognitive prompt (Critchley and Nagai 2013). EDA responses are useful since they are easy to measure and correspondingly difficult to suppress. However, EDA needs to be interpreted carefully due to how it is sensitive to a wide variety of stimuli.

While researchers have studied arousal and valence independently, little empirical work has been done to assess the two together. EDA signals do not illuminate positive or negative affect within arousal, and reliance on self-reported valence information without corroboration is insufficient for sound research. Accordingly, this work links two different types of data, biosignals and survey data, in order to study both axes of the circumplex model of emotion. Self-reported survey data allows for the examination of different types of socializing with level of emotional arousal. The goal of this project is to determine if different types of socializing are associated with increased chances of positive or negative experiences, as well as increased emotional arousal.

Accordingly, I next test the following hypotheses:

1) Socializing, in particular socializing with groups of friends, will result in *more positive* affect compared to not socializing.

2) Socializing, in particular socializing with groups of friends, will result in *less negative* affect compared to not socializing.
3) Socializing will be associated with more significant emotional arousal, compared to not socializing.

DATA AND METHODS

Data collection for the StudentHD pilot project occurred on a large, predominantly white Midwestern university campus during the fall of 2016 and the spring of 2017. Given that a focus of StudentHD was to prospectively analyze the effects of discrimination and related stress exposure on outcomes for racial-/ethnic-minority students, participants were recruited for the study through list-serv emails sent to campus groups focused on students of color, in addition to the distribution of flyers around campus (Jochman et al. 2019). Following an intake interview, fall 2016 participants were enrolled for a two-week period while spring 2017 participants were enrolled for one week.

Participation in the project involved the completion of daily diaries, distributed through text messages each morning and evening in order to assess daily experiences, activities, and sleep, as well as the collection of biosignal data through Empatica E4 wristbands. Each day involved a short morning survey, which asked about sleep quantity and quality, and a more detailed evening diary where participants were asked to document their experiences and activities throughout the day. This process was dynamically guided by survey design, which asked participants about routine activities such as class attendance, mealtimes, time studying and time at work, exercise, and naps. Beyond these activities, participants detailed their social experiences, including racial experiences (like discrimination), socializing, and of particular relevance, emotional affect.

For biosignal data collection, the E4 devices were placed on the students' non-dominant ventral wrist, and the data were uploaded each day to the cloud through a provided laptop. Fall participants also wore a second wristband on the dominant ventral wrist, and had the potential to receive up to $270 in compensation upon completing all study procedures (two lab visits for the intake and exit interviews, all daily diaries, and for wearing the wristbands throughout the day) over the two-week period. Spring participants could receive up to $144 for completing all study procedures for one week (while wearing one wristband instead of two). All study procedures were approved by the university's institutional review board.

Given the level of detail that participants provided in the evening surveys, each day's activity could be divided into 15-minute intervals, or "moments," spanning from when the student woke up to when the evening survey was completed. The time interval of fifteen minutes was chosen to reflect the precise and fluctuating quality of electrodermal activity — since emotional arousal states can be brief or extended over a period of time, it is important to segment the data into moments that can reflect this variation. The segmentation of waking day time into 15-minute segments allowed investigators to link survey responses to biosignal data in order to provide a comprehensive log of activity for analysis.

DEPENDENT VARIABLES & SAMPLE SELECTION

This study uses data from the Empatica E4's electrodermal activity (EDA) sensor, which indexes sympathetic nervous system (SNS) arousal from small changes in sweating in a relatively linear fashion (Garbarino et al. 2014; Picard, Fedor, and Ayzenberg 2016; Poh, Swenson, and Picard 2010). The raw signals from the sensors were processed in 5-minute periods using a reverse inference dynamic causal model to estimate sudomotor neuron activity (SNA) from non-specific skin conductance fluctuations. These 5-minute periods are then grouped into the 15-minute "moments" to correlate with the survey data, forming moments of the average, minimum, maximum, and max-min difference in EDA-SNA rates. In total, the EDA measures that provide the focus for this paper's analysis were joined with the participants' moments to provide 120,864 moments from 151 participants. The number of observations was limited to "waking hours" of 7am to 12am, reducing the sample to 84,844 moments. Five participants had too much missing data from both the daily diary covariates and the E4 devices, resulting in an eligible sample of 146 participants who together provided 56,915 moments. Of this eligible sample, ten participants were further dropped — six after being identified as EDA non-responders, or participants with extremely low EDA activity (and resultingly minimal variability), and four for having too few observations remaining after the removal of empty t-1 EDA lags throughout their time series — as summarized in Tables 1, 2, and 3, this resulted in a final analytic sample of 136 participants who jointly contributed 40,981 moments.

Table 1: Sample selection summary.

Step	N	t
Base N, t	151	120,864
Keep: 7am-12am	151	84,844
Drop: missing	146	56,915
Drop: low EDA responders	140	54,548
Drop: empty t-1 lags	136	40,981

Table 2: Descriptive statistics for the sample.

	Freq.	**%/Mean**	**SD**	**Min**	**Max**
Black	76	55.88			
Continental African	19	13.97			
White	9	6.62			
Hispanic/Latinx	24	17.65			
Asian	8	5.88			
Female		61.76		0	1
Age		20.38	1.921	18	31
Year in School		2.022	1.183	1	4
Fall Study Participant		0.213		0	1
Days in Study		8.382	2.836	2	16

Table 3: EDA summary statistics.

	Mean	SD	Min	Max	% of Sample
EDA Average					
Close friend	22.87	39.84	0	146.67	6.28
Group of friends	32.55	46.42	0	149.00	6.64
Romantic partner	28.14	42.39	0	146.33	2.69
Full sample	23.76	39.91	0	149.00	
EDA Minimum					
Close friend	13.13	32.77	0	146.00	6.28
Group of friends	20.42	40.77	0	148.00	6.64
Romantic partner	15.94	35.81	0	144.00	2.69
Full sample	13.14	32.98	0	149.00	
EDA Maximum					
Close friend	33.98	52.05	0	150.00	6.28
Group of friends	46.24	57.47	0	150.00	6.64
Romantic partner	41.92	54.91	0	150.00	2.69
Full sample	36.13	52.71	0	150.00	
EDA Difference					
Close friend	20.85	35.78	0	150.00	6.28
Group of friends	25.82	37.89	0	150.00	6.64
Romantic partner	25.98	38.52	0	150.00	2.69
Full sample	22.99	37.66	0	150.00	

Another section of the evening daily diary asked participants to report when they felt *negative* and *positive* throughout the day. For the negative affect section, participants were asked, “[t]hink about how negative, anxious, bad, or stressed you felt throughout the day. Were there instances during the following 3-hour periods when you felt **very negative, anxious, bad, or stressed?** ” In the positive affect section, participants were asked a similar question: “[t]hink about how positive, excited, or good you felt throughout the day. Were there instances during the following 3-hour periods when you felt **very positive, excited, or good?**" If participants responded affirmatively to either statement for a 3-hour time period, they were directed to conditional questions to further detail their positive and negative experiences in 15-minute increments within each of the selected timeframes. Tables 4 and 5 summarize the number of moments that were associated with positive and negative affect, respectively.

Table 4: Positive affect summary for moments.

	Count	**% of Sample**
No positive affect, no socializing	30716	74.95
No positive affect, CF	1316	3.21
No positive affect, GF	1219	2.97
No positive affect, GF + CF	251	0.61
No positive affect, RP	674	1.64
No positive affect, RP + CF	47	0.11
No positive affect, RP + GF	29	0.07
No positive affect, RP + CF + GF	5	0.01
Positive affect, no socializing	4536	11.07
Positive affect, CF	697	1.70
Positive affect, GF	936	2.28
Positive affect, GF + CF	207	0.51
Positive affect, RP	260	0.63
Positive affect, RP + CF	14	0.03
Positive affect, RP + GF	36	0.09
Positive affect, RP + CF + GF	38	0.09

Socializing with CF = close friend; GF = group of friends; RP = romantic partner

Table 5: Negative affect summary for moments.

	Count	% of Sample
No negative affect, no socializing	33290	81.23
No negative affect, CF	1859	4.54
No negative affect, GF	2041	4.98
No negative affect, GF + CF	439	1.07
No negative affect, RP	861	2.10
No negative affect, RP + CF	52	0.13
No negative affect, RP + GF	60	0.15
No negative affect, RP + GF + CF	43	0.10
Negative affect, no socializing	1962	4.79
Negative affect, CF	154	0.38
Negative affect, GF	114	0.28
Negative affect, GF + CF	19	0.05
Negative affect, RP	73	0.18
Negative affect, RP + CF	9	0.02
Negative affect, RP + GF	5	0.01

Socializing with CF = close friend; GF = group of friends; RP = romantic partner

Of the 40,981 moments visualized in Tables 4 and 5, 6,724 (16.41%) were positive, while 2,336 (5.7%) were negative. It was more common for respondents to experience self-reported positive and negative emotional affect by themselves, rather than with other people. Given that respondents were asked to indicate positive and negative affect in separate sections, it was possible for the same moment to be categorized as both positive and negative — however, as summarized in Table 6, this only applied to 141 moments (0.34%) in the total sample. Thus, of the 40,981 moments in the analytic sample, 2,195 (5.36%) moments were indicated to have solely negative affect, compared to 6,583 (16.06%) with positive affect.

Table 6: Overall affect summary for moments.

	Count	% of Sample
No positive or negative affect, no socializing	28849	70.40
No positive or negative affect, CF	1179	2.88
No positive or negative affect, GF	1116	2.72
No positive or negative affect, GF + CF	234	0.57
No positive or negative affect, RP	617	1.51
No positive or negative affect, RP + CF	38	0.09
No positive or negative affect, RP + GF	24	0.06
No positive or negative affect, RP + GF + CF	5	0.01
Negative affect, no socializing	1867	4.56
Negative affect, CF	137	0.33
Negative affect, GF	103	0.25
Negative affect, GF + CF	17	0.04
Negative affect, RP	57	0.14
Negative affect, RP + CF	9	0.02
Negative affect, RP + GF	5	0.01
Positive affect, no socializing	4441	10.84
Positive affect, CF	680	1.66
Positive affect, GF	925	2.26
Positive affect, GF + CF	205	0.50
Positive affect, RP	244	0.60
Positive affect, RP + CF	14	0.03
Positive affect, RP + GF	36	0.09
Positive affect, RP + GF + CF	38	0.09
Both positive and negative affect, no socializing	95	0.23
Both positive and negative affect, CF	17	0.04
Both positive and negative affect, GF	11	0.03
Both positive and negative affect, GF + CF	2	0.00
Both positive and negative affect, RP	16	0.04

Socializing with CF = close friend; GF = group of friends; RP = romantic partner

Key Predictors

For the main independent variables of interest, being with a *romantic partner, close friend,* or a *group of friends*, each evening survey asked: "Over the course of the day, did you spend time with any of the following people: romantic partner, close friend, group of friends?" If a respondent indicated that they did, they were further prompted to select which 3-hour blocks they were with the relevant people, then asked to indicate the range of socializing time in 15-minute increments within the 3-hour blocks. Multiple selection was possible, meaning that respondents could be with different types of friends simultaneously at different times of the day.

Control Variables

Several within-day measures were included in the study to assist in characterizing common student experiences, activities, and emotions throughout the day. In this study, these variables helped to mediate for cases where respondents' reactivity might be elevated elsewhere, or conditional on their state prior to being with other people. As seen in Table 7, these indicators were included within the study to reflect when study participants had *breakfast*, *lunch*, and *dinner*, were *in class*, *studying* or *at work*, or were *exercising* or *napping.* Time fixed effects were included to capture variability by *time of day* by *day of week.* Additionally, a *lagged* variable was included for each type of EDA measure to help control for the deflection from where people were when they were previously not with their friends. These lagged measures control for EDA in the prior moment.

Table 7: Means for moments.

	Close friend	Group of friends	Romantic partner	Full Sample
Breakfast	0.020	0.018	0.017	0.017
Lunch	0.062	0.064	0.029	0.032
Dinner	0.065	0.094	0.074	0.034
Nap	0.018	0.004	0.050	0.035
In class	0.061	0.078	0.011	0.100
Studying	0.106	0.083	0.058	0.092
At work	0.023	0.042	0.014	0.050
Exercising	0.026	0.034	0.025	0.013

RESULTS

Models were assessed in a variety of ways in order to ensure robustness and address inferential consistency across modeling assumptions.

POSITIVE AND NEGATIVE AFFECT

To test the relationship between positive and negative affect and types of socializing, I ran random intercept logistic regression models that were clustered on participants and include fixed effects for time of day and day of week. Since these are random intercept models, some additional variables relating to the participant are added to the model in addition to the controls in Table 6: the respondent's *age (centered),* and whether the respondent is *Black (non-US)*, *Continental African*, *Hispanic*, and/or *female*. The models included time and person fixed effects. The results are summarized in Table 8.

Table 8: Models for positive and negative affect.

	Positive Affect Odds Ratio (Std. Error)	Negative Affect Odds Ratio (Std. Error)
Romantic Partner	2.626***	1.740***
	(0.320)	(0.348)
Close Friend	4.584***	1.435**
	(0.327)	(0.210)
Group of Friends	5.467***	1.695***
	(0.384)	(0.255)
Lag	91.508***	246.182***
	(4.847)	(21.819)
Breakfast	1.669***	1.436
	(0.267)	(0.385)
Lunch	1.462***	0.637**
	(0.159)	(0.146)
Dinner	1.519***	0.807

Table 8, cont.

	(0.157)	(0.178)
Black (Non-US)	1.146	0.316**
	(0.231)	(0.115)
Continental African	1.188	0.825
	(0.304)	(0.352)
Hispanic	1.105	1.730
	(0.249)	(0.610)
Female	1.334*	1.469
	(0.226)	(0.420)
Age (centered)	0.978	1.174**
	(0.043)	(0.082)
Nap	0.721***	0.636*
	(0.095)	(0.151)
In Class	0.755***	1.247*
	(0.067)	(0.159)
Studying	1.155**	1.485***
	(0.092)	(0.178)
At Work	1.163	0.967
	(0.119)	(0.159)
Exercising	2.456***	0.948
	(0.369)	(0.298)
Day	1.006	0.985
	(0.008)	(0.013)

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

The odds of experiencing positive affect when with romantic partners is 2.63 (p<0.001) times as much that of being without them, compared to 4.58 (p<0.001) times that when with a close friend and 5.47 (p<0.001) times when that when with a group of friends. Comparatively, the odds of experiencing negative affect when with romantic partners is 1.74 (p=0.006) times as much that of being without them, compared to 1.43 (p=0.014) times that when with a close friend and 1.69 (p<0.001) times when with a group of friends. All are significant at either the 1 percent or 5 percent level. Accordingly, the odds of experiencing positive affect when socializing with groups of friends is more than twice that of socializing with romantic partners, even though the odds of experiencing positive affect around romantic partners is already elevated. These findings reinforce the idea that socializing is associated with more positive affect.

EDA

The goal of analyzing EDA outcomes is to examine how different types of social interaction impact emotional arousal. The final linear regression models estimate standardized EDA using a fixed-effects estimator with heteroscedasticity-consistent robust standard errors, while incorporating the aforementioned control variables in addition to a lagged variable to capture the effect of prior 15-minute momentary arousal. For each type of EDA outcome (average, maximum, minimum, and max-min difference), four different models were used: Model 1 used standardized EDA values; Model 2 used EDA values that have been Winsorized at the 99th percentile so that the smallest and largest data points were approximately three standard deviations below and above the mean to limit the effects of outliers; Model 3 used unstandardized EDA measures that were first transformed with a hyperbolic sine transformation, being roughly equivalent to a log transformation before Winsorizing and standardizing; and Model 4 used a zero-inflated binomial regression model to estimate EDA as a rate conditional on the covariates and the probability that EDA is 0, given the high percentage of zero values.

Results were similar across all four model types. Table 9 summarizes the results for the average, maximum, minimum, and max-min difference 5-minute EDA-SNA rate over the 15-minute moment using standardized EDA values. Full models across specifications are available in the Appendix.

Table 9: Average, maximum, minimum, and max-min difference in EDA-SNA rates.

	Average (z)	Maximum (z)	Minimum (z)	Max-Min Difference (z)
	(1)	(2)	(3)	(4)
Romantic Partner	0.0003	-0.029	0.018	0.012
	(0.035)	(0.034)	(1.163)	(1.224)
Close Friend	-0.061***	-0.039*	-0.057**	0.009
	(0.022)	(0.022)	(0.669)	(0.757)
Groups of Friends	0.153***	0.154***	0.154***	0.067***
	(0.023)	(0.022)	(0.734)	(0.778)
Lag Y	0.014***	0.009***	0.013***	0.007***
	(0.0001)	(0.0001)	(0.007)	(0.006)
Breakfast	-0.034	-0.035	-0.022	-0.047
	(0.033)	(0.034)	(1.099)	(1.347)
Lunch	0.003	0.002	0.010	-0.0004
	(0.025)	(0.025)	(0.780)	(0.990)
Dinner	-0.067***	-0.053**	-0.030	-0.024
	(0.025)	(0.025)	(0.812)	(0.971)
Nap	-0.098***	-0.105***	-0.099***	-0.072***
	(0.021)	(0.023)	(0.610)	(0.963)
In Class	-0.076***	-0.063***	-0.057***	-0.033*
	(0.014)	(0.016)	(0.436)	(0.636)
Studying	-0.124***	-0.134***	-0.102***	-0.120***
	(0.013)	(0.014)	(0.395)	(0.580)
At Work	0.073***	0.093***	0.093***	0.104***
	(0.020)	(0.021)	(0.692)	(0.856)
Exercising	0.765***	0.660***	0.873***	0.073
	(0.051)	(0.043)	(2.052)	(1.693)
Day	0.0002	-0.0001	0.0004	-0.002
	(0.001)	(0.002)	(0.048)	(0.061)
Constant	-0.433***	-0.445***	-0.298***	-0.148*
	(0.060)	(0.066)	(1.730)	(2.930)

Table 9, cont.

Person Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	40,771	40,771	40,147	40,771
R^2	0.296	0.240	0.222	0.073
Adjusted R^2	0.291	0.235	0.217	0.067
Residual Std. Error	0.825 (df = 40504)	0.863 (df = 40504)	0.862 (df = 39880)	0.956 (df = 40504)
F Statistic	63.878*** (df = 266; 40504)	48.160*** (df = 266; 40504)	42.712*** (df = 266; 39880)	12.068*** (df = 266; 40504)

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Model (1) in Table 9 shows that being with a close friend involves a decrease in average arousal of 0.061 standard deviations, which could indicate relaxation. In contrast, being with a group of friends is on average associated with an EDA-SNA rate increase of 0.153 standard deviations. Results for being with a romantic partner were not statistically significant.

Model (2) shows that being with a close friend is associated with an increase of 0.39 standard deviations in maximum EDA-SNA rates. However, being with a group of friends involves an increase of 0.154 standard deviations in maximum EDA-SNA rates. Being with a group of friends appears to have the largest impact. Spending time with a group of friends was the most consistent socialization type predictor, as the results for romantic partners were not significant and the estimates for being with a close friend were only marginally significant.

Being with a close friend is associated with a decrease in minimum EDA-SNA rates of 0.057 standard deviations in Model (3). Contrastingly, being with a group of friends is associated with an increase in minimum EDA-SNA rates by 0.154 standard deviations. Results for romantic partners remained not significant.

Similar to previous results, the strength of results for groups of friends is similar in Model (4). The max-min difference in momentary EDA-SNA activity was on average elevated by 0.067 standard deviations for respondents socializing with a group of friends, compared to 0.009 standard deviations with a close friend and 0.012 standard deviations with a romantic partner (though the latter two results were not significant). Small results for this EDA outcome variable imply that the maximum and minimum EDA-SNA rates are not different, while larger numbers are associated with elevated arousal and potential spikes in activity, assuming minimum rates remain stable. Accordingly, this shows that while respondents socializing with groups of friends were associated with a larger range of EDA-SNA activity.

Table 10: Interactions between positive and negative affect and types of socializing.

	Average (z)		Maximum (z)		Minimum (z)		Max-Min Difference (z)	
	positive	negative	positive	negative	positive	negative	positive	negative
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Positive Affect	-0.018		-0.014		-0.009		-0.018	
	(0.014)		(0.015)		(0.015)		(0.017)	
Negative Affect		0.042**		0.048**		0.041*		0.033
		(0.020)		(0.021)		(0.021)		(0.024)
Romantic Partner	-0.031	0.018	-0.043	-0.010	0.001	0.033	0.023	0.013
	(0.033)	(0.029)	(0.035)	(0.030)	(0.035)	(0.030)	(0.038)	(0.033)
Close Friend	-0.099***	-0.054***	-0.061**	-0.038*	-0.088***	-0.042**	0.010	0.004
	(0.023)	(0.019)	(0.024)	(0.020)	(0.024)	(0.020)	(0.026)	(0.022)
Group of Friends	0.100***	0.149***	0.105***	0.151***	0.091***	0.153***	0.041	0.063***
	(0.023)	(0.018)	(0.024)	(0.019)	(0.024)	(0.019)	(0.027)	(0.021)
Lagged Y	0.014***	0.014***	0.009***	0.009***	0.013***	0.013***	0.007***	0.007***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Positive x Romantic Partner	0.089		0.040		0.041		-0.030	
	(0.056)		(0.059)		(0.059)		(0.065)	
Positive x Close Friends	0.108***		0.061		0.084**		0.004	
	(0.037)		(0.039)		(0.039)		(0.043)	
Positive x Group of Friends	0.122***		0.116***		0.145***		0.066	
	(0.035)		(0.037)		(0.037)		(0.041)	
Negative x Romantic Partner		-0.239**		-0.264***		-0.197**		-0.039
		(0.096)		(0.100)		(0.100)		(0.111)

Table 10, cont.

Negative x Close Friend		-0.091		-0.018		-0.202***		0.068
		(0.068)		(0.071)		(0.072)		(0.079)
Negative x Group of Friends		0.046		0.051		-0.014		0.089
		(0.077)		(0.080)		(0.081)		(0.089)
Constant	-0.433***	-0.432***	-0.444***	-0.444***	-0.297***	-0.297***	-0.149*	-0.148*
	(0.066)	(0.066)	(0.069)	(0.069)	(0.070)	(0.070)	(0.077)	(0.077)
N	40,771	40,771	40,771	40,771	40,147	40,147	40,771	40,771
R^2	0.296	0.296	0.241	0.240	0.222	0.222	0.074	0.074
Adjusted R^2	0.291	0.291	0.235	0.235	0.217	0.217	0.067	0.067
Residual Std. Error	0.825 (df = 40500)	0.825 (df = 40500)	0.862 (df = 40500)	0.862 (df = 40500)	0.862 (df = 39876)	0.862 (df = 39876)	0.956 (df = 40500)	0.956 (df = 40500)
F Statistic	63.063*** (df = 270; 40500)	62.982*** (df = 270; 40500)	47.513*** (df = 270; 40500)	47.498*** (df = 270; 40500)	42.193*** (df = 270; 39876)	42.136*** (df = 270; 39876)	11.902*** (df = 270; 40500)	11.910*** (df = 270; 40500)

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table 10 shows the interactions between positive or negative affect and the types of socializing in the sample using the standardized EDA-SNA rates across operationalization. The models in Table 10 control for breakfast, lunch, dinner, nap times, being in class, studying, being at work, exercising, and the time of day by day of week. The interaction of positive affect with a group of friends was significant for the standardized average, minimum, and maximum momentary EDA-SNA rates, while the interaction of positive affect with a close friend was significant for the standardized average and minimum momentary EDA-SNA rates only. Interestingly, while the interaction of negative affect and a romantic partner was significant for the standardized average, minimum, and maximum momentary EDA-SNA rates, the interaction of negative affect and a close friend was only significant for minimum momentary EDA-SNA activity, while no interactions were significant for negative affect and a group of friends. This could mean that events linked with negative affect occurring while socializing with romantic partners have more pronounced emotional arousal, an effect that might be the result of being more openly frustrated or visibly emotional when with a romantic partner, either due to outside forces or issues within the relationship. People could use their time with romantic partners, presumably people they trust and can confide in, to ruminate on and share frustrating experiences — accordingly, while relying on a romantic partner for catharsis may be negative in the moment, the process may help someone move past their negative emotions. Future directions for this data should incorporate the lagged prior negative affect variable in order to further test these ideas.

DISCUSSION

The goal of this study was to determine if different types of socializing are associated with positive or negative affect, as well as examining how these types of socializing impact emotional arousal as measured through EDA, an indicator of emotional arousal. Respondents socializing with groups of friends did experience more emotional arousal compared to when socializing with close friends or romantic partners. In the context of a college environment, these estimates make sense — people are more likely to be in high-arousal states in groups, compared to when they're with a close friend or a romantic partner.

Humans, as social beings, demonstrate a strong affinity to seek out friendships and share emotions with others (Wagner et al. 2014). Studies have shown that friendship formation is impacted by how easily people can make friends, and people often people make friends with people the same age or race — Black students, in particular, are generally the most cohesive racial category (Goodreau et al. 2009). In a new environment, particularly one that is a predominantly white institution, it makes sense that students would cluster in groups with people similar to them in order to socialize. The structure of college being a new environment for young adults creates an incubator for students to explore new experiences outside of the sphere of parental control. Accordingly, it makes sense that people would seek out groups of friends to create enjoyable and exciting socializing experiences. Experiences with close friends and romantic partners are generally lower arousal and more intimate, and it is unlikely that respondents will have sustained high-arousal intimacy. Instead, their socializing likely encompasses a range of emotions, perhaps involving periods of relaxation or lower-arousal activity.

Another hypothesis discussed how socializing, particularly with groups of friends, would be associated with more positive affect and less negative affect. These results, as depicted in Tables 8 and 10, are slightly more discordant with the original hypothesis. Socializing with groups of friends was associated with the largest positive affect, followed by socializing with a close friend and then with a romantic partner, as hypothesized. Meanwhile, socializing with romantic partners was associated with the most negative affect, but socializing with a group of friends were slightly more associated with negative affect than socializing with a close friend. The magnitude of negative affect compared to positive affect was much smaller overall. For example, while the odds of experiencing positive affect when socializing with a group of friends was 5.467 times as much as compared to being without them, the odds of experiencing negative affect when with a group of friends was just 1.69 times as much. In other words, socializing with a group of friends tended to be positive, but was occasionally a negative experience.

One potential explanation for this relates to how people choose to cope with negative experiences. For moments associated with negative affect, students could have been indicating a negative experience that happened to them, or a negative experience that was sought out as the result of feeling unpleasant. Even controlling for lagged effect, it likely takes some time to convert the state of feeling negatively to one of feeling neutrally or positively once more. Research has pointed to interpersonal interactions in friendship groups as a primary influence on overall growth and development during college (Pascarella and Terenzini 1991). These interpersonal environments help to mediate institutional-level peer group effects, an effect that might be particularly relevant for minority students at a predominantly white institution (Antonio 2004). Considering that one goal of the original data collection was to examine the effects of discriminatory experiences on health processes, it is possible that the majority-minority sample selected for groups of friends who could help each other cope with difficult situations through community.

Additionally, of the 8,778 moments in the study that had positive and/or negative affect, just 419 of those 15-minute periods had romantic partner involvement. Accordingly, these results should be examined carefully within this context — it is difficult to disaggregate individual-level variation in relationship quality that might complicate relatively small samples of romantic partner interactions. No questions in the survey inquired about long-distance partnerships, so it is further possible that some people within the samples had significant others who were not physically located on the same campus. 70 out of 136 respondents were also freshmen, who have the added complication of being new to a college campus and thus, a new dating pool. The small number of romantic moments may also imply a lack of relationships within the younger-leaning sample. Given their immersion into a novel environment, it would make sense that freshmen (and even sophomores) might focus on socializing in groups in order to create more social connections, rather than taking the time to build a new close relationship, romantic or otherwise.

This study is impacted by a few limitations. Given that this is a pilot study, future studies would benefit from a larger sample size in addition to leveraging random sampling techniques to obtain participants. Additionally, since this study uses individual-level data, there is a potential for recall bias and person-to-person inconsistency. For example, college students may not be trusting enough of researchers to disclose the full range of their social experiences, even when receiving compensation — accordingly, alcohol and marijuana use, in addition to sexual experiences, might be undersold or omitted from survey results. Furthermore, the definition of "close" friend may vary from person to person, particularly if the respondent is naturally shy or withdrawn and less trusting of their ability to form social bonds (Burgess et al. 2006). Given that how each respondent defined each type of socializing was impacted by personal variation, it is possible that some interactions that were assessed as being with that of a "close friend" for some people would not have fallen under that category for others. It is difficult to determine how people categorized any social interactions with significant positive or negative impact that occurred with peers who were acquaintances, or friends to a less close degree. Since the surveys demanded daily, consistent responses on smartphones, social relationships and interactions were captured in a limited way. Future studies should make efforts to standardize definitions as much as possible in order to make comparisons more meaningful.

Overall, this study pioneers a novel way to directly measure emotional arousal in different relationship contexts in early adulthood. This unique technique has potential implications for how this topic can be studied in future literature. Given this foundation, future student surveys can focus on different topics in order to assess varied dimensions of student emotional and mental health, such as the impact of social media. Additionally, more components of social network theory can be built into the study design in order to create a more concrete network of friendship connections. Examining friendship dyads, for example, could strengthen the socializing components of this study, particularly within a college campus context. This study contributes to the emerging literature on how biosignal collection can be a way to distinctly measure the effects of social experiences on physical health.

APPENDIX

Table 11: Models for average EDA-SNA rates.

	Avg. (z)	Winsorized Avg. (z)	Unstandardized Avg.	Zero-Inflated Negative Binomial
	OLS	*OLS*	*OLS*	*zero-inflated count data*
	(1)	(2)	(3)	(4)
Romantic Partner	0.0003	0.002	-1.559	0.083***
	(0.035)	(0.035)	(1.307)	(0.006)
Close Friend	-0.061***	-0.062***	-1.930**	0.042***
	(0.022)	(0.022)	(0.781)	(0.004)
Group of Friends	0.153***	0.162***	7.024***	0.195***
	(0.023)	(0.023)	(0.831)	(0.004)
Lagged Average	0.014***	0.014***	0.581***	0.007***
	(0.0001)	(0.0001)	(0.005)	(0.00002)
Breakfast	-0.034	-0.034	-0.129	-0.022***
	(0.033)	(0.033)	(1.195)	(0.008)
Lunch	0.003	0.0003	-0.468	-0.001
	(0.025)	(0.025)	(0.865)	(0.006)
Dinner	-0.067***	-0.070***	-1.847**	-0.035***
	(0.025)	(0.025)	(0.888)	(0.005)
Nap	-0.098***	-0.104***	-4.083***	-0.050***
	(0.021)	(0.020)	(0.715)	(0.007)
In Class	-0.076***	-0.072***	-2.129***	-0.049***
	(0.014)	(0.014)	(0.500)	(0.004)
Studying	-0.124***	-0.126***	-4.770***	-0.113***
	(0.013)	(0.013)	(0.469)	(0.004)
At Work	0.073***	0.085***	5.542***	0.046***
	(0.020)	(0.021)	(0.745)	(0.004)
Exercising	0.765***	0.773***	32.653***	0.340***
	(0.051)	(0.050)	(1.885)	(0.005)

Table 11, cont.

Day	0.0002	0.0002	-0.093*	-0.006***
	(0.001)	(0.002)	(0.054)	(0.0003)
Constant	-0.433***	-0.441***	4.985**	3.667***
	(0.060)	(0.061)	(2.038)	(0.002)
Person Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	40,771	40,771	40,981	40,981
R^2	0.296	0.311	0.486	
Adjusted R^2	0.291	0.306	0.482	
Log Likelihood				-257,158.500
Residual Std. Error	0.825 (df = 40504)	0.823 (df = 40504)	28.714 (df = 40714)	
F Statistic	63.878*** (df = 266; 40504)	68.619*** (df = 266; 40504)	144.519*** (df = 266; 40714)	

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table 12: Models for maximum EDA-SNA rates.

	Maximum (z) *OLS*	Winsorized Maximum (z) *OLS*	Unstandardized Maximum *OLS*	Zero-Inflated Negative Binomial *zero-inflated count data*
	(1)	(2)	(3)	(4)
Romantic Partner	-0.029	-0.027	-2.525	0.012**
	(0.033)	(0.034)	(1.637)	(0.005)
Close Friend	-0.039*	-0.042*	-1.292	0.022***
	(0.022)	(0.022)	(1.018)	(0.004)
Group of Friends	0.154***	0.162***	9.130***	0.139***
	(0.022)	(0.022)	(1.058)	(0.003)
Lagged Max	0.009***	0.010***	0.504***	0.004***
	(0.0001)	(0.0001)	(0.005)	(0.00001)
Breakfast	-0.035	-0.033	-0.324	-0.005
	(0.033)	(0.034)	(1.604)	(0.007)
Lunch	0.002	0.0002	-0.203	0.013***
	(0.025)	(0.025)	(1.176)	(0.005)
Dinner	-0.053**	-0.053**	-2.081*	-0.024***
	(0.025)	(0.025)	(1.188)	(0.004)
Nap	-0.105***	-0.110***	-5.629***	0.016***
	(0.023)	(0.023)	(1.082)	(0.005)
In Class	-0.063***	-0.060***	-2.376***	-0.032***
	(0.015)	(0.016)	(0.733)	(0.003)
Studying	-0.134***	-0.135***	-7.044***	-0.096***
	(0.014)	(0.014)	(0.687)	(0.003)
At Work	0.093***	0.100***	7.980***	0.043***
	(0.021)	(0.021)	(1.020)	(0.003)
Exercising	0.660***	0.672***	34.596***	0.257***
	(0.043)	(0.043)	(2.050)	(0.004)
Day	-0.0001	-0.0003	-0.133*	-0.004***
	(0.002)	(0.002)	(0.075)	(0.0002)

Table 12, cont.

Constant	-0.445***	-0.445***	13.959***	4.198***
	(0.065)	(0.066)	(3.113)	(0.002)
Person Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	40,771	40,771	40,981	40,981
R^2	0.240	0.249	0.409	
Adjusted R^2	0.235	0.244	0.406	
Log Likelihood				-305,410.100
Residual Std. Error	0.863 (df = 40504)	0.862 (df = 40504)	40.638 (df = 40714)	
F Statistic	48.160*** (df = 266; 40504)	50.501*** (df = 266; 40504)	106.134*** (df = 266; 40714)	

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table 13: Models for minimum EDA-SNA rates.

	Minimum (z) *OLS* (1)	Winsorized Minimum (z) *OLS* (2)	Unstandardized Minimum *OLS* (3)	Zero-inflated Negative Binomial *zero-inflated count data* (4)
Romantic Partner	0.018	0.021	-1.045	0.098***
	(0.036)	(0.038)	(1.163)	(0.008)
Close Friend	-0.057**	-0.061***	-1.819***	0.022***
	(0.023)	(0.023)	(0.669)	(0.006)
Group of Friends	0.154***	0.173***	5.870***	0.172***
	(0.023)	(0.024)	(0.734)	(0.005)
Lagged Min.	0.013***	0.015***	0.522***	0.005***
	(0.0002)	(0.0002)	(0.007)	(0.00003)
Breakfast	-0.022	-0.026	0.179	0.059***
	(0.034)	(0.035)	(1.099)	(0.012)
Lunch	0.010	-0.001	-0.607	-0.020***
	(0.028)	(0.027)	(0.780)	(0.008)
Dinner	-0.030	-0.038	-0.723	0.036***
	(0.028)	(0.027)	(0.812)	(0.007)
Nap	-0.099***	-0.105***	-3.404***	-0.056***
	(0.020)	(0.021)	(0.610)	(0.010)
In Class	-0.057***	-0.050***	-1.177***	-0.044***
	(0.014)	(0.014)	(0.436)	(0.005)
Studying	-0.102***	-0.106***	-3.241***	-0.082***
	(0.013)	(0.013)	(0.395)	(0.006)
At Work	0.093***	0.113***	4.875***	-0.033***
	(0.021)	(0.022)	(0.692)	(0.005)
Exercising	0.873***	0.905***	32.962***	0.318***
	(0.064)	(0.063)	(2.052)	(0.005)
Day	0.0004	0.001	-0.071	-0.002***
	(0.002)	(0.002)	(0.048)	(0.0004)

Table 13, cont.

Constant	-0.298***	-0.320***	-0.172	3.922***
	(0.064)	(0.065)	(1.730)	(0.003)
Person Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	40,147	40,147	40,981	40,981
R^2	0.222	0.253	0.406	
Adjusted R^2	0.217	0.248	0.402	
Log Likelihood				-147,851.100
Residual Std. Error	0.862 (df = 39880)	0.857 (df = 39880)	25.512 (df = 40714)	
F Statistic	42.712*** (df = 266; 39880)	50.886*** (df = 266; 39880)	104.402*** (df = 266; 40714)	

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Table 14: Models for max-min difference EDA-SNA rates.

	Standardized Difference *OLS* (1)	Winsorized Difference *OLS* (2)	Unstandardized Difference *OLS* (3)	Zero-inflated Negative Binomial *zero-inflated count data* (4)
Romantic Partner	0.012	0.014	0.218	-0.032***
	(0.034)	(0.034)	(1.224)	(0.006)
Close Friend	0.009	0.006	0.736	-0.021***
	(0.022)	(0.022)	(0.757)	(0.005)
Groups of Friends	0.067***	0.073***	3.039***	-0.007
	(0.021)	(0.022)	(0.778)	(0.004)
Lagged Diff.	0.007***	0.007***	0.258***	0.001***
	(0.0002)	(0.0002)	(0.006)	(0.00002)
Breakfast	-0.047	-0.045	-0.948	0.042***
	(0.036)	(0.037)	(1.347)	(0.008)
Lunch	-0.0004	-0.004	-0.059	-0.005
	(0.027)	(0.027)	(0.990)	(0.006)
Dinner	-0.024	-0.022	-0.821	-0.050***
	(0.027)	(0.027)	(0.971)	(0.006)
Nap	-0.072***	-0.078***	-2.732***	0.128***
	(0.027)	(0.026)	(0.963)	(0.006)
In Class	-0.033*	-0.029	-0.739	-0.023***
	(0.017)	(0.018)	(0.636)	(0.004)
Studying	-0.120***	-0.122***	-4.443***	-0.036***
	(0.016)	(0.016)	(0.580)	(0.004)
At Work	0.104***	0.111***	4.963***	-0.052***
	(0.024)	(0.024)	(0.856)	(0.004)
Exercising	0.073	0.074	1.197	-0.376***
	(0.046)	(0.047)	(1.693)	(0.008)
Day	-0.002	-0.002	-0.110*	-0.0003
	(0.002)	(0.002)	(0.061)	(0.0003)

Table 14, cont.

Constant	-0.148*	-0.147*	20.678***	4.001***
	(0.080)	(0.081)	(2.930)	(0.002)
Person Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	40,771	40,771	40,981	40,981
R^2	0.073	0.076	0.167	
Adjusted R^2	0.067	0.070	0.162	
Log Likelihood				-319,432.700
Residual Std. Error	0.956 (df = 40504)	0.961 (df = 40504)	34.483 (df = 40714)	
F Statistic	12.068*** (df = 266; 40504)	12.573*** (df = 266; 40504)	30.726*** (df = 266; 40714)	

Notes: ***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

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