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Research Paper

A longitudinal investigation of the impact of emotional reactivity and COVID-19 stress exposure on substance use during the pandemic

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ABSTRACT

Background: Substance use has spiked during the COVID-19 pandemic, highlighting potential links between reactivity to pandemic-related stress and increases in substance use engagement. Leveraging population-level exposure to a novel environmental stressor, the current study investigated whether emotion reactivity measured prior to the pandemic predicts the degree to which COVID-related stress impacts future substance use during the pandemic.

Methods: Participants included 240 socioeconomically diverse adults ($M/SD_{age}=33.47/9.39$ years old) who were recruited from communities disproportionately impacted by the pandemic, with COVID-19 positivity and unemployment rates higher than the national average. All participants completed a research study prior to the start of the pandemic, and 90 of those participants were randomly selected to complete a follow-up study approximately six months into the pandemic.

Results: On average, the sample reported high levels of stressors that they attributed specifically to the COVID-19 pandemic. Results revealed that trait emotional reactivity moderated the impact of pandemic-inflicted stressors on future substance use, such that COVID-related stress exposure was associated with an increase in substance use for individuals who tend to experience negative emotions for prolonged periods of time.

Limitations: Limitations of the study are that the data were collected in a fixed timeframe of the COVID-19 pandemic and the exclusive use of self-report measures.

Conclusions: The longitudinal design of the present study extends the current literature by highlighting the potential role of emotional reactivity in predicting substance use coping behaviors. Findings suggest that emotion reactivity may be a useful intervention target among individuals highly impacted by the pandemic.

1. Introduction

The COVID-19 pandemic has not only led to devastating rates of illness and deaths worldwide but has also led to a spike in various mental health problems. One such clinical problem is increased engagement in substance use, with emerging work showing increases in initiation and severity of substance use during the COVID-19 pandemic (Czeisler et al., 2020). These elevated rates of substance use are particularly alarming given recent work that has shown that substance users are not only at an increased-risk for contracting the COVID-19 virus, but are also likely to suffer worse health complications and display poorer treatment outcomes than those who do not use substances (Wang et al., 2021; Wei and Shah, 2020). These data highlight substance use as a high-risk behavior during the COVID-19 pandemic, making the identification of those most vulnerable for increased substance use a high research priority.

Negative reinforcement models posit that substance use can lead to a reduction in negative affect, which in turn reinforces future substance use, particularly during negative emotional states (Goeders, 2004). Indeed, previous research shows that sustained stress exposure, like that caused by large-scale disasters, can lead to decreases in perceptions of coping self-efficacy, thus increasing the likelihood that individuals will turn to substance use to alleviate negative affect (Alexander and Ward, 2018). The COVID-19 pandemic has not only instilled fear of disease, but has also led to lifestyle changes (e.g., social distancing protocols, changes in work and home life), which have led to sustained increases in stress and uncertainty (Marroquín et al., 2020; McKnight-Eily et al., 2021; Ornell et al., 2020). In this context, increases in substance use during this period could be understood as a maladaptive coping strategy used to alleviate stress. Indeed, recent studies have linked COVID-related worry to substance use coping motivations (Rogers et al.,

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2020). Taken together, these findings suggest that substance use engagement may be particularly high among individuals who are heavily impacted by the pandemic (McKay and Asmundson, 2020; Taylor et al., 2021).

To address the elevated rates of substance use during prolonged stressors, like the COVID-19 pandemic, most effectively it is necessary to identify the characteristics of individuals who are at heightened risk for substance use and subsequent poor outcomes. Individual differences in emotional reactivity may be a particularly useful indicator given that individuals with high levels of emotional reactivity exhibit poor adjustment following stressful events (Busso et al., 2014). More specifically, individuals who score high on measures of emotional reactivity tend to report persistent and intense negative affect to a wide array of environmental stressors (Carthy et al., 2010), suggesting a trait-like emotional vulnerability that confers risk for a range of psychopathology and maladaptive behaviors (Nock et al., 2008). Given the prolonged duration of the COVID-19 pandemic, individuals who score high on the emotional persistence facet of emotional reactivity would be at particularly high risk of difficulties with emotion regulation and maladaptive coping, because they are likely to experience elevated arousal and negative affect throughout the pandemic (Boyes et al., 2017; Ripper et al., 2018).

Sustained negative affect in response to protracted environmental stressors may, in turn, cause individuals high on emotional persistence to engage in impulsive and maladaptive behaviors to provide temporary relief from the emotional distress (Crowell et al., 2009; Linehan, 1993). Consistent with this conceptualization, empirical evidence shows that emotional reactivity is associated with greater likelihood of substance use (Gottfredson and Hussong, 2013), with longitudinal studies showing that emotional dysregulation is predictive of future externalizing tendencies, such as substance use (Kim and Cicchetti, 2010). Presumably, these associations may be driven by the desire to cope with ongoing negative affect, which is consistent with developmental models of substance use disorders that posit trait-levels of emotional reactivity interact with environmental stressors to predispose some individuals to develop problematic substance use behaviors (Chaplin et al., 2018).

Although previous work has shown that substance use rates tend to increase during largescale stressors, substantially less is known about moderating factors of this association. This limits our ability to identify individuals at greatest risk for increased substance use following stress exposure, which is key for prevention and intervention efforts. Leveraging population level exposure to a novel environmental stressor, the current study extends previous literature by testing whether (i) COVID-19 related stress exposure predicts substance use during the pandemic above and beyond pre-pandemic substance use levels in a sample of community adults and (ii) dispositional emotional persistence measured prior to the pandemic moderates the impact of COVID stress on substance use behaviors. We hypothesized that (i) COVID-19 stress exposure would positively predict substance use during the pandemic above and beyond baseline substance use and (ii) the tendency to experience persistent negative emotions in response to environmental stressors would significantly moderate the association between COVID and substance use behaviors, such that this association would be strongest among individuals characterized by high emotional persistence.

2. Methods

2.1. Participants

Participants were 240 community adults ($M/SD_{age}=33.47/9.39$; 50.5% women) who completed a baseline research study prior to the COVID pandemic (between November 2017 to February 2020). Participants were recruited from the community using flyers and online advertisements, and interested individuals were eligible to participate if they were between the ages of 18–55 and fluent in the English language.

A subset of these participants ($N = 93$) was randomly selected to complete a follow-up study approximately six months into the COVID-19 pandemic (between August 2020 and September 2020) that sought to assess current functioning during the pandemic. Importantly, most of the sample came from communities that were disproportionately impacted by the pandemic, with COVID-19 positivity and unemployment rates higher than the national average at the time of assessment (Cerron, 2020).

2.2. Procedure

Written and oral consent was obtained from all individuals prior to participation. Participants completed a battery of self-report measures, a clinical interview, and a neuroimaging protocol across two study visits. The University Institutional Review Board approved all protocols and procedures (Protocol #'s: 1073423-17, 1361164-1, 1590453-6). All participants completed an in-person research study prior to the start of the COVID-19 pandemic. A subset of participants was invited to complete a virtual follow-up study seeking to examine impacts of the COVID-19 pandemic on mental health and engagement in risky behaviors.

2.3. Measures

COVID stress. A COVID-19 Impact Scale was created for the present study to assess

COVID-19 stress exposure. Eighteen items were used to assess for stressors spanning social (e.g., social disconnectedness), financial (e.g., difficulty paying bills), and health (e.g., contracting COVID-19) domains, in addition to difficulty accessing basic needs (e.g., medical attention, access to transportation) and changes to daily life (e.g., loss of childcare). A complete list of items and frequency of endorsement are provided in Table 1. To ensure that the stressor was caused specifically to the COVID-19 pandemic, participants were asked to indicate whether the stressor “happened *BECAUSE* of the COVID-19 pandemic (1)” or “did not happen (0)”. A total score was computed by summing the number of stressors endorsed that showed good internal consistency in this sample (range = 0–14 stressors; Cronbach’s alpha=0.82). Positive skewness was further reduced using a Blom transformation prior to data analysis.

In addition, a single item was used to assess for degree of COVID-related worry. Specifically, participants were asked to indicate how much time they spent worrying about the COVID-19 pandemic on a scale from 1 (“never”) to 5 (“most of the day”). This measure was used in follow-up analysis to assess for psychological distress related to the pandemic as a potential predictor of future substance use.

Substance use. Lifetime substance use was assessed using the *Risky, Impulsive, and Self-Destructive Questionnaire* (RISQ; Sadeh and

Table 1
Frequency of endorsement of COVID-19 stressors.

COVID-Stressors	% Endorsed
Feeling disconnected from friends or family	58.3%
Major changes in working hours or working conditions	53.6%
Social isolation (e.g., loss of friendships)	41.7%
Major change in finances (e.g., more debt)	36.9%
Separation from family members	32.1%
Difficulty paying bills and/or buying groceries	31.0%
Religious or cultural activities disrupted	24.4%
A family member or close friend contracted COVID-19	21.4%
Increase in childcare responsibilities (e.g., loss of daycare)	21.4%
Change in living situation or condition	20.2%
Increase in the number of arguments with family or friends	17.9%
Loss of employment or job	15.5%
Difficulty getting transportation	14.3%
Difficulty getting medical care	13.1%
Family member became serious ill	7.1%
Death of a loved one or close friend	3.6%
You became seriously injured or ill	2.4%
You contracted COVID-19	1.2%

Baskin-Sommers, 2017), a self-report measure that assesses a range of adult risky behaviors. Eight substance use items included engagement in five types of illicit drugs [sedatives, cocaine/crack, marijuana, heroin, hallucinogens], misuse of prescription drugs (e.g., abusing currently prescribed drugs, using prescriptions illicitly), and two excessive use of alcohol behaviors. As described elsewhere (Sadeh and Baskin-Sommers, 2017), responses to each item were categorized into five bins that constrained the range of possible responses at the high end of the distribution: 0, 1–10, 11–50, 51–100, >100 times. Skewness was further reduced using a Blom transformation prior to data analysis.

Lifetime substance use: A total lifetime frequency composite score was created by summing items to index lifetime substance use engagement, which showed excellent reliability in our sample (Cronbach's alpha = 0.87).

Pandemic substance use: For each substance, participants were asked to indicate how many times they engaged in these behaviors in the past 30 days. A past-month substance use composite score was created by summing the same eight substance use items in the past 30 days to index substance use during the COVID-19 pandemic. Skewness was reduced using a Blom transformation prior to data analysis. Almost half of participants (48.8%) reported some degree of past-month substance use during the pandemic, with frequencies ranging from one time to 500 times in the past 30 days (median=10 times).

Emotional persistence. The tendency to experience negative emotional responses for a prolonged time was assessed using the *Emotion Reactivity Scale* (Nock et al., 2008). The *Persistence* subscale consists of four items and assesses how long emotional responses tend to last (e.g., “when I am angry/ upset, it takes me much longer than most people to calm down.”; “when something happens that upsets me, it’s all I can think about for a long time”). Items are rated on a five-point Likert scale from 0 (“not at all like me.”) to 4 (“completely like me.”). This measure was administered at the baseline assessment and responses were averaged to create an Emotional Persistence score. This subscale showed excellent reliability in our sample (Cronbach's alpha = 0.82).

2.4. Data analytic plan

A series of ANOVA and chi-square tests were conducted to determine whether group differences in demographic characteristics and key study variables existed between participants with follow-up data (N = 93) vs. no follow-up data (N = 147). We found that these individuals did not differ in age (p = 0.06), biological sex (p = 0.79), trait emotional reactivity (p = 0.33), or pre-COVID substance use (p = 0.07). Consistent with previous work (e.g., Lusk et al., 2017), maximum likelihood with robust standard errors (MLR) was used to account for missing data using full information maximum likelihood estimation (Allison, 2003), which allowed the use of all available data (e.g., all participants with pre-COVID baseline assessment) in the analyses. First, we conducted a linear regression to test whether COVID Stressors impacted Pandemic Substance Use above and beyond Lifetime Substance Use. Next, an interaction term was added to test whether Emotional Persistence moderated the association between COVID Stressors and Pandemic Substance Use, with Lifetime Substance Use included as a covariate. Age and biological sex were also included as covariates. Standardized results are reported below.

All analyses were conducted in Mplus v.8 (Muthén and Muthén, 2017). Data used in this study can be made available upon request from the authors.

3. Results

Descriptive statistics revealed high rates of exposure to an array of COVID Stressors (see Table 1). Notably, slightly more than half of participants reported feeling physically disconnected from family and friends (58.3%) and experiencing major changes in work schedules and/

or conditions (53.6%). Over a third of participants reported a major change in finances, such as increased debt or loss of income (36.9%). Although only 1.2% of the sample reportedly contracted the COVID-19 virus, 21.4% of participants reported having a family member or close friend who contracted the novel coronavirus. No sex differences emerged for total COVID Stress ($\beta = -0.08, p = 0.43$). However, age was negatively correlated with COVID Stress, such that older participants reported less stress exposure than younger adults.

As expected, pre-COVID substance use was a strong positive predictor of substance use during the pandemic ($\beta = 0.62, p < 0.001$). Notably, COVID Stress positively predicted substance use during the pandemic above and beyond lifetime history of use ($\beta = 0.21, p = 0.04$), such that individuals who reported more COVID-related stress exposure also reported more substance use engagement during the pandemic. We then tested a moderation analysis to examine whether baseline levels of trait Emotional Persistence moderated the observed association between COVID Stressors and Pandemic Substance Use. Results are reported in Table 2. The analysis revealed a significant interaction between COVID Stress and Emotional Persistence on Pandemic Substance Use ($\beta = 0.45, p < 0.001$), such that COVID Stress was associated with greater substance use for individuals who tend to experience negative emotions for prolonged periods of time, over and above pre-pandemic levels of substance use (see Fig. 1). The model explained 54.1% of the variance in substance use during the COVID-19 pandemic.

Next, we ran a supplementary analysis to test whether psychological distress related to the pandemic and trait emotional reactivity was also predictive of increased substance use. As expected, a significant interaction between COVID-related Worry and Emotional Persistence on Pandemic Substance Use emerged ($\beta = 0.48, p = 0.02$), such that time spent worrying about COVID-19 was associated with greater substance use for emotionally-reactive individuals who tend to experience negative emotions for prolonged periods of time, above and beyond included covariates. This suggests that psychological distress may represent a key potential mechanism of risk transmission that warrants further investigation.

4. Discussion

There is a critical demand for substance use intervention services during the COVID-19 pandemic, given rising rates of substance use during the pandemic and emerging data showing that substance-using individuals are at high-risk for poor health and treatment outcomes that are exacerbated by the unique challenges of the COVID-19 pandemic (Ornell et al., 2020). To address this need, research must investigate individual differences in the susceptibility of increased substance use during protracted large-scale stressors, to identify those individuals at greatest risk for poor health outcomes. The current study examined whether and, for whom, COVID-19 stress exposure impacted substance use engagement using a longitudinal design that accounted for pre-pandemic substance use and examined trait emotional persistence as a predisposing vulnerability factor for pandemic-related increases in substance use. Our results indicated that exposure to COVID-19 stress was associated with more substance use

Table 2
Emotional persistence moderates the impact of COVID stress on past month substance use during COVID-19 pandemic.

Model	B (SE)	P-value
Age	-0.03 (0.09)	0.76
Sex	0.02 (0.08)	0.84
Baseline Lifetime Substance Use	0.64 (0.08)	<0.001
COVID-related Stressors	-0.17 (0.15)	0.25
Dispositional Emotion Persistence	0.04 (0.07)	0.64
COVID-related Stress X Emotion Persistence	0.45 (0.11)	<0.001

Note. N = 240. Biological sex was coded as Female (0) and Male (1). R² = 0.54. Bolded terms represent significant effects at the p < 0.001 level.

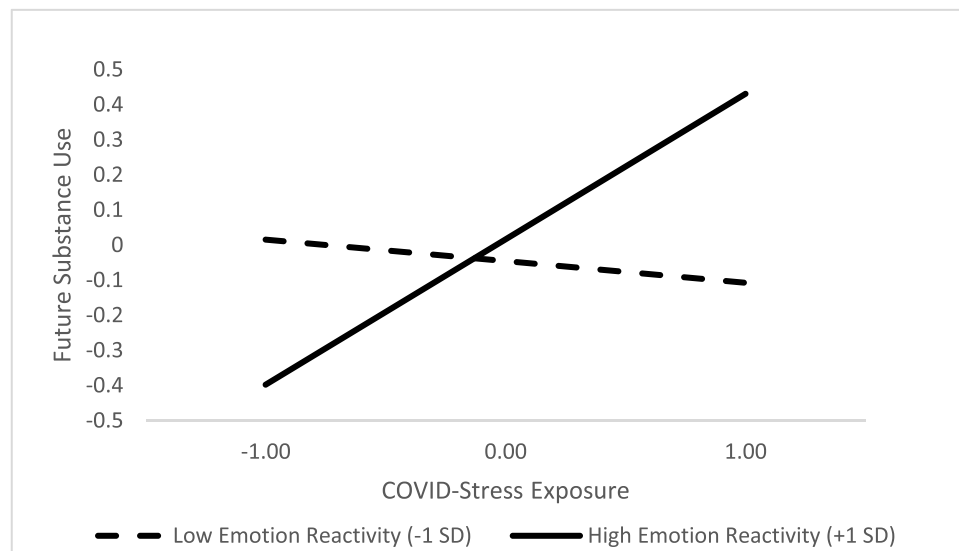


Fig. 1. Trait emotional reactivity moderates the impact of COVID stress and future substance use.

approximately six months into the pandemic, even after accounting for lifetime history of substance use. Further, findings revealed that the persistence component of emotional reactivity moderated this association, suggesting that individuals who experience prolonged negative affect are at particularly elevated risk for increased engagement in substance use among those who are experiencing high rates of COVID stress.

Existing research shows that collective stressors are often associated with increases in an array of mental health issues, including substance use, and newly available data have shown similar increases in substance use engagement during the COVID-19 pandemic (e.g., Czeisler et al., 2020). Indeed, the COVID-19 pandemic not only resulted in increased worry about disease contraction, but also posed significant and sustained changes to lifestyle routine and social interactions (e.g., mandatory quarantines, social distancing protocols), which in and of themselves have been linked to increases in stress, anxiety, and depression (e.g., Marroquín et al., 2020). Our results showed a main effect of COVID-19 stress exposure on substance use, even accounting for lifetime history of pre-pandemic substance use frequency, suggesting as the degree of stress exposure increases, so does the degree of substance use engagement. Consistent with negative reinforcement models of substance use (Baker et al., 2004), these findings suggest that the observed increases in substance use during the pandemic may be a means of coping with ongoing stress. Indeed, one recent study found that COVID-related worry was associated with higher endorsement of using substances to cope (Rogers et al., 2020). The longitudinal design of the present study extends these findings by showing emotional persistence assessed prior to the pandemic impacted substance use as it related to COVID-19 stress, highlighting the potential role of emotional reactivity in predicting substance use coping behaviors.

While existing research has identified risk factors for substance use during large-scale stressors, less research has sought to examine moderators of this relationship. Given that not all individuals engaged in substance use during the COVID-19 pandemic, there may be trait-level vulnerability factors that predispose some individuals to be at greater risk to engage in substance use following stress. The current findings revealed that the effect of COVID stress and substance use was stronger for individuals who tend to experience negative emotions for prolonged periods of time. One potential explanation of this relationship may be that the tendency to engage in perseverating cognitive styles (e.g., worry, rumination) perpetuates negative affect, which in turn interferes with successful use of emotion regulation strategies and may explain the slow return to baseline following emotional reactivity to stressors

(Brosschot et al., 2005). In the context of sustained stress exposure during the pandemic, the tendency to engage in emotional perseveration may represent a deficit in emotion regulatory capacity that increases the likelihood of substance use in the face of COVID-related stress. This interpretation would be in line with recent work linking emotion dysregulation to increased substance use during the COVID-19 pandemic (Buckner et al., 2020).

The urgent need for substance interventions during the COVID-19 pandemic has already been established, given the alarming rates of substance use and emerging data showing the substance-using individuals are particularly vulnerable to poor COVID-19 outcomes (Dubey et al., 2020). To address this need, it is necessary to illuminate individual differences in emotional functioning that may exacerbate stress-induced substance use. Findings suggest that it may be useful for clinicians to assess for trait emotional reactivity, to identify those at elevated risk for substance use during sustained stressors, like a global pandemic. This is particularly important given findings from one study that found that emotional reactivity, as opposed to frequency of negative emotions, was a unique predictor of symptom reduction in a clinical trial of the unified protocol for the transdiagnostic treatment of emotional disorders (Sauer-Zavala et al., 2012). Given research linking emotion dysregulation, stress reactivity and substance use among stress-exposed individuals (e.g., Tull et al., 2018), our findings suggest that substance use treatments should seek to target emotional reactivity in relation to pandemic stress as a potential means to decrease substance use. Specifically, treatments that target emotion regulation, such as Dialectical Behavior Therapy (DBT; Linehan, 1993), may be particularly useful in mitigating substance use among highly stressed exposed individuals. Indeed, one clinical trial found that DBT- Skills Training, which targets transdiagnostic emotion dysregulation, was effective at reducing emotion dysregulation and anxiety, while increasing effective emotion regulation skills usage (Neacsiu et al., 2014). Taken together, it appears that while trait emotional reactivity may be difficult to modify, the resulting impairment following prolonged emotional responses to stressors may be reduced through behavioral therapeutic approaches that target emotion regulation.

The current study has several strengths including recruitment of a socio-economically diverse sample of adults exposed disproportionately impacted by the COVID-19 pandemic, the use of a longitudinal design that examined predictive validity of trait emotional reactivity on future substance use, and a timely research question given the alarming substance use rates during the pandemic. Findings should be interpreted considering study limitations. First, data collection occurred between

October and December 2020, which precludes our understanding of how these processes may have manifested earlier in the pandemic. Second, given the reliance on self-report measures, replicating results with other measures (e.g., diagnostic interviews, urine screens) would bolster our findings. Third, the focus of this study was to examine emotional perseverance as a moderator of the association between stress exposure and substance use. However, there are likely other important moderators and mediators of this relationship that warrant further investigation in future studies. For example, future research could examine whether persistent psychological distress during sustained stressors, like the pandemic, is a mechanism of risk transmission among stress-exposed individuals.

Given the sustained stress inflicted by the COVID-19 pandemic, research is needed to identify individuals at greatest risk for substance use during this time. The goal of the current study was to examine whether the persistence component of emotional reactivity moderate the association between pandemic-related stress and substance use. Findings revealed that individuals that have the tendency to perseverate on emotional responses are at particular risk for engagement in substance use in the face of COVID stress. This finding suggests that substance use intervention efforts should target emotion reactivity as a means for reducing substance use among individuals highly impacted by the health pandemic. Findings from the current study could be bolstered by continued investigations into individual differences in the associations between COVID stress and substance use engagement.

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