

Emotion

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BRIEF REPORT

Emotional Complexity Under High Stress: Do Protective Associations for Risk Behaviors Persist Even During a Pandemic?

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Risk behaviors like substance use and binge eating are often used to cope with negative emotions. Engagement in these behaviors has been exacerbated by the COVID-19 pandemic. Past research suggests that complex emotion conceptualizations captured as emotion differentiation (ability to discriminate between emotional states) and polarity (ability to integrate positive and negative features of emotional experience) may be protective. We examined associations of mean affect intensity, emotion differentiation, and emotion polarity with frequency of daily substance use and binge eating across 10 days in a demographically diverse sample of U.S. adults ($N = 353$) recruited between March 24 and April 9, 2020, when stay-at-home orders were initiated. Owing to the nested data structure and excessive zero values, analyses were conducted using multilevel zero-inflated negative binomial regression. Consistent with past research, negative affect was positively associated with frequency of substance use and binge eating. Importantly, results indicated that negative emotion differentiation was protective, predicting greater likelihood of not using substances and binge eating at all across the sampling period. These effects remained even after controlling for mean affect intensity, emotion polarity, and positive emotion differentiation. Neither positive emotion differentiation nor emotion polarity were significantly associated with either behavior. Our results suggest that greater complexity in conceptualization of negative emotions facilitates some protection against risk behaviors such as substance use and binge eating, even during periods of high environmental stress. These findings have important implications for optimizing interventions to reduce engagement in risk behaviors.

Keywords: binge eating, COVID-19, emotion differentiation, emotional complexity, substance use

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The COVID-19 pandemic and its accompanying containment efforts during the early months have been associated with increased stress, anxiety, and depression (Aknin et al., 2022) and engagement in

risk behaviors like substance use (e.g., alcohol, illicit drugs, and medication misuse) and binge eating (e.g., Czeisler et al., 2020; Termorshuizen et al., 2020). Critically, there has been a significant increase in weekly U.S. emergency department visits for drug overdoses during this time (up to 45%), as well as relapse among individuals with eating disorders pre- versus peripandemic (Castellini et al., 2020; Holland et al., 2021). Although seemingly disparate, substance use and binge eating are known risk and maintenance factors of psychopathology that operate similarly in part by down-regulating negative emotional states (Hayes et al., 1996; Johnson et al., 2013). Indeed, research has found that increases in negative affect (NA) and decreases in positive affect (PA) precede engagement in risk behaviors, followed by subsequent decreases in NA (e.g., Selby et al., 2008). Through this process of reinforcement, the frequency of behaviors can increase over time. Hence, although engagement in behaviors like substance use/binge eating provides temporary relief from NA, there are significant long-term costs for physical and mental health. Therefore, it is important to identify factors that may protect against these behaviors.

Growing research suggests that complex conceptualizations of one's emotional experience, or emotional complexity, may be

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Study data and syntax can be accessed at <https://osf.io/967ch/> (Seah et al., 2022).

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important to understanding behaviors broadly aimed at regulatory action, including substance use/binge eating, that manifest across the spectrum of psychological health (Kashdan et al., 2015). Two facets of emotional complexity in self-reported emotion have been investigated (Grossmann et al., 2016): *emotion differentiation* (“differentiation”; also termed “granularity”) and *emotion polarity* (“polarity”; also termed “dialecticism/synchrony”). Differentiation reflects the degree to which one makes fine-grained distinctions between similarly valenced emotional states (fear vs. sadness vs. disgust; Barrett et al., 2001), whereas polarity reflects the degree that emotional experiences are viewed in extremes (e.g., feeling all good *or* all bad) instead of shades of gray (Rafaeli et al., 2007). Both are measured using experience-sampling methodology, where individuals repeatedly report emotional experiences across time to derive indices of differentiation/polarity. Although largely conceptualized as an “ability” that is stable, there is also evidence of variability and change in differentiation/polarity within individuals depending on contextual factors like stress (Erbas et al., 2018; Zautra, 2003) as well as intervention (e.g., Van der Gucht et al., 2019).

Several theoretical and treatment models of psychopathology suggest that attending to specific negative emotions, as well as integrating positive and negative features of emotional experience, may be protective against risk behaviors (e.g., Linehan, 1993). Through the process of discriminating emotions, individuals may gain awareness, understanding, and efficacy in regulating their emotional experiences, and thus respond adaptively to situational demands (Barrett et al., 2001; Kalokerinos et al., 2019; Kashdan et al., 2015). Conversely, deficits in emotion conceptualization (e.g., Alexithymia) have been associated with maladaptive coping behaviors (Taylor et al., 1997). Prior research has also suggested that adopting complex conceptualizations of negative emotion may mitigate the behavioral consequences of maladaptive rumination, facilitating psychological distancing and down-regulation of negative emotion (Seah et al., 2020; Zaki et al., 2013).

Indeed, recent meta-analyses indicate that differentiation of negative emotions (NED) in particular may protect against risk behaviors, including substance use and disordered eating, across clinical/nonclinical samples (O’Toole et al., 2020; Seah & Coifman, 2021). Findings regarding positive emotion differentiation (PED), however, are mixed, with some studies reporting benefits consistent with NED (e.g., substance use, Emery et al., 2014; eating, Mikhail et al., 2020) whereas others reported null results (Sheets et al., 2015; Williams-Kerver & Crowther, 2020). Finally, findings from Coifman et al. (2012) suggest that polarity may protect against high-risk behaviors common to borderline personality disorder, including binge eating and substance use.

Although these constructs are promising indicators, there has been markedly little research testing emotional complexity in relation to behavioral adaptation in times of heightened stress. Limited prior research has investigated benefits of emotional complexity against stress with respect to health behaviors (Coifman et al., 2014) and depression/anxiety (Nook et al., 2021; Starr et al., 2020) but not risk behaviors. This is important because considerable research suggests that emotional complexity is harder to accomplish under high stress, with most individuals exhibiting more simplified and polarized emotion conceptualizations (Coifman et al., 2012; Erbas et al., 2018; Zautra, 2003). Moreover, emotional complexity indicators have generally been examined separately and emerging research suggests that it may be important to consider their

differential effects on psychological outcomes (e.g., Liu et al., 2020). Therefore, given the stressful nature of the COVID-19 pandemic, it provides a naturalistic context to test whether benefits of emotional complexity (and which indicator in particular) would persist and prove protective against risk behaviors.

The Present Investigation

The present study tested associations between negative/positive emotion differentiation, polarity, and self-reported substance use and binge eating, respectively, during the early months of the COVID-19 pandemic. This was a secondary analysis of data collected from a larger study examining the effects of an online math intervention on COVID-19 risk perception from a demographically diverse sample of U.S. adults between March 24 and April 9, 2020, when states across the United States were implementing stay-at-home orders (Thompson et al., 2021).¹

Because previous research has suggested differentiation (particularly NED) and polarity could *both* provide benefits during stress, we predicted that NED and polarity would be negatively associated with substance use/binge eating. This association, however, was not hypothesized for PED given mixed prior findings. Although differentiation and polarity are estimates that reflect dynamic processes within the individual during emotion conceptualization that should be independent of the intensity (or level) of emotion, research has demonstrated that these processes become more challenging when negative emotions are high (e.g., Dejonckheere et al., 2019). Therefore, we controlled for mean affect intensity in our analyses. Finally, we tested these emotional complexity indicators simultaneously in the same model, which could provide information about the unique benefits of each construct and suggest key targets for intervention.

Method

Participants

Participants ($N = 627$) completed a baseline assessment and daily diaries administered through Qualtrics panels. The larger study found that the math intervention influenced COVID-19 risk perceptions, worry, and positive affect during some periods of the daily diary. Thus, we only included participants who received no intervention ($n = 353$).

Recruitment was stratified on key demographic dimensions (including age/sex/education) to match distribution across the United States (although the lowest level of education was underrepresented in the final sample). From this initial sample of 353, 85 participants (24%)² were excluded owing to insufficient diaries or variability in negative/positive affect ratings to derive emotional

¹ Details regarding the math intervention and diary variables are documented in Thompson et al. (2021). The OSF preregistration (including the data) can be accessed here: <https://osf.io/9hc7d> (Fitzsimmons et al., 2021).

² There were no significant differences in demographics (age, sex, race, or ethnicity) between excluded individuals and the final sample. Of those excluded, $n = 36$ responded to only one diary entry whereas $n = 36$ had insufficient variability in affect ratings (e.g., rating of 1 across affect items, across days), which made it impossible to derive intraclass correlation coefficient values of differentiation. The remaining $n = 13$ did not report age or biological sex.

complexity indicators ($n = 72$) or other missing data ($n = 13$). We excluded 69 more participants because we were unable to derive reliable indices of differentiation. The final sample ($n = 199$) was 55% female, 80% White/Caucasian, and reported mean age of 50.42 ($SD = 16.06$). Detailed demographics are available in the online supplemental materials.

Procedure

Participants provided online informed consent and completed a baseline online session assessing math skills. This involved comparing fatality information for COVID-19 versus the flu and solving math problems related to health decision-making. The control group received no intervention nor guidance/support/feedback when making comparisons or completing problems. Afterward, participants were invited to complete 10 days of electronic diaries. Those who did were compensated \$1 per diary (up to \$10 total). Attention checks were embedded to assess engagement with online materials. Study procedures were approved by Kent State University IRB.

Measures

Experience Sampling Diary

Participants received 10 days of once-daily diaries by e-mail via Qualtrics at 7:00 p.m. (EST).³ For each diary, participants rated emotions and reported engagement in substance use and binge eating over the past day (see online supplemental materials). The mean number of diaries completed across 199 participants was 8.63 ($SD = 1.96$; range: 2–10), indicating adequate compliance (86%).

Momentary Self-Reported Emotions. Participants provided ratings of current emotional state on a 5-point Likert scale, ranging from 1 = *not at all* to 5 = *extremely* across six negative (*fear, sadness, distress, anger, disgust, guilt*) and six positive (*relief, enjoyment, amusement, happiness, affection, joy*) emotion words, forming the NA and PA scales. These words were selected based on affective circumplex models commonly used in studies of polarity and differentiation (Rafaeli et al., 2007; Seah & Coifman, 2021). Order of word presentation was randomized and counter-balanced. Reliability was computed at between-person (R_{KF}) and within-person (R_C) levels (Cranford et al., 2006). Emotion scales demonstrated good reliability (NA scale: $R_{KF} = .99$, $R_C = .71$; PA scale: $R_{KF} = .99$, $R_C = .77$).

Mean Affect Intensity. Mean levels of NA and PA were calculated for each participant across all diaries.

Emotion Differentiation. NED/PED were derived by calculating the average intraclass correlation coefficient (ICC) with absolute agreement for negative/positive affect ratings respectively across all diary signals by participant (Seah & Coifman, 2021). Sixty-nine participants had negative ICCs for NED ($n = 37$) and/or PED ($n = 38$). Because reliable ICCs are between 0 and 1, we excluded these negative values (Giraudeau, 1996).⁴ Higher ICCs indicate greater similarity in ratings across affect items, suggesting poorer differentiation. To ease interpretation, ICC values were subtracted from 1 so that higher values indicated higher NED/PED (Kashdan et al., 2015).⁵

Emotion Polarity. Polarity was derived via mixed-level modeling where the random effects for the slope coefficient are retained as a person-level index that estimates the within-person momentary association of negative/positive emotional experience across all diaries (Rafaeli et al., 2007). Lower scores (more negative associations) reflect a highly dichotomous or polarized emotional experience (e.g., feeling good *or* bad) or less complexity.

Substance Use. For each diary, participants completed two items assessing whether they “used substances (refers to alcohol, stimulants, and/or intoxicating substances or drugs)” or “misused medication (refers to using over-the-counter or prescribed medication in ways that were not intended, including using more amounts than indicated on the label)” over the past day. If an individual engaged in *either* behavior (substance use/misused medication) on a given day, we coded a score of 1 and 0 if not. Combining across both items, 49% of participants reported substance use at least once.

Binge Eating. Participants also reported whether they “binged on food (refers to eating an amount of food larger than most people would eat in the same amount of time while feeling a lack of control)” over the past day. Forty-eight percent reported binge eating at least once.

Data Analytic Plan

Inspection of the data indicated positively skewed distribution of substance use (skewness = 1.44) and binge eating (skewness = 1.85) owing to excessive zero scores. Specifically, individuals denied engaging in substance use or binge eating 79% and 84% of the time, respectively, across the sampling duration. Moreover, of all participants, 51% and 52% did not at all engage in substance use and binge eating, respectively. Note that such skewed distributions are common in research investigating risk behaviors (e.g., substance use) in the general population (Atkins et al., 2013).

Owing to the nested data structure and excessive zeros, we used zero-inflated negative binomial (ZINB) mixed effects modeling using GLMMadaptive package (v0.8-5) in R v4.1.3 (Rizopoulos, 2022).⁶ ZINB is appropriate for data with excessive zeros because it assumes

³ Given that participants could live in different time zones, they received each diary at their local time (e.g., 4:00 p.m. for those living on the West Coast). Participants had up to 5 hours after receiving each diary to complete it. Importantly, there were no differences in diary compliance based on time zone or geographic region. Information regarding other variables measured in the diary as part of the larger study can also be accessed here: <https://osf.io/9hc7d> (Fitzsimmons et al., 2021).

⁴ Note that negative ICC scores are common in differentiation research (e.g., Liu et al., 2020; Seah et al., 2020). However, there is no current consensus regarding interpretation of negative ICC values as an index of differentiation (Seah & Coifman, 2021). Therefore, we opted to exclude them from our analyses to be cautious.

⁵ Some researchers have opted to normalize distribution of raw ICC values using a Fisher's z transformation (e.g., Kalokerinos et al., 2019). Our results remained the same even when using ICC values that were Fisher-transformed. Specifically, mean NA was significantly positively associated with frequency of substance use ($B = .36$, $SE = .14$, $p = .008$) and binge eating ($B = .40$, $SE = .11$, $p < .001$). Similarly, NED significantly predicted zero-values (i.e., did not use substances at all [$B = 6.49$, $SE = 2.95$, $p = .028$] nor binge eat [$B = 7.01$, $SE = 3.39$, $p = .038$]).

⁶ We initially analyzed the data using fixed effects ZINB regression. Despite differences in analytic strategy, results were similar: mean NA was positively associated with substance use ($B = .29$, $SE = .14$, $p = .044$) and binge eating ($B = .37$, $SE = .10$, $p < .001$); NED significantly predicted zero-values (i.e., did not use substances at all [$B = 2.48$, $SE = .98$, $p = .011$] nor binge eat [$B = 3.28$, $SE = 1.01$, $p = .001$]).

that zero-values are attributable to a mixture of two distinct populations: one where the target behavior is always absent (e.g., individuals who do not use substances at all), also known as “true zero,” and another population of individuals who would sometimes use (expected users) but not within the sampling period, also known as “sampling zero” (Coxe et al., 2009). Therefore, in ZINB, predicting the frequency of a behavior is conditional on the likelihood of the values being from a hypothetical subsample of individuals that are predicted to “always” report zero behavior. ZINB models also allow either the use of different sets of predictors to predict the two outcomes (zero-values and counts) or use the same set of predictors and determine whether they are differentially associated with the outcome, while also accounting for overdispersion in the data.

Here, we used the same set of predictors (mean affect intensity and emotional complexity indicators) to predict zero-values (i.e., likelihood of not using substances/binge eat) and counts (i.e., frequency of behavior among individuals expected to engage in substance use/binge eating) to examine the differential predictive utility of predictor variables. Separate mixed-models were used to predict substance use/binge eating each day (yes/no) with all predictors entered at the between-person level. This approach allows for aggregation of behaviors across the duration of sampling while accounting for random intercepts. All predictors were grand-mean-centered to aid interpretation of results. Given that participants varied in the number of diaries completed, we also included the natural log of the number of diaries completed as an offset variable with regression coefficient equal to 1 in our models.

Power Considerations

We anticipated small effects given past research examining associations between differentiation/polarity and risk behaviors (Coifman et al., 2012; Seah & Coifman, 2021), as well as variability in our sample’s age range (where these behaviors are likely to be enacted less frequently in older adults) and the unusual stressful context. Power estimation for ZINB requires simulation that would have to be based on prior information that was unavailable (Doyle, 2009; Williamson et al., 2021). Hence, we relied on past studies that have also used ZINB regression models to predict similar outcomes with comparable sample size (e.g., Simons et al., 2006: $n = 292$), suggesting that our investigation would be adequately powered.

Results

Preliminary Analyses

Table 1 provides the bivariate correlations between primary outcome variables (including mean, *SD*, and range).⁷ Frequency of substance use and binge eating were positively associated with each other and mean NA but not significantly associated with NED, PED, or polarity. As in past research, emotional complexity indicators were positively associated.

Primary Analyses

Substance Use

Table 2 describes results of the ZINB mixed-effects model. As in past research, mean NA ($B = .37, p = .005$) was positively associated with frequency of substance use (count model). Specifically, the

expected frequency of substance use was 1.45 times (or 45%) higher for each unit increase in mean NA (holding all other predictors constant). In contrast, NED ($B = 8.08, p = .009$) was associated with higher log odds of not using substances at all (zero model). No significant associations were observed for mean PA, PED, and polarity.

Binge Eating

Also described in Table 2, mean NA ($B = .40, p < .001$) was positively associated with frequency of binge eating (count model). The expected frequency of binge eating was 1.49 times (or 49%) higher for each unit increase in mean NA (holding all other predictors constant). Again, NED ($B = 11.45, p = .017$) was associated with higher log odds of not binge eating at all (zero model). No significant associations were observed for mean PA, PED, and polarity.

Discussion

The COVID-19 pandemic has been associated with increased psychological distress and risk behaviors such as substance use and binge eating. Given their deleterious consequences on mental and physical health, and the role of negative emotion in driving these behaviors, the present study sought to examine whether emotional complexity may be protective in this challenging context. Overall, we found that individuals who were more able to distinguish between negative emotions (differentiation) were less likely to engage in substance use and binge eating early in the pandemic, highlighting its protective effects. Importantly, this effect remained even after controlling for mean affect intensity, PED, and polarity. In contrast, PED and polarity were not associated with either behavior. Consistent with past research, NA predicted greater tendency to engage in both risk behaviors whereas PA was not associated (e.g., Selby et al., 2008). Together, these results provide further evidence for the unique benefits of NED even in highly stressful contexts like a pandemic.

Interestingly, that polarity was not associated with either behavior was inconsistent with prior findings. However, it may be that past research linking polarity to risk behaviors was in samples with greater variability in both polarity and risk behavior engagement (e.g., borderline personality: Coifman et al., 2012). We also did not find benefits of PED on risk behaviors (e.g., Williams-Kerver & Crowther, 2020), which contradicts some studies suggesting otherwise (e.g., Mikhail et al., 2020). These mixed findings highlight a need for further clarification of the role of PED in behavioral adaptation. Most important, however, is that NED remained beneficial even after statistically controlling for polarity and PED. Given shared variance among these indicators of emotional complexity, our findings suggest that NED may afford unique benefits during times of stress and highlight its relevance for intervention.

The following limitations should be considered when interpreting our findings. First, it is unclear the extent to which our sample was experiencing elevated stress because we did not directly assess stress levels. However, the negative psychological impact of the COVID-19 pandemic (particularly during the early months) is well-

⁷ We also explored demographic differences in frequency of substance use and binge eating owing to biological sex, ethnicity, and race in the final sample ($n = 199$). Results are reported in the online supplemental materials.

Table 1*Means, Standard Deviations, and Zero-Order Correlations Between Primary Outcome Measures (n = 199)*

Measure	1	2	3	4	5	6	7	8	9
1. Age	—								
2. Diaries completed	.01	—							
3. Mean negative affect	-.12	.01	—						
4. Mean positive affect	-.13	-.06	-.19**	—					
5. NED	.19**	.06	-.12	-.03	—				
6. PED	.18*	-.02	-.18*	.11	.24**	—			
7. Emotion polarity	-.003	.02	-.24**	.31**	-.26**	.16*	—		
8. Substance use ^a	-.07	.05	.14*	.05	-.01	.02	.02	—	
9. Binge eating ^a	-.26**	.08	.32**	.10	-.10	-.13	.01	.19**	—
<i>M</i>	50.42	8.63	1.99	2.05	.57	.45	-.03	1.79	1.39
<i>SD</i>	16.06	1.96	0.82	0.78	.26	.27	.27	2.68	2.05
Range	19 – 82	2 – 10	1.02 – 4.68	1.02 – 4.67	.08 – 1.00	.03 – 1.00	-.89 – .87	0 – 10	0 – 10

Note. NED = negative emotion differentiation; PED = positive emotion differentiation.

^aFrequency of behavior was aggregated across the period of sampling (up to 10 days).

* $p < .05$. ** $p < .01$.

documented (Aknin et al., 2022), which provides some support for our assumption. Next, our sample was demographically diverse on some aspects (age, sex, education) but was not racially diverse. Therefore, findings may not generalize to certain ethnic/racial minority groups. The frequency and duration of experience-sampling was also limited, potentially constraining the variability of experiences captured. The range and type of daily substance use and binge eating captured was also limited by single-item dichotomous (yes/no) measures. As with most research involving self-report, misinterpretation

of item wording is also possible. However, it was important to minimize participant burden during such a challenging time. Finally, the use of correlational analyses precluded interpretations regarding causality.

Despite limitations, the present research highlights the protective utility of emotional complexity against risk behaviors during periods of high stress, extending prior research in key ways. Importantly, NED uniquely predicted lower likelihood of substance use and binge eating, providing further support for its

Table 2

Zero-Inflated Negative Binomial Mixed-Effects Models Predicting Count of Days Engaging Behavior (Count Model) and Likelihood of Not Engaging Behavior at All (Zero Model)

Predictors	<i>B</i>	<i>SE</i>	<i>Z</i>	95% CI	<i>p</i>
Frequency of substance use (count model)					
Intercept	-3.78**	.22	-17.15	[-4.21, -3.35]	<.001
Mean negative affect	.37**	.13	2.82	[.11, .62]	.005
Mean positive affect	.17	.14	1.20	[-.11, .45]	.230
Negative emotion differentiation	.64	.44	1.48	[-.21, 1.50]	.139
Positive emotion differentiation	.38	.37	1.01	[-.36, 1.11]	.314
Emotion polarity	-.32	.40	-0.80	[-1.09, .46]	.423
Likelihood of not using substances at all (zero model)					
Intercept	-2.83**	.80	-3.52	[-4.41, -1.26]	<.001
Mean negative affect	-1.02	.80	-1.27	[-2.58, .55]	.202
Mean positive affect	-1.00	.91	-1.10	[-2.79, .79]	.273
Negative emotion differentiation	8.08**	3.08	2.62	[2.04, 14.13]	.009
Positive emotion differentiation	-1.31	2.34	-0.56	[-5.89, 3.27]	.576
Emotion polarity	-3.83	3.12	-1.23	[-9.95, 2.28]	.219
Frequency of binge eating (count model)					
Intercept	-3.75**	.22	-16.77	[-4.18, -3.31]	<.001
Mean negative affect	.40**	.11	3.65	[.18, .61]	<.001
Mean positive affect	.26	.13	1.95	[-.001, .52]	.051
Negative emotion differentiation	.44	.40	1.11	[-.34, 1.22]	.267
Positive emotion differentiation	.26	.45	0.57	[-.63, 1.14]	.571
Emotion polarity	-.30	.32	-0.94	[-.93, .33]	.345
Likelihood of not binge eating at all (zero model)					
Intercept	-2.35*	1.07	-2.18	[-4.45, -.24]	.029
Mean negative affect	-2.06	1.46	-1.41	[-4.92, .80]	.158
Mean positive affect	-1.45	1.47	-0.99	[-4.32, 1.43]	.323
Negative emotion differentiation	11.45*	4.79	2.39	[2.06, 20.84]	.017
Positive emotion differentiation	6.00	3.49	1.72	[-.83, 12.84]	.085
Emotion polarity	-5.47	3.65	-1.50	[-12.61, 1.68]	.134

Note. $n = 199$. *B* = unstandardized coefficient; *SE* = standard error; CI = confidence interval.

* $p < .05$. ** $p < .01$.

clinical relevance. Our findings suggest that how one conceptualizes negative emotional experience confers behavioral benefits, even during an unprecedented stressful context.

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