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Expecting the Unexpected: Predicting Panic Attacks From Mood, Twitter, and Apple Watch Data

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ABSTRACT Objective: Panic attacks are an impairing mental health problem that affects 11% of adults every year. Current criteria describe them as occurring without warning, despite evidence suggesting individuals can often identify attack triggers. We aimed to prospectively explore qualitative and quantitative factors associated with the onset of panic attacks. Results: Of 87 participants, 95% retrospectively identified a trigger for their panic attacks. Worse individually reported mood and state-level mood, as indicated by Twitter ratings, were related to greater likelihood of *next-day* panic attack. In a subsample of participants who uploaded their wearable sensor data (n = 32), louder ambient noise and higher resting heart rate were related to greater likelihood of *next-day* panic attack. Conclusions: These promising results suggest that individuals who experience panic attacks may be able to anticipate their next attack which could be used to inform future prevention and intervention efforts.

INDEX TERMS Panic attacks, wearables, apple watch, mental health, twitter.

IMPACT STATEMENT This prospective study on the greatest number of panic attacks to date suggests daily mood rating, state-level Twitter mood, and wearables data could each help predict next-day panic attack onset.

I. INTRODUCTION

Over 28% of adults have experienced at least one panic attack in their lifetime, with over 11% having experienced a panic attack in the past year [1]. Panic attacks are impairing, with physiological and psychological symptoms including increased heart rate, hyperventilation, shaking, feelings of faintness, as well as self-perceived lack of control, and fear of another panic attack occurring [2]. The DSM-5 currently defines panic attacks as an "abrupt surge of intense fear or discomfort that reaches a peak within minutes" that comes out of nowhere [2], suggesting there are no triggers for an attack. One report goes as far as to state that, "A hallmark feature of panic disorder is that attacks occur without warning." [3]. If true, panic attacks would be almost impossible to predict, leaving those who experience panic attacks feeling a loss of control over their own bodies. However, some data suggests that many panic attacks may indeed have specific triggers [4]. If triggers of panic attacks are identified, they could predict panic attack onset, and ultimately be used to give back some semblance of control to those who experience panic attacks.

Many studies examining panic attacks induce panic attacks medically [5] or experientially via interoceptive therapy [6] in

a laboratory. We have only recently started to identify triggers of naturally occurring panic attacks. The DSM-5 mentions cognitive risk factors associated with panic attacks, but new evidence suggests they could have a causal role in panic [7]. Our previous work demonstrates nearly all (98%) of 85 participants suffering from panic attacks could identify a trigger of their latest attack [4] whereas only 2% reported they were unsure of the trigger [4]. However, participants were given a forced choice, and the study coincidently began at the start of the COVID-19 pandemic, which both likely impacted participant responses. It is important to further examine panic attack triggers outside those limitations and prospectively to investigate if it is possible to predict panic attack occurrence.

While there is a dearth of literature on panic attack triggers outside of a laboratory, there are more studies examining triggers of acute anxiety or mood. For instance, acute anxiety has been associated with prior lack of sleep [8] and caffeine use [9]. Daily mood has been associated with getting an adequate amount of sleep (8+ hours), exercise (30+ minutes), servings of fruits and vegetables (4+), water (4+ glasses) and singing/playing an instrument in college students [10]. Our previous study suggests panic attacks are associated with poor daily wellness behaviors, but reports were retrospective [4], and likely influenced by experiencing the panic attack [11]. Therefore, there may be within-person changes prior to panic attack onset that could be identified in longitudinal studies.

There is also evidence that collective environmental factors are associated with acute anxiety. For instance, the COVID-19 pandemic was linked to increases of mortality-related thoughts [12]. Other collective negative events such as acts of terrorism, human loss, and political rulings affecting civil rights have been seen to impact individuals' mental health [13], [14], with proximity to the event (location or personal relevance), moderating the strength of that impact [14]. This connection between societal-level negative events and anxiety may be even more relevant for highly anxious individuals who attend more to potential external threats [15]. The Hedonometer [16], [17] is a public access tool that codes Twitter valence as a barometer for collective English-language and US state-level mood. For instance, mood based on the positive and negative valence of words used in Tweets was significantly reflective of the relative mental and physical health of those in specific geographic regions, as well as collective negative experiences such as unemployment [18], education levels and obesity rates [17]. This metric may provide an important societal measure of mood.

Given the growing prevalence of consumer wearable devices that capture objective physiology, there is also an opportunity to explore passively collected objective within-person data. Heart rate metrics have been linked to the onset of panic attacks. One study followed individuals with panic disorder prospectively for two days using an array of wired physiological sensors. They found significant changes in heart rate occurred 45 minutes prior to the onset of a panic attack [19]. Others have also noted heart rate changes to precede panic attacks, but with variable prevalence across patients [19], [20], [21], [22]. Respiration features have also been found to be promising signals preceding panic attacks by 47 minutes and even more prevalent across participants than heart rate changes [19]. Ambient noise is also known to increase stress levels and may lead to atypical activation of the autonomic nervous system (e.g., [23]). Recent advances in consumer wearable devices enable easier continuous measurement of heart rate metrics, respiration, and ambient noise. However, it is not yet known how these measurements may relate to panic attacks a full day prior.

In the current study, we aimed to identify factors associated with the onset of panic attacks to ultimately inform future prevention and intervention efforts. We first assess qualitative reports of panic attack triggers on content and prevalence. We next test whether daily individual- and societal-level factors are associated with a greater likelihood a *same-day* and/or *next-day* panic attack. Finally, we examine the ability of consumer wearable data to prospectively predict a *next-day* panic attack.

TABLE 1. Demographics of Full Sample and Apple Watch Subsample

	Details	*N=86 % (n)*	*n=32 %(n)*
Gender Identity	Woman	63.2% (55)	93.8% (30)
	Man	35.6% (31)	6.3% (2)
	Non-Binary/Other	0% (0)	0% (0)
Race	White, Non-Hispanic	49.4% (43)	68.8% (22)
	African American	33.3% (29)	9.4% (3)
	Asian-Pacific	8.0% (7)	15.6% (5)
	Latinx	4.6% (4)	3.1% (1)
	Bi-racial	3.4% (3)	3.1% (1)
Education	High school or GED	8.0% (7)	6.3% (2)
	Some college	25.3% (22)	31.2% (10)
	Bachelor's degree	40.2% (35)	40.6% (13)
	Graduate degree	25.3% (22)	21.9% (7)
Household Income	$0-$25,000	16% (14)	28.1% (9)
	$25,001-$50,000	13.6% (12)	15.6% (5)
	$50,001-$75,000	11.3% (10)	3.1% (1)
	$75,001-$100,000	29.8% (26)	34.4% (11)
	>$100,000	27.6% (24)	18.8% (6)
Mental Health	At least 1 diagnosis	53.1% (51)	65.6% (21)

II. RESULTS

Demographic information for the 87 participants with at least one day of survey data and of the 32 participants with Apple Watch data are in Table 1. Participants reported living across 30 U.S. states and regularly experiencing panic attacks lasting 17.6 minutes ($SD = 16.7$). While the full sample was relatively diverse, those with Apple Watch data were almost all women, affluent, and mostly White, Non-Hispanic. Attrition was high yet demographics did not differ by week (see Supplemental Material) except that women were more likely to complete than men. One participant chose not to respond to demographic questions but completed daily surveys.

A. QUALITATIVE PANIC ATTACK TRIGGERS

Qualitative content analysis [4], [24] was conducted on open text responses of reported triggers of 268 panic attacks. The

TABLE 2. Qualitative Analysis of Panic Attack Triggers

Trigger Category	PA Freq (N=268)	Part Freq (N=64)	Examples
Emotional Health	96 (35.82%)	31 (29.69%)	"feeling overwhelmed"
Relational Conflict	41 (15.30%)	24 (37.5%)	"had a fight with my husband"
Physical Health	38 (14.18%)	19 (29.69%)	"Headache"
Physical Environment	28 (10.45%)	18 (28.13%)	"Being in a car while it's snowing"
Social Situation	19 (7.09%)	13 (20.31%)	"Too many people"
Sleep Problem	16 (5.97%)	12 (18.75%)	"Lack of sleep"
Financial Problem	15 (5.60%)	7 (10.94%)	"Financial stress"
Substance Use	15 (5.60%)	6 (9.38%)	"Some drinks"
Work/School Problem	14 (5.22%)	8 (12.5%)	"Nervous about exam tomorrow"

TABLE 3. Same-Day Panic by Reported Behaviors and Hedonometer

	Individual Models			Final Model		
	OR	95% CI	p	OR	95% CI	p
Mood	**0.88**	**0.86-0.90**	**<.001**	**0.97**	**0.94-0.99**	**<.001**
Sleep	**0.91**	**0.89-0.93**	**<.001**	1.01	0.98-1.03	.099
Eat	**0.90**	**0.89-0.92**	**<.001**	1.00	0.97-1.03	.731
Stress	**1.14**	**1.12-1.16**	**<.001**	1.00	0.97-1.02	.691
Exercise	1.05	0.99-1.11	.121	--	--	--
Caffeine	**0.92**	**0.87-0.98**	**.005**	1.01	0.95-1.07	.104
Alcohol	0.94	0.87-1.03	.186	--	--	--
Rec Drug	**0.80**	**0.68-0.94**	**.006**	1.10	0.93-1.31	.
Pres Drug	1.04	0.89-1.03	.233	--	--	--
Conflict	**0.82**	**0.76-0.88**	**<.001**	1.03	0.95-1.11	.442
Weekend	**0.47**	**0.43-0.51**	**<.001**	0.93	0.83-1.04	.197
All Mood	0.76	0.23-2.48	.651	--	--	--
State Mood	0.44	0.16-1.19	.106	--	--	--

most reported triggers were related to emotional health, relational conflict, physical health, and physical environment (Table 2). Less than 5% of panic attacks were triggered by categories of thoughts, concern for others, being confronted by bad news, loss, or being in therapy. Only 7 (2.6%) of panic attack triggers were reported as unsure.

B. RETROSPECTIVE REPORTS OF PANIC ATTACKS

For same-day panic attacks (reports of wellness behaviors, Hedonometer, and panic attack experiences in the same 24 hours), 1247 days were analyzed (Table 3). Gender, race, mental health disorder diagnosis and number of days since the start of the study were included as covariates in subsequent models. Adjusted models showed several wellness behavior associations with *same-day* panic attacks. In a final model, including all significant variables from individual models, only worse individual mood remained significant. Odds Ratios (OR) and 95% Confidence Intervals (CIs) are included.

TABLE 4. Next-Day Panic by Reported Behaviors and Hedonometer

	Individual Models			Final Models		
	OR	95% CI	p	OR	95% CI	p
Mood	**0.97**	**0.95-0.99**	**.015**	**0.97**	**0.95-0.99**	**.017**
Sleep	.099	0.97-1.14	.446	--	--	--
Eat	.099	0.97-1.01	.350	--	--	--
Stress	1.01	0.99-1.02	.610	--	--	--
Exercise	1.06	1.00-1.12	.050	--	--	--
Caffeine	1.01	0.95-1.07	.703	--	--	--
Alcohol	1.01	0.92-1.11	.786	--	--	--
Rec Drugs	1.09	0.92-1.29	.309	--	--	--
Pres Drugs	0.99	0.92-1.07	.877	--	--	--
Conflict	1.01	0.94-1.09	.766	--	--	--
Weekend	0.92	0.83-1.03	.157	--	--	--
All Mood	.31	0.09-1.09	.068	--	--	--
State Mood	**0.20**	**0.08-0.53**	**.007**	**0.22**	**0.09-0.56**	**.002**

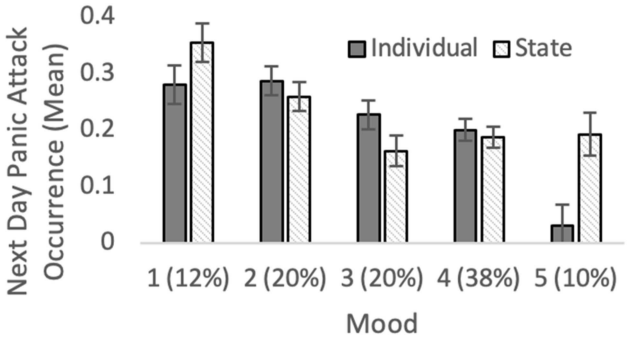

FIGURE 1. Next-day panic by binned individual behaviors and hedonometer.

C. PROSPECTIVE REPORTS OF PANIC ATTACKS

For next-day panic attacks (reports of wellness behaviors, and Hedonometer related to the panic attack experiences in the following 24 hours), 1160 days were analyzed (Table 4). Adjusted models showed worse individual and state mood were related to greater *next-day* panic attack likelihood. Both remained significant in a final model, demonstrating unique factor variance. For Fig. 1, State Mood was binned according to individual mood rating percentages (10% of days were "Great" on individual mood, thus the top 10% of state mood was binned). A "Great" individual mood was 8.5 times *less* likely to have a *next-day* panic attack compared to lower ratings. A "Poor" state mood was 2 times *more* likely to have a *next-day* panic attack than higher ratings.

D. PROSPECTIVE APPLE WATCH DATA AND PANIC ATTACKS

A subsample of 32 participants successfully uploaded Apple Watch data. At varying availability, they had the following metrics: daily heart rate variability (HRV), activity, resting heart rate (RHR), respiratory rate (RR) and ambient noise (Noise) (Table 5). Given features were daily aggregates based on calendar day and not necessarily the 24 hours prior to the panic attack we did not analyze same-day Apple Watch data which includes post-panic attack physiology unrelated to panic attack onset risk.

TABLE 5. Apple Watch Data Characteristics

Measures	People	Days	Panic Days	Mean (SD)
HRV	32	273	48	41.41 (18.54)
RHR	32	241	40	66.09 (7.50)
Activty	32	264	44	
Distance				2.77 (1.69)
Flights				4.36 (3.22)
Steps				5,934 (3,621)
RR	18	135	32	16.48 (1.72)
Noise	10	125	23	62.51 (5.43)

Note: HRV = Heart Rate Variability in milliseconds, RHR = Resting Heart Rate in beats per minute, Flights = Stair flights climbed, Distance = miles walked, RR = Respiratory Rate in breaths per minute, Noise = Ambient Noise Level in decibels, People = Number of participants with the associated measure, Days = Number of days with measure available, Panic Days = Number of days with the measure available where panic attack occurred, SD = standard deviation. Means winzorized at 95%.

TABLE 6. Next-Day Panic by Apple Watch Data

Measures	Est.	Std. Error	CIs	p-value
HRV	.001	.002	-.003-.006	.562
RHR	.009	.004	.000 - .018	.046
Activty	-.008	.026	-.060 - .043	.748
RR	-.009	.038	-.085 - .066	.808
Noise	.021	.009	.003 - .038	.021

Note: HRV = Heart Rate Variability deviation, RHR = Resting Heart Rate deviation, Activity = aggregate measure derived from distance walked, steps, and flights of stairs climbed, RR = Respiratory Rate deviation, Noise = Ambient Noise Level, CIs = confidence interval of the model estimate. The * indicates statistical significance at the 0.05 level.

State Mood was added as a covariate to Apple Watch models as a significant passive data form in previous models. Adjusted models demonstrated increases in resting heart rate above an individual's mean value during the study and higher ambient noise levels were related to greater next-day panic attack likelihood (Table 6). Notably, we also explored ambient noise deviation and found a similarly significant linear effect (b =.003, S.E. = .009, CIs = .015-.052, p = .001).

Further examining these results, we see that deviations in RHR from a participant's mean over the study result in large changes to their likelihood of experiencing an attack the next day (Fig. 2, left, top). Deviations as small as 1 BPM above, and 5 BPM below, the mean RHR can yield more than a 100% increase (5 BPM below: .09 vs. .19; 1 BPM above: .09 vs. .23) in likelihood for experiencing a next-day panic attack. This can be observed in data from an example subject (Fig. 2, left, bottom) where deviations of 3, 4 and 5 BPM above the mean correspond to a next-day panic attack.

Similarly, relatively small changes in ambient noise level can yield dramatic changes to the likelihood of experiencing a panic attack the next day (Fig. 2, right, top). For daily ambient noise on par with a typical conversation (∼60 dB), participants have a likelihood of experiencing a next-day panic attack of approximately .18. Increasing the ambient noise level above 70 dB increases the likelihood of experiencing a panic attack about 80% to .33. Interestingly, decreasing the ambient noise level below 57 dB dramatically reduces the likelihood of experiencing a panic attack (.18 to .01), but this may be impacted by a small sample size of quiet days (n = 15). This manifests in data from an example subject (Fig. 2, right, bottom), where you can see that days with ambient noise above 65 dB are associated with subsequent panic attacks.

III. DISCUSSION

In this study we have demonstrated that several psychophysiological factors precede panic attacks by an entire day. In a qualitative analysis of panic attack triggers, we found most participants (95%) could identify a trigger. In prospective analyses, we found that daily poor individual and state mood (assessed via Twitter [16]) both contributed to likelihood of having a panic attack the next day. Finally, we identified promise that passively collected wearable data may be prospectively linked with *next-day* panic attacks.

A. QUALITATIVE PANIC ATTACK TRIGGERS

In contrast with DSM panic attack criteria and associated reporting describing lack of trigger as a hallmark of panic attacks, we found that for most people can identify a trigger for most panic attacks. The most common trigger reported was related to emotional health. This trigger category is consistent with the DSM, which states that negative affect and anxiety are "risk factors" for panic attacks [3], which may indeed be a more indicative term than "trigger" due to its non-specific nature. We need to learn more about the patterns and metrics of emotional health triggers to use them to help predict panic attack onset, such as timing between feeling onset or peak rating. However, other reported triggers did include specific times or places (i.e., a conflict, physical surroundings, substance use, or an upcoming exam), which suggest they may be used to predict panic attacks. Consistent with our past research, relational conflict and physical health are in the top three most prevalent triggers and fewer than 5% of people stated "unsure" as a panic attack trigger [4]. These similar results may suggest that lack of trigger may *not* in fact be a hallmark of panic attacks and should be further assessed.

B. QUANTITATIVE PANIC ATTACK TRIGGERS

Consistent with the literature, many wellness behaviors were associated with same-day panic attacks, acute anxiety, and mood. Interestingly, only mood rating remained significant in the final model. Wellness behaviors have been found to be highly associated with daily mood [10] and thus daily mood may mediate wellness and panic attack likelihood or vice versa.

We identified prospective associations between individual mood, Hedonometer-derived state mood and likelihood of a panic attack on the following day. Experiencing a "Great" mood seems to protect against the likelihood of having a panic attack. This is consistent with previous literature demonstrating that positive moods allow individuals to better adapt to stressors [25] that may have otherwise triggered a panic attack. Efforts in developing interventions could focus on cultivating positive mindsets [26].

New York had one of the lowest state-moods of the study on April 12, 2022, a day when there was a mass shooting in a New York City subway resulting in multiple injuries. The reporting and public response to this tragedy contributed, in part, to the low Hedonometer score. State moods capturing events such as these were associated with the likelihood of a

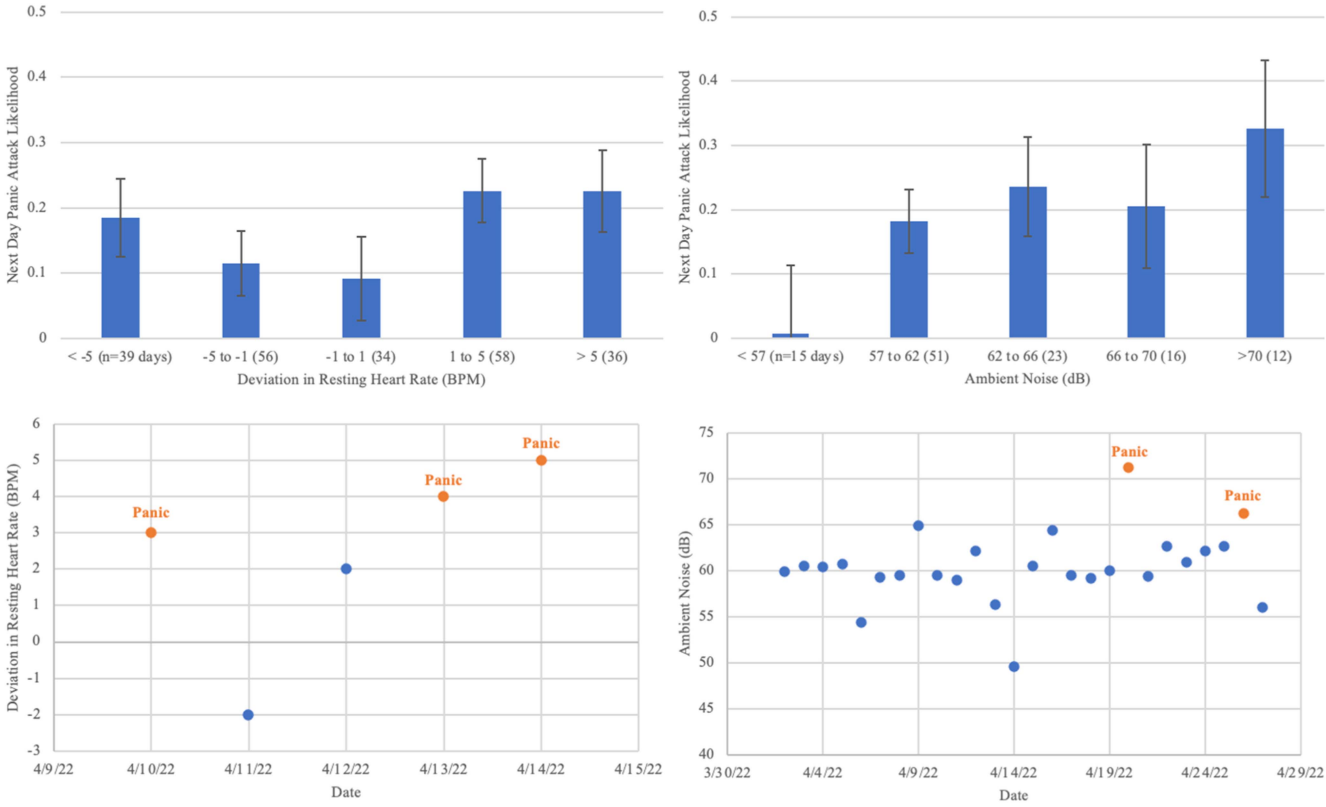

FIGURE 2. **Larger deviations in RHR above and below the mean are associated with higher likelihood of a panic attack the next day (left, top). As seen in the case study of an example subject (left, bottom), deviations of 3, 4 and 5 beats per minute (BPM) correspond to subsequent days where a panic attack was experienced. Higher ambient noise is associated with a higher likelihood of experiencing a panic attack the next day (right, top). As seen in the case study of an example subject (right, bottom), ambient noise above 65 dB corresponds to subsequent days where a panic attack was experienced. Error bars represent standard error.**

next-day panic attack in our study. Hedonometer scores derived from all English-language Tweets did not reach significance. This may suggest that proximity to the event moderates the strength of the association between societal-level mood and panic attacks, consistent with previous literature [13], [14], [27] which may be especially strong in highly anxious individuals [28], [29]. Psychoeducation on why and how panic attacks occur has been shown to be an effective intervention at least short-term [30], [31], and thus adding these results to psychoeducation may increase that benefit.

C. APPLE WATCH DATA

Results suggest that both measures of a person's internal physiological state (e.g., resting heart rate), and their external environment (e.g., ambient noise, state mood) are significantly related to experiencing a panic attack the next day. Changes in resting heart rate are known to be induced by both sympathetic activation and parasympathetic withdrawal [32], and have been linked to stress-related disorders (e.g., [33]) and in the minutes preceding panic attacks [19]. Similarly, those with anxiety and depression are particularly sensitive to ambient noise which may lead to atypical activation of the autonomic nervous system (e.g., [23]). Our results indicating associations between elevated resting heart rate and ambient noise and experiencing a next-day panic attack may imply that elevated allostatic load predisposes an individual to an attack and should likely be investigated further.

D. LIMITATIONS

This was a convenience sample recruited from Facebook, who owned an Apple Watch and an iPhone, and had experienced at least two panic attacks in the past month. Most participants had achieved higher education and had an income over $75000 dollars. Furthermore, there was high attrition and only 37% of participants uploaded Apple Watch data. Therefore, we must caution the generalization of any conclusions as our sample is not representative of the United States or people who suffer from regular panic attacks. Our recruitment, attrition, and sample demographics each pose risks to the external validity of this study. Additionally, participants reported their mood, sleep, eating, and exercise habits after reporting whether they had a panic attack. It is likely that the same-day factors found to be significantly associated with panic attacks were biased by the occurrence of the attack. Future work should consider wearable data at more precise intervals to enable a more detailed examination of potential predictors of panic attacks. Additional metrics (i.e., tidal volume [19] should also be investigated using alternative wearables

as non-significant effects (i.e., respiration) may be due, in part, to the accuracy of the Apple Watch measures and when they were collected. Further research with a larger and more diverse sample size are also needed to inform generalizable conclusions.

IV. CONCLUSION

Overall, results suggest individuals who experience panic attacks may be able predict the onset of their next panic attack. This information could improve specificity of single session psychoeducation interventions [31] and could inform ecological momentary interventions which help users implement cognitive or behavioral therapy strategies effective in reducing panic [34] at key moments of risk [35] to help prevent the panic attack altogether.

V. MATERIALS AND METHODS

Participants were recruited through advertisements on Facebook in Spring 2022. Ads were targeted at users identified by Facebook as "highly anxious" and "interested in Apple Watches." Study eligibility required that all participants 1) lived in the United States, 2) owned an iPhone and 3) an Apple Watch, 4) were at least 18 years old, and 5) had experienced at least one panic attack in the last seven days. The protocol was approved by the University of Vermont Institutional Review Board (STUDY00001909, approved January 18, 2022). After e-consenting, participants were asked to complete an initial survey and then the daily survey for the following 28 days and upload their Apple Watch data weekly. Participants earned a $20 Amazon gift card each week they were enrolled. Eighty-seven of 107 individuals who signed an e-consent completed at least one daily survey. There was significant attrition in this completely remote study. At the end of each week, participants were withdrawn if they had completed less than 15% of their weekly surveys. Twenty-two were withdrawn after week one, 25 after week two, and one after week three. Thirty-two participants uploaded Apple Watch data, four with one week of data, one with two, and 27 with all four weeks.

A. MEASURES

The initial survey (15 minutes) included items on basic demographic information. The daily survey (5 minutes) included items on whether they had experienced a panic attack and associated descriptive information including what they believed their trigger was (open text response), their mood, and wellness behaviors. Unfortunately, due to reporting ambiguity, we were not able to extract reliable timing of participant panic attacks from these daily surveys. Participants were also asked to upload their Apple Watch data weekly after wearing it every day. Features extracted from the Apple Watch were daily measures of resting heart rate (RHR), heart rate variability (HRV, defined by Apple as the standard deviation of beat-to-beat intervals - SDNN), respiratory rate (RR), and ambient noise levels (Noise). A single RHR measurement is reported by the watch each day based on heart rate measurements taken during sleep. The watch also reports estimates of distance walked, steps taken, and stair flights climbed. We combined these metrics into a single aggregate activity feature (Activity) by averaging subject-specific z-scores of each metric for each participant each day. We also consider the mean HRV, RR (recorded during sleep), and Noise each day in our analyses. The Hedonometer is a tool using Twitter data to characterize the overall happiness of a group of people (e.g [36]). Here, we aggregate all English language Tweets as "All Mood" and all Tweets within the state of the U.S. the participant resides in as "State Mood".

B. ANALYTICAL PLAN

Mixed Regressions, with an autoregressive covariance structure were used to estimate the presence of a panic attack. In this approach, participant ID is introduced as a cluster (class) variable to account for repeated, correlated observations within individuals. Robust variance estimates (i.e., sandwich type estimates) adjusted the standard errors of the parameter estimates for the within-person nesting of observations. All statistical analyses were performed in SPSS (Version 28.0.1.1, IBM). We conducted 33 mixed regression models. Findings were considered statistically significant at $p<.050$ using the BH-FDR method [37], [38], which shows similar minimization of false positives as Bonferroni but has a lower false negative rate.

SUPPLEMENTARY MATERIALS

Supplementary Materials include a table of attrition on participant demographics by week, details on the daily survey items, Hedonometer, and Apple Watch measures.

AUTHOR CONTRIBUTIONS

E. W. M. and R. S. M. wrote the initial draft and edited the manuscript. S. L., I. B., S. B., and G. L. performed the experiments. M. A., C. M. D., P. S. D., B. L., E. W. M., and R. S. M. processed data and analyzed the results. C. M. D., P. S. D., B. L., E. W. M., R. S. M., M. P., and W. E. C. contributed to data interpretation. C. M. D., P. S. D., B. L., E. W. M., R. S. M., M. P., and W. E. C. provided critical feedback and helped shape the research, analysis, and manuscript. All authors reviewed the manuscript.

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