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Predicting Negative and Positive Affect During COVID-19: A Daily Diary Study in Youths

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The COVID-19 pandemic has the potential to profoundly affect youths' mental health. Understanding predictors of affective responding to the pandemic is critical for prevention and intervention efforts. This study examines emotion regulation as an important predictor of youth's changes in positive and negative affect. The present study of 115 participants (62 girls, M_{age} = 11.77) explores the relation between pre-existing emotion regulation strategies, as measured by multi-week daily diaries pre-COVID, and youths' mean positive and negative affect levels and variability during a 28-day period amidst the pandemic, while including COVID-related worries and isolation as important moderators. The findings provide important insight into interactions between pre-existing vulnerabilities and COVID-related stressors in predicting affective adjustment in youth.
Key words: emotion regulation – stress coping – positive affect

The outbreak of a novel coronavirus disease (COVID-19) has been projected to negatively impact the mental health of countless individuals around the world (Guessoum et al., 2020). Especially in the initial phase of the pandemic, daily life was affected in numerous ways. In the United States, most schools closed along with other public places, and "stay at home" orders were put in place while cases of COVID-19 infections and deaths increased rapidly. This initial phase of the pandemic in the United States was a rapidly changing situation with high levels of uncertainty regarding the duration and severity of the pandemic (Polack et al., 2021; Koffman, Gross, Etkind, & Selman, 2020). This stressful situation set the stage for worries about the risk of COVID-19 infection and other impacts of the pandemic, which may have increased rates of anxiety and led to other changes in daily affect (Taylor, Landry, Paluszek, Rachor, & Asmundson, 2020). In addition, social isolation resulting from social distancing recommendations and lockdown measures may have resulted in increasing rates of depression and other adverse psychological outcomes (Banerjee & Rai, 2020; Pietrabissa & Simpson, 2020).

Indeed, accumulating evidence on the impacts of COVID-19 shows that concerns about contagion and social restrictions were linked to heightened levels of negative affect among adults (Megias-Robles, Gutierrez-Cobo, Cabello, Gomez-Leal, & Fernandez-Berrocal, 2021; Sica et al., 2021; Zhang, Gao, Gross, Shrum, & Hayne, 2021). Fewer studies, however, have focused on the impact of COVID-19 on children and adolescents. Given that adolescence is a period characterized by heightened stress sensitivity, however, adolescents may be especially sensitive to the challenges posed by the pandemic (Cohodes, Kitt, Baskin-Sommers, & Gee, 2021). In addition, adolescence is a time of increased need for peer interactions (Orben, Tomova, & Blakemore, 2020). Therefore, adolescents may have experienced significantly elevated levels of isolation and distress as a result of COVID-related social restrictions (Guessoum et al., 2020; Loades et al., 2020). To better understand how the early stages of the pandemic affected adolescents' well-being, this study examined the associations between COVID-related worries, concerns about social restrictions, and adolescents' affect during the first months of the pandemic, when "stay at home" recommendations and school closures were still in effect. The present study focused on changes in negative and positive affect, examined by daily diary assessments over several weeks. Importantly, not everyone reacted to the pandemic in the same way. The present investigation aimed to better understand individual differences in responding to these challenges by examining whether pre-pandemic indi-

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vidual differences in emotion regulation were a predictor changes in negative and positive affect during this time.

Daily Changes in Negative and Positive Affect

Given the uncertainty and constant changes in the early phase of the pandemic, affect changes in response to new stressors need to be examined as a dynamic process. While most of the existing research on COVID-related impacts has relied on one-time, retrospective assessment, the current study utilized repeated daily assessments to capture adolescents' daily negative and positive affect over time. Stressful events generally increase the experience of negative affect (Troy, Saquib, Thal, & Ciuk, 2019), and not surprisingly, previous work has mostly focused on the observation of increased rates of negative affect in adults during COVID-19 (Megias-Robles et al., 2021; Zhang et al., 2021). However, other work suggests that changes in positive affect may be an indicator of longer-term negative outcomes and increase risk for mental disorders such as depression (Young, Sandman, & Craske, 2019). Further, higher levels of positive affect are associated with better psychological adjustment in times of crisis, and greater well-being following stressful life events (Burke et al., 2019; Forbes, Eckstrand, Rofey, & Silk, 2021; Tugade & Fredrickson, 2004). Positive affect has been shown to serve as a protective factor that allows adults and adolescents to better recover from stress and promotes post-traumatic growth (Forbes et al., 2021; Orejuela-Davila, Levens, Sagui-Henson, Tedeschi, & Sheppes, 2019), which may be especially relevant to adolescents' ability to cope during the ongoing COVID-19 pandemic.

Notably, in addition to mean levels of affect, *variability* in affect is an important measure of emotional responding (Kuppens, Van Mechelen, Nezlek, Dossche, & Timmermans, 2007; Rocke, Li, & Smith, 2009) that may predict functional outcomes in adolescents. For example, greater positive affect variability signifies less stable positive affect, which has been linked to depressive symptoms and other adverse psychological outcomes in adolescents (van Roekel et al., 2016). Similarly, greater negative affect variability can interact with higher levels of negative affect, predicting higher risk for psychopathology in youth (Nelis & Bukowski, 2019; Schneiders et al., 2006). Examining variability in affect is only possible with repeated daily assessments of affect across an extended period of time (Trull, Lane, Koval, & Ebner-Priemer, 2015). Therefore, this daily diary study captured not only the cumulative effects of the pandemic on affect, but also the day-to-day dynamic changes in affect as measured by variability.

Predictive Utility of Emotion Regulation

To better understand changes in affect during times of stress, it is important to consider existing emotion regulation strategy use. Emotion regulation refers to a heterogeneous set of processes by which emotions are modified (Gross, 2014). Indeed, different emotion regulation strategies may either upregulate or downregulate affect (Orejuela-Davila et al., 2019; Troy et al., 2019), and have been linked to heightened risk for anxiety and depression in response to stressful events (Joormann & Stanton, 2016; Sheppes et al., 2014). A close examination of individual differences in emotion regulation strategy use seems particularly important in youths exposed to stressors (Bariola, Gullone, & Hughes, 2011; Zeman, Cassano, Perry-Parrish, & Stegall, 2006). As a period characterized by increasing academic and social challenges, adolescence is also a time in which youths are expected to become more independent in their own emotion regulation strategy use, separate from the reliance on caregivers (Eisenberg et al., 2001). Indeed, prior work proposed that the increase in emotion regulation demands is related to the increasing rates of depression during adolescence (Forbes, Fitzpatrick, Magson, & Rapee, 2019).

Emotion regulation strategies have been shown to be differentially effective in regulating affect (Berking & Wupperman, 2012; Berking et al., 2008), to predict varied stress responses (Krkovic, Clamor, & Lincoln, 2018), and to incur additional costs in adolescents' psychological well-being longitudinally (Henry, Castellini, Moses, & Scott, 2016). Such predictive utility of emotion regulation strategies highlights the importance of studying emotion regulation not only as a mechanism linked with heightened risk of emotional disorders (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Barlow, Allen, & Choate, 2016; Fresco, Mennin, Heimberg, & Ritter, 2013), but also as a prospective predictor of longitudinal functional outcomes. For instance, greater engagement in rumination predicts hyper-reactivity to subsequent stressors (Krkovic et al., 2018) and elevated suicidal ideation a year later (Miranda & Nolen-Hoeksema, 2007), whereas frequent use of savoring predicts overall well-being and life satisfaction (Ramsey & Gentzler, 2014). Differential longitudinal outcomes have been linked

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with habitual use of different emotion regulation strategies. In response to negative affect, for example, problem-solving is often linked with better coping (Sarfan, Gooch, & Clerkin, 2018), whereas rumination is seen as responsible for a deteriorated mood and an elevated risk for depression among adolescents (Donaldson & Lam, 2004; Kuyken, Watkins, Holden, & Cook, 2006).

While early work on emotion regulation has primarily focused on responding to negative affect, increasing evidence has underlined the importance of the regulation of positive affect (Forbes et al., 2021; Young et al., 2019). In particular, savoring, as a response to positive events that enhances the experience of positive affect (Miyamoto & Ma, 2011; Wood, Heimpel, & Michela, 2003), has a negative association with symptoms of depression and other affective illnesses, in both children and adults (Irvin, Bell, Steinley, & Bartholow, 2020). Dampening, on the other hand, downregulates the experience of positive affect and has been associated with higher depressive symptoms (Feldman, Joormann, & Johnson, 2008). The tendency to engage in dampening over savoring as a response to positive affect has been linked with not only lower self-esteem and reduced life satisfaction (Wood et al., 2003), but also symptoms of depression and anxiety (Eisner, Johnson, & Carver, 2009). These studies show the importance of considering individual differences in emotion regulation when predicting affective responding to a stressful event such as COVID-19.

The Present Study

To assess dynamic changes in the affective experience of children and adolescents from before COVID-19 to the early phase of the pandemic, this study used multi-week daily diaries at both time points to enable assessment of mean levels of affect as well as affect variability (Trull et al., 2015). In particular, individual differences in COVID-related worries and in responding to COVID-related social restrictions were assessed to examine how these interacted with pre-COVID individual differences in emotion regulation to predict positive and negative affect.

We hypothesized that onset of COVID-19 would be associated with affective disturbance, manifested as increases in mean negative affect and negative affect variability, as well as decreases in mean positive affect and increases in positive affect variability. We further predicted that changes in affect would be positively related to COVID-related worries and responding to social restrictions. Finally, we hypothesized that pre-COVID use of emotion regulation strategies would interact with COVID-related worries and social isolation in predicting affect levels and variability during the pandemic, contributing to the differential susceptibility to adverse effects of stress among youths. In particular, we hypothesized that greater tendency to use savoring and problem-solving (previously linked to better outcomes) would increase positive affect and downregulate negative affect when under stress. We further hypothesized that greater tendency to engage in dampening and rumination (previously linked with worse outcomes) would be associated with lower levels of positive affect, higher levels of negative affect, as well as greater affect variabilities during COVID. To our knowledge, this is one of very few studies to examine adolescent affect before and during the pandemic, and the first study to examine the impact of pre-COVID regulation strategies on affective experiences during COVID.

METHOD

Participants

Wave 1. The study was advertised via flyers in the Yale University area, Craigslist, and social media. Youth aged 9-15 were invited to participate in a 21-day daily diary study about emotions and social interactions. Participants were only included if they had daily access to any device connected to the Internet (e.g., mobile phone, tablet, and computer). Compensation was $40 for those who completed 60% of surveys (i.e., at least 13 diary entries) and $60 for those who completed at least 90% (i.e., at least 19 diary entries). Of the 148 participants recruited, 139 youths (94% of the overall sample; 73 girls and 66 boys; M_{age} = 11.89, SD = 2.14) completed at least 60% of all diary entries and 103 participants completed at least 90% of all diary entries. The age range was 8–15 after including children who turned 9 during the diary period. Participants completed a mean of 19.08 (of 21) diary entries (SD = 2.14).

Wave 2. Participants who completed Wave 1 and indicated an interest in future studies were invited to Wave 2 of the study. Wave 2 consisted of a one-time "COVID Impacts" questionnaire and a 28-day diary period. Considering the increased length of Wave 2 diary entries (i.e., additional week), participants received $50 if they completed

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60% of surveys and $70 if they completed at least 90%. 115 out of 116 participants who started Wave 2 completed at least 13 diary entries ($M_{ENTRIES}$ = 25.90, SD = 3.28, range = 14–30). 108 participants completed at least 19 diary entries. Tables S1 and S2 present demographic characteristics for both waves; there are no significant gender differences in age, race/ethnicity, or number of diary days completed.

Final sample characteristics. The final analysis included 115 participants (62 girls and 53 boys) who participated in both waves (Wave 1: M_{age} = 11.77, SD = 2.13; Wave2: M_{age} = 12.64, SD = 2.12) in Wave 2. The sample was mainly Caucasian (73%). The average time lapse between the two waves was 310 days (SD = 58.81, range = 222–436). Youths included in the final sample were similar to those excluded (due to insufficient number of entries) in terms of gender ($\chi^2[1] = 1.30$, $p = .254$), race ($\chi^2[6] = 7.80$, $p = .253$), and age at Wave 1 ($t[146] = 1.60$, $p = .112$). The two groups also did not differ on mean positive and negative affect at Wave 1 (ps > .261). Zero-order correlations between all study variables are presented in Table S3.

Measures

COVID-19-related questions. In the initial consent session for the Wave 2, we asked youths to answer six questions regarding COVID-19 and how it had impacted them. These questions were created for this study's purpose and are detailed below.

To assess the objective disruption to their routine, we asked participants if their school had been moved to an online format and if their usual activities had been canceled. To measure the subjective experience of COVID-19-related impacts, we asked participants to rate 1) the degree of worries that they themselves, their family members, and someone they know will be infected by the coronavirus; 2) how much they are bothered by school closure, usual activities being canceled, and having to stay at home. Participants responded with a number along the scale from 0 (*not at all*) to 100 (*extremely*).

The six questions assessing COVID-related impacts were subjected to principal component analysis (PCA) with direct oblimin rotation (i.e., the extracted components were allowed to be correlated). PCA results showed that items related to COVID-19 impacts could be reduced to two components: "COVID-related worries" (i.e., the degree of worries that they themselves or others will be infected) and "distress related to COVID-induced social restrictions/isolation" (i.e., the degree to which participants are bothered by having to stay at home or usual activities being canceled). Table 1 provides the resulting PCA component loadings for both factors.

Diary measures. *Affect.* Affect was assessed using the 10-Item Positive and Negative Affect Schedule for Children (PANAS-C; Ebesutani et al., 2012). The 10-Item PANAS-C consists of two parts, each with 5 items measuring positive (e.g., "joyful," "proud") and negative (e.g., "sad," "scared") affect, respectively. Participants were asked to rate each emotion on a scale of 1 (*not at all*) to 5 (*extremely*) based on their experience of that emotion at the moment of filling out the questionnaire. The PANAS-C is a well-established measure with good internal consistency (α's ranging from .80 to .90) and strong reliability across time (Sanmartín et al., 2018). Between-subject reliability in this study was .85 for positive affect and .75 for negative affect at Wave 1; .86 for positive affect and .81 for negative affect at Wave 2. Within-subject reliability was .73 for positive affect and .78 for negative affect at Wave 1;.71 for positive affect and .77 for negative affect at Wave 2. Intraclass correlation coefficient (ICC) scores for the current sample were ICC = .58 for positive affect and ICC = .40 for negative affect at Wave 1; ICC = .88 for positive affect and ICC = .88 for negative affect at Wave 2.

Emotion regulation strategies. Items from two questionnaires were selected to measure the implementation of different emotion regulation strategies. The Children's Response Styles Questionnaire (CRSQ; Abela et al. 2004) assesses engagement in rumination or problem-solving as a response style to regulate negative emotions. The present study adopted two items to assess each strategy (e.g., "Think 'I'm ruining everything'" for rumination and "I thought of a way to make my problem better" for problem-solving). Participants were asked to respond based on their utilization of each emotion regulation strategy that day. Items were rated on 5-point scales, ranging from 0 ("irrelevant - was not in a bad mood/did not use this strategy") to 4 ("almost all of the time"). The CRSQ has demonstrated good reliability and validity in samples of early adolescents (Abela et al., 2002). Intraclass correlation (ICC) scores, indicating the percentage of between-person variance out of all variances (between and within), were 0.53 for problem-solving and 0.40 for rumination. We calculated the

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TABLE 1
PCA Component Loadings for COVID-related Worries and Social Restriction

	Component	
Items assessing the impacts of COVID	*COVID-related worries*	*COVID-related social restriction*
Worried about themselves getting COVID	0.**821**	0.016
Worried about someone they know getting COVID	0.**912**	0.020
Worried about family members getting COVID	0.**922**	−0.031
Bothered by having to stay at home	0.088	0.**803**
Bothered by school closure	0.034	0.**825**
Bothered by usual activity being canceled	−0.099	0.**812**
% of variance explained	44.921	27.907

Note. Pattern matrices are provided. Component loadings >.30 are in bold.

between- and within-subject reliabilities using procedures outlined in Shrout and Lane (2012). For a given measure, the between-subject reliability coefficient is the expected between-subject reliability estimate for a single typical day. The within-subject reliability coefficient is the expected within-subject reliability of change within individuals over the daily diary entries. The between-person and within-person reliabilities were .68 and .60 for rumination; .77 and .45 for problem-solving. These reliabilities are considered acceptable for within-individual measures (Shrout, 1998; Nezlek, 2017).

To measure positive emotion regulation strategies, the study adopted seven items from the Responses to Positive Affect questionnaire for Children (RPA-C; Bijttebier, Raes, Vasey, & Feldman, 2012). The scale captures the use of two emotion regulation strategies, dampening (e.g., "Think 'I don't deserve this'") and savoring (e.g., "Notice how you feel full of energy"). We used five items to assess savoring and two items to assess dampening. Items were rated on 5-point scales, ranging from 0 ("irrelevant - was not in a good mood/did not use this strategy") to 4 ("almost all of the time"). The scale has demonstrated acceptable internal consistency and structural validity (Feldman et al., 2008). ICC scores were 0.56 for savoring and 0.43 for dampening. The between-person and within-person reliabilities ranged between fair and moderate (Shrout, 1998; Nezlek, 2017): .83 and .54 for savoring, and .66 and .41 for dampening. These reliabilities are considered acceptable for within-individual measures (Shrout, 1998; Nezlek, 2017). All measures were included in both waves.

Power Analysis

The present study is part of a larger project on emotions and social interactions; sample size was determined for Wave 1. Power analysis was conducted using PASS software (https://www.ncss.com/software/pass), based on data from the first 18 participants and adjusting for intra-class correlations. Based on the power analysis, we aimed for a sample of 120 participants assuming 80% power and a two-sided α of 0.05 to detect the slope between emotion regulation strategies and depressive symptoms. At Wave 1, we continued with participant recruitment until 120 participants completed at least 60% of the diary entries. To offset potential attrition, we increased the diary period from 21 days at Wave 1 to 28 days at Wave 2, while aiming for the same sample size of 120 participants.

Procedure

Wave 1. Wave 1 lasted from 1/31/2019 to 9/23/2019. During the initial laboratory visit with a parent, each youth participant signed an assent form and the parent signed a consent form. Participants then completed a practice survey and a demographics questionnaire on a computer. A research assistant was available to answer questions and to ensure that all items on the survey were clear to the participants. Every evening for subsequent 21 days, participants received a link via email to complete the daily survey on a secure website (Qualtrics). Participants were instructed to complete the survey before going to bed. Each link was set to expire after 14 hr.

Wave 2. Wave 2 took place between 3/30/2020 and 6/8/2020. On 3/10/2020, the governor of Connecticut declared a state public health emergency. Public schools were closed on 3/13/2020; shopping malls and public amusement places on 3/18/2020, and non-essential businesses were closed on 3/23/

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2020; "stay at home" and mandatory face-covering in public orders were issued 3/28/2020. Connecticut started Phase 1 of reopening 5/20/2020; Phase 2 started after the end of data collection (6/17/2020). According to the CT Department of Public Health (https://data.ct.gov/Health-and-Human-Services/COVID-19-Tests-Cases-Hospitalizations-and-Deaths-S/rf3k-f8fg), during the dates of Wave 2 data collection, there were 44,179 confirmed cases of COVID-19, 293-1972 individuals hospitalized per day due to COVID-19, and 4097 COVID-related deaths in the State of Connecticut, where the data were collected. By the time data collection ended, the number of cases throughout the United States was 1,961,781 confirmed cases and 111,774 deaths.

To recruit for Wave 2, Wave 1 participants were contacted by e-mail or phone. An online Zoom session was scheduled for youths and parents who expressed interest in the study, during which they gave assent and consent (respectively, through Qualtrics) and received instructions about the diary. During the initial Zoom session, youths also filled out a demographic questionnaire that included additional COVID-19-related questions. Every evening for the subsequent 28 days participants received a link via email to the daily diary survey. Participants were asked to complete the survey before going to bed. The link expired after 16 hr.

Statistical Analysis

Mean levels of affect and emotion regulation strategy use for each participant were calculated across the entire diary period. The mean square successive deviation (MSSD) was used to measure affect variability. The MSSD quantifies each participants' affect variability by comparing the affect level on each day to the day that immediately preceded it. The MSSD is reflective of day-to-day fluctuations by capturing both the magnitude and temporal dependency of affective variability, in contract to standard deviation (*SD*) which reflects the magnitude but not the temporal dependency (Jahng, Wood & Trull, 2008; Bos, Jonge & Cox, 2019). The MSSD was calculated for positive and negative affect in Wave 2, as an index for affect variability during the COVID-19 pandemic.

To examine the hypothesis that COVID-related worries and isolation moderate the relationship between emotion regulation strategy use before COVID and affect during COVID, hierarchical regression analyses were conducted using SPSS version 26 (IBM, 2010). Models were built to predict the following outcome variables at Wave 2: mean positive (Model 1) and negative affect level (Model 2), positive (Model 3) and negative affect variability (Model 4). In step 1, the following covariates were entered to control for possible confounds: mean affect level at Wave 1 (Model 1 and 2) and mean affect level at Wave 2 (Model 3 and 4). In Step 2, COVID-related worries and isolation were added to assess their impacts on affect level and variability, respectively. The use of different emotion regulation strategies at Wave 1 was added to the models in Step 3. Specifically, positive emotion regulation strategies, savoring and dampening, were added as possible predictors of positive affect at Wave 2, whereas negative emotion regulation strategies, rumination and problem-solving, were added to models predicting negative affect at Wave 2. Step 4 included interaction variables between COVID-related impacts and emotion regulation strategies, which were created by multiplying independent variables from Steps 2 and 3.

Finally, to control for age and gender differences, all analyses were repeated with age and gender added in Step 1. All findings reported below remained significant after accounting for the variance explained by age and gender.

RESULTS

COVID-related Impacts

The overwhelming majority of participants [112/115 (97.4%)] endorsed that school had been moved to an online format. 106 participants (92.2%) confirmed that their usual activities had been canceled due to COVID-19. 44 out of 115 participants (38.3%) reported knowing someone who had or might have had COVID. The mean level of COVID-related worries was 41.15 (SD = 25.96, range = 0-100). The mean level of COVID-related isolation was 51.25 (SD = 28.35, range = 0-100).

Changes in Affect During COVID

Mean levels of positive and negative affect. We examined time (before vs. during COVID-19) and valence (positive vs. negative) of mean affect levels as two within-participant factors. The main effect of valence was significant (F[1, 114] = 143.63, $p < .001$, $\eta^2 = .56$), but not the main effect of time (F[1, 114] = 1.27, $p = .262$, $\eta^2 = .01$). There was, however, a significant interaction between time and valence (F[1, 114] = 11.27, $p = 0.001$, $\eta^2 = .09$; see Figure 1). In the follow-up paired t-tests, we

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observed significantly higher levels of negative affect (t[114] = 4.024, p <.001, d = .34) during COVID-19 compared to the prior year (see Table 2). There was no significant difference in the mean levels of positive affect (t[114] = −1.364, p = .175, d = .10) before versus during COVID.

Affect variability. We examined time (before vs. during COVID-19) and valence (positive vs. negative) of affect variability as within-participant factors. The main effects of valence (F[1, 114] = 44.21, p <.001, η^2 = .28) and time (F[1, 114] = 7.90, p = .006, η^2 = .07) were both significant, indicating a higher level of positive affect variability as compared to negative affect variability, as well as a decrease in affect variability from Wave 1 to Wave 2. There was also a significant interaction between time and valence of affect variability (F[1, 114] = 7.11, p = 0.009, η^2 = .06; see Figure 2). In the follow-up paired t-tests, we observed significantly lower levels of positive affect variability (t[114] = −3.685, p <.001, d = .39) during COVID-19 compared to the prior year (see Table 2), but there was no significant difference in negative affect variability (t[114] = −0.983, p = .328, d = .11) before versus during COVID.

Predicting Changes in Mean Levels of Negative Affect During COVID

Next, we tested whether individual differences in emotion regulation before COVID-19 predicted changes in negative affect levels from pre- to during COVID while examining COVID-related worries and isolation as possible moderators of this relationship. In a regression model (see Table 3, Model 1b) with (1) COVID-related worries, (2) pre-COVID use of negative emotion regulation strategies, and (3) interactions between COVID-related worries and pre-COVID emotion regulation strategies predicting changes in negative affect levels from prior to during COVID, pre-COVID rumination significantly predicted higher negative affect. In addition, there was an interaction between negative emotion regulation strategies, specifically rumination and problem-solving, and COVID-related worries in predicting changes in negative affect (see Table 3, Model 1b). In the model that examined COVID-related isolation as a moderator, no significant predictors or interactions were found (see Table 3, Model 1a).

Simple slope tests revealed that the association between pre-COVID rumination and changes in negative affect was not significant for participants experiencing high levels of COVID-related worries (β = −.074, t = −.463, p = .645). However, this association was significant for those reporting low levels of COVID-related worries, such that greater tendency to use rumination before COVID (β = .341, t = 2.214, p = .029) predicted more negative affect during COVID. Despite the significant interaction, simple slope analysis showed no significant associations between problem-solving and negative affect for the different levels of COVID-related worries.

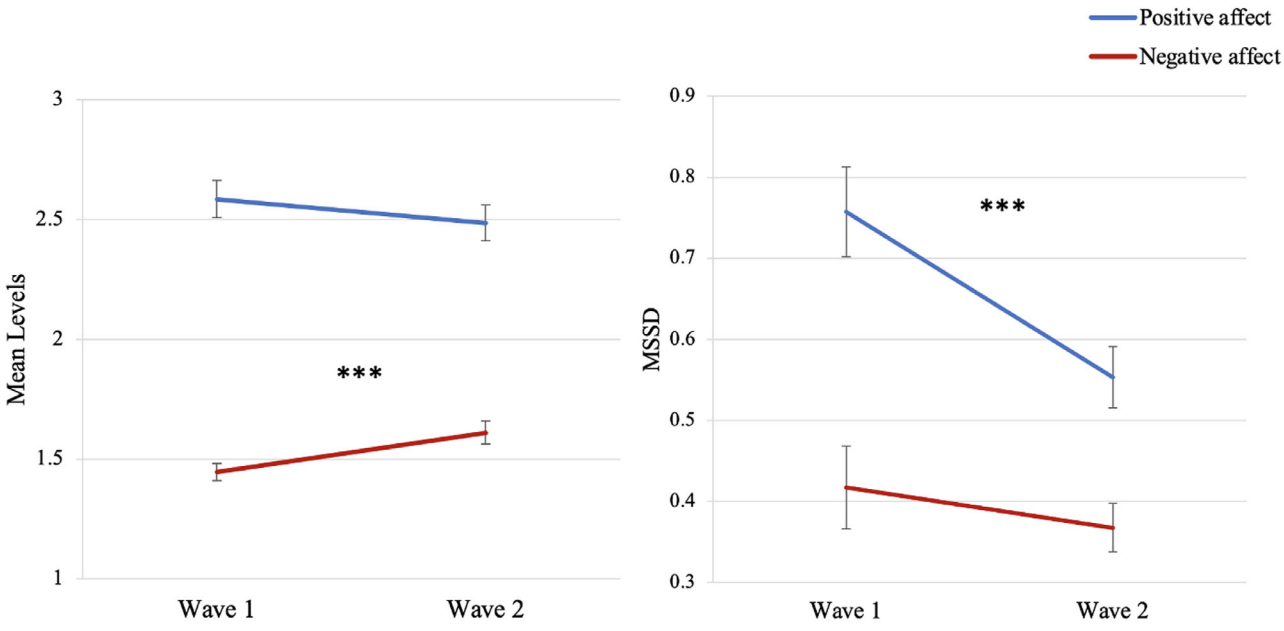

FIGURE 1 Positive and negative affect levels and variability before versus during COVID. ***p <.001.

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TABLE 2
Mean Levels of Affect and Affect Variability Before (Wave 1) versus During COVID-19 (Wave 2)

	Before COVID-19		*During COVID-19*		*Test statistic*		
	Mean (SD)	*Range*	*Mean* (SD)	*Range*	t	df	*Cohen's* d
Positive affect	2.57 (0.82)	1.09–4.93	2.49 (0.82)	1.00–4.97	–1.364	114	.10
Negative affect	1.45 (0.40)	1.00–2.98	1.61 (0.53)	1.00–3.55	4.024***	114	.34
Positive affect variability	0.75 (0.59)	0.03–3.22	0.55 (0.41)	0–2.00	–3.685***	114	.39
Negative affect variability	0.42 (0.55)	0–2.97	0.37 (0.32)	0–1.41	–0.983	114	.11

*** $p < .001$.

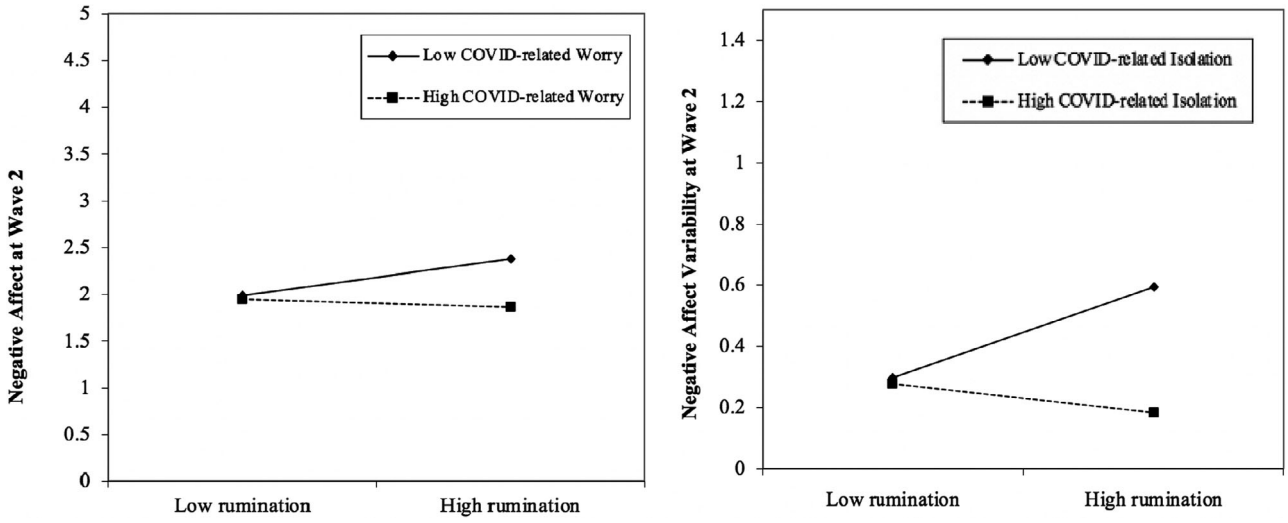

FIGURE 2 Moderation of the association between negative affect and rumination by COVID-related worries and isolation. *Note.* High and low values depict ±1 *SD* from the mean.

Predicting Changes in Negative Affect Variability During COVID

To better understand whether pre-COVID use of emotion regulation strategies predicted changes in negative affect variability while examining the moderating effect of COVID-related impacts, we first built a regression model (see Table 3, Model 2a) with (1) COVID-related isolation, (2) pre-COVID use of negative emotion regulation strategies, and (3) interactions between COVID-related isolation and pre-COVID emotion regulation strategies predicting negative affect variability during COVID. We found that pre-COVID use of rumination and lower engagement in problem-solving significantly predicted greater negative affect variability (see Table 3, Model 2a). The interaction between rumination and COVID-related isolation also significantly predicted changes negative affect variability during the pandemic. A similar interaction was not found between problem-solving and COVID-related isolation. In a second regression model with the same emotion regulation strategies and COVID-related worries predicting changes in negative affect variability during COVID (instead of isolation), only pre-COVID rumination was a significant predictor (see Table 3, Model 2b).

Simple slope tests showed that greater use of rumination before COVID predicted greater negative affect variability only in those experiencing low levels of COVID-related isolation ($\beta = .259$, $t = 2.869$, $p = .005$). The same association was not significant in those with high levels of COVID-related isolation (see Figure 2; $\beta = -.082$, $t = -.993$, $p = .323$).

Predicting Changes in Mean Levels of Positive Affect During COVID

To examine the moderating role of COVID-related isolation and worries on the relationship between emotion regulation strategies before COVID and

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TABLE 3
Hierarchical Regression Analyses for Variables Predicting Negative Affect (Model 1), Negative Affect Variability (Model 2), Positive Affect (Model 3) and Positive Affect Variability (Model 4) during COVID

Variable	*β*	SE	p	R^2	ΔR^2	*Variable*	*β*	SE	p	R^2	ΔR^2
Model 1a: COVID-related isolation predicting negative affect						*Model 1b: COVID-related worries predicting negative affect*					
Step 1: Wave 1 negative affect	.470***	.136	<.001	.347	.347	Step 1: Wave 1 negative affect	.470***	.127	<.001	.347	.347
Step 2: COVID-related isolation	.188	.002	.149	.350	.004	Step 2: COVID-related worries	.084	.003	.551	.347	.001
Step 3: Rumination	.372	.217	.112	.375	.025	Step 3: Rumination	.530*	.205	.017	.370	.023
Problem-solving	−.014	.162	.956			Problem-solving	−.368	.125	.057		
Step 4: COVID-related isolation × Rumination	−.208	.004	.468	.382	.008	Step 4: COVID-related worries × Rumination	−.570*	.004	.042	.402	.032
COVID-related isolation × Problem-solving	−.016	.003	.955			COVID-related worries × Problem-solving	.530*	.003	.027		
Model 2a: COVID-related isolation predicting negative affect variability						*Model 2b: COVID-related worries predicting negative affect variability*					
Step 1: Wave 2 negative affect	.592***	.051	<.001	.399	.399	Step 1: Wave 2 negative affect	.551***	.053	<.001	.399	.399
Step 2: COVID-related isolation	.097	.001	.430	.406	.007	Step 2: COVID-related worries	.193	.002	.160	.399	<.001
Step 3: Rumination	.713**	.127	.002	.419	.013	Step 3: Rumination	.546*	.124	.013	.414	.014
Problem-solving	−.475*	.091	.038			Problem-solving	−.232	.076	.221		
Step 4: COVID-related isolation × Rumination	−.728**	.002	.006	.460	.041	Step 4: COVID-related worries × Rumination	−.527	.002	.057	.435	.022
COVID-related isolation × Problem-solving	.462	.002	.081			COVID-related worries × Problem-solving	.185	.002	.432		
Model 3a: COVID-related isolation predicting positive affect						*Model 3b: COVID-related worries predicting positive affect*					
Step 1: Wave 1 positive affect	.601***	.090	<.001	.472	.472	Step 1: Wave 1 positive affect	.569***	.095	<.001	.472	.472
Step 2: COVID-related isolation	−.226	.006	.265	.489	.017	Step 2: COVID-related worries	−.072	.007	.742	.472	<.001
Step 3: Savoring	.455**	.152	.004	.503	.014	Step 3: Savoring	.324*	.153	.043	.486	.014
Dampening	−.398**	.193	.005			Dampening	−.236	.194	.092		
Step 4: COVID-related isolation × Savoring	−.473*	.002	.025	.544	.041	Step 4: COVID-related worries × Savoring	−.275	.003	.226	.499	.013
COVID-related isolation × Dampening	.559**	.004	.008			COVID-related worries × Dampening	.364	.004	.136		
Model 4a: COVID-related isolation predicting positive affect variability						*Model 4b: COVID-related worries predicting positive affect variability*					
Step 1: Wave 2 positive affect	.304**	.055	.008	.052	.052	Step 1: Wave 2 positive affect	.335**	.054	.003	.052	.052
Step 2: COVID-related isolation	−.599*	.004	.034	.052	<.001	Step 2: COVID-related worries	−.635*	.004	.029	.063	.011
Step 3: Savoring	−.268	.105	.228	.072	.020	Step 3: Savoring	−.445*	.094	.027	.083	.020
Dampening	−.240	.134	.224			Dampening	−.111	.125	.547		
Step 4: COVID-related isolation × Savoring	.206	.002	.484	.123	.051	Step 4: COVID-related worries × Savoring	.536	.002	.075	.145	.062
COVID-related isolation × Dampening	.589*	.002	.047			COVID-related worries × Dampening	.395	.003	.220		

*$p < .05$, **$p < .01$, ***$p < .001$.

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changes in positive affect levels during COVID, we first built a regression model (see Table 3, Model 3a) with (1) COVID-related isolation, (2) pre-COVID use of positive emotion regulation strategies, and (3) interactions between COVID-related isolation and pre-COVID emotion regulation strategies predicting positive affect levels during COVID. Greater engagement in savoring and lower use of dampening before COVID significantly predicted higher positive affect during COVID. The same model also revealed that there was a significant interaction between pre-COVID savoring and COVID-related isolation, as well as between pre-COVID dampening and COVID-related isolation, in predicting changes in positive affect levels during the pandemic. In a second regression model with the same emotion regulation strategies and COVID-related worries predicting positive affect levels during COVID, only savoring was a significant predictor (see Table 3, Model 3b). COVID-related worries did not interact with either pre-COVID savoring or dampening in predicting changes in positive affect during COVID.

Simple slope tests showed that the association between pre-COVID use of positive emotion regulation strategies (i.e., savoring and dampening) and changes in positive affect during COVID was not significant for participants experiencing high levels of COVID-related isolation ($\beta = .225$, $t = 1.455$, $p = .149$; $\beta = .006$, $t = -.048$, $p = .962$). However, this association was significant for those reporting low levels of COVID-related isolation, such that greater use of savoring ($\beta = .335$, $t = 2.905$, $p = .004$) and less engagement in dampening before COVID ($\beta = -.342$, $t = -2.564$, $p = .012$) predicted higher levels of positive affect during the pandemic (Figure 3).

Predicting Changes in Positive Affect Variability During COVID

To better understand the moderating role of COVID-related isolation and worries on the relationship between emotion regulation strategies before COVID and positive affect variability during COVID, we first built a regression model (see Table 3, Model 4a) with (1) COVID-related isolation, (2) pre-COVID use of positive emotion regulation strategies, and (3) interactions between COVID-related isolation and pre-COVID emotion regulation strategies to predict positive affect variability during COVID. COVID-related isolation predicted less positive affect variability. Pre-COVID use of dampening was moderated by COVID-related isolation in predicting greater positive affect variability. No significant moderation was found between COVID-related isolation and savoring, and neither savoring nor dampening significantly predicted positive affect variability during COVID. In a second regression model testing the effect of the same emotion regulation strategies and COVID-related worries on positive affect variability during COVID, greater COVID-related worries and more frequent use of savoring before COVID significantly predicted more stable positive affect during the pandemic (see Table 3, Model 3b). COVID-related worries did not interact with either pre-COVID savoring or dampening in predicting positive affect variability during COVID.

Simple slope tests showed that the association between dampening and positive affect variability was only significant in those experiencing high levels of COVID-related isolation, with greater use of dampening predicting an increased positive affect variability (Figure 3; $\beta = .234$, $t = 2.203$, $p = .030$). The same association was not significant in those with low levels of COVID-related isolation (Figure 3; $\beta = -.049$, $t = -.544$, $p = .588$).

All hierarchical regression models presented above were repeated with emotion regulation strategies at Wave 2 (instead of those at Wave 1) as the possible predictor of affect changes during COVID. No significant interactions between emotion regulation strategies at Wave 2 and COVID-related impacts were found (Table S4). To control for gender and age differences, all analyses were repeated with gender and age added in Step 1. All findings reported above remained significant after accounting for the variance explained by gender (Table S5) and age (Table S6).

DISCUSSION

The main aim of the current study was to examine dynamic changes in daily negative and positive affect from pre-COVID to during the initial, acute stage of the COVID-19 pandemic in youth. In addition, we hypothesized that emotion regulation strategy use before COVID would be moderated by COVID-related worries and isolation to predict changes in affect during COVID-19. To examine this hypothesis, we utilized a unique design that involved two waves of daily diaries, one a year prior to COVID-19, and the other shortly after pandemic-induced school closures. Our results point to important interactions between pre-COVID emotion regulation strategies and COVID-related impacts in predicting adolescents' affect during the pandemic.

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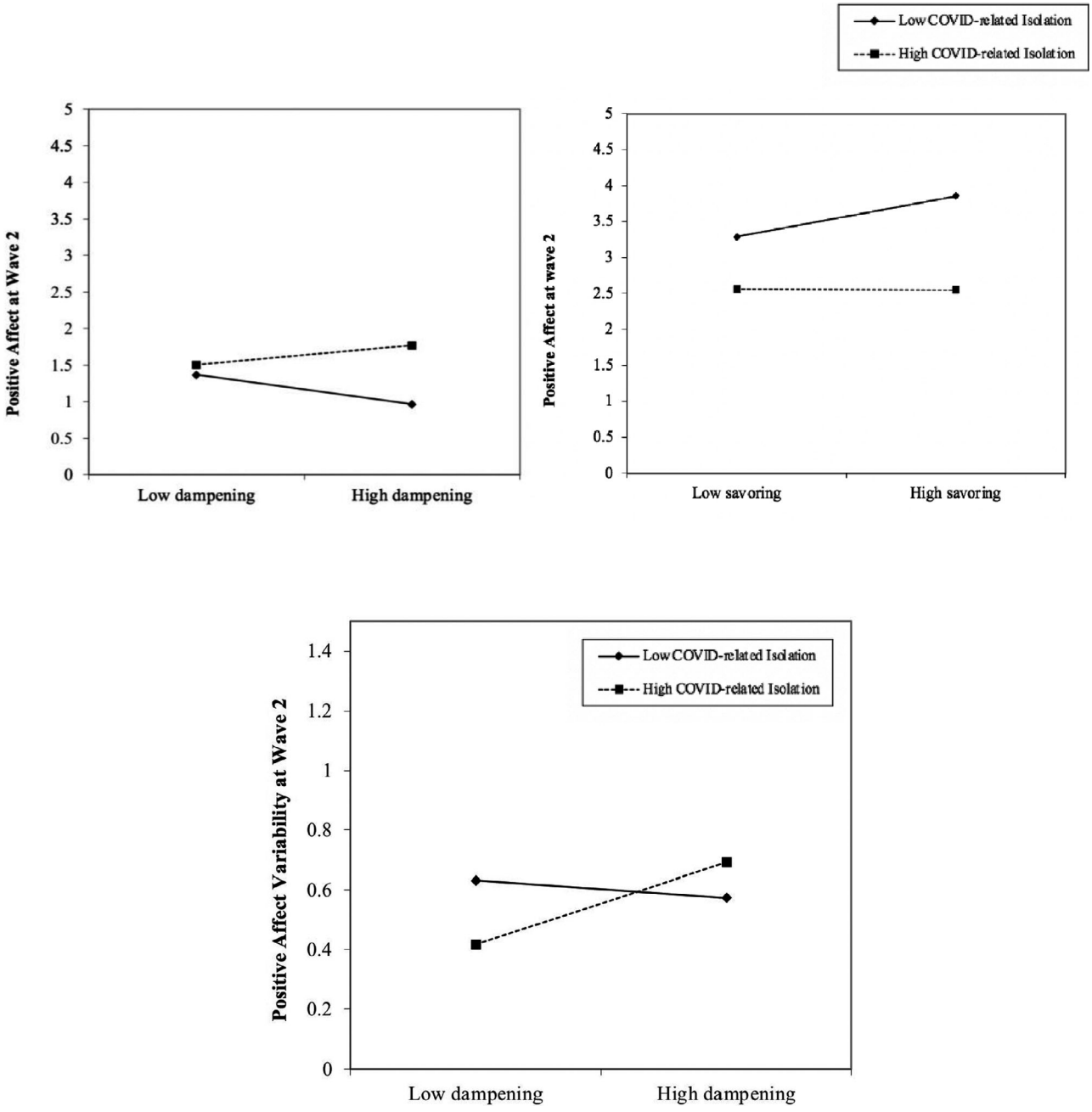

FIGURE 3 Moderation of the association between positive affect during COVID and emotion regulation strategies before COVID by COVID-related worries and isolation.

Affect Mean Levels and Variability During COVID-19

While we observed a significant increase in negative affect during COVID, as predicted, there was no significant decrease in the mean level of positive affect before versus during the pandemic. Different from our hypothesis, negative affect variability did not change significantly, while positive affect variability decreased during COVID, which showcased more stable (though not lower) positive affect. The reduced variability in positive affect may reflect the fact that during the initial stages of COVID-19 there were fewer opportunities to engage in activities that upregulate positive affect, such as social or sporting events, or going to new places (Heller et al., 2020). These findings demonstrate that it is important to differentiate negative

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and positive affect when examining response to a stressor and that examining variability in addition to mean level may increase our understanding of affective responding. Our findings are in line with prior work on psychological adjustment and stress responding in adolescence (Fredrickson, Tugade, Waugh, & Larkin, 2003; Tugade & Fredrickson, 2004), and contribute important findings on COVID-19 as a specific stressor.

Predictive Utility of Emotion Regulation Strategies

As hypothesized, frequent use of savoring prior to COVID-19 predicted greater and more stable positive affect during COVID-19, whereas frequent use of dampening predicted decreases in positive affect. Similarly, higher frequency of rumination pre-COVID predicted increases in negative affect. Our findings are in line with the accumulating literature on positive emotion regulation as a crucial predictor for affective coping in youths (Davis & Suveg, 2014; Lord, Rumburg, & Jaser, 2015). For example, studies have shown that emotion regulation strategies that increase positive affect (e.g., savoring) may support cognitive development in youths by avoiding prolonged hypothalamic–pituitary–adrenocortical (HPA) hyperactivity (Helion, Krueger, & Ochsner, 2019; Young et al., 2019). In particular, habitual use of emotion regulation strategies is important in predicting affective outcomes during the pandemic, given the uncertainty of outcomes, which increases the load of both affective and cognitive processing, and the limited social resources during quarantine (Restubog, Ocampo, & Wang, 2020), which requires adolescents to rely more on their pre-existing coping strategies.

Importantly, the relationship between prior use of emotion regulation strategies and affect changes during the pandemic was moderated by the subjective experience of COVID-related worries and concerns about social restrictions. We found that COVID-related social restrictions, not worries, interacted with pre-COVID use of savoring and dampening in predicting positive affect during COVID. Indeed, social interactions, especially peer relationships, can be crucial in promoting positive affect during adolescence (Alivernini et al., 2019; Dishion & Tipsord, 2011). On the other hand, COVID-related worries, not isolation, interacted with pre-COVID rumination and problem-solving, in predicting negative affect. This is in line with previous research linking repetitive negative thinking, which may exacerbate COVID-related worries, with negative affect in adolescents (McEvoy et al., 2019; Rood, Roelofs, Bogels, & Alloy, 2010). The specificity of COVID-related social isolation to positive affect and worries to negative affect mark a significant contribution to the existing literature, adding greater granularity to our understanding of the differential impact of various COVID-related stressors on affective experience.

It is important to note that the association between pre-COVID positive emotion regulation strategies (i.e., savoring and dampening) and positive affect was only significant for participants experiencing low levels of COVID-related isolation. A similar pattern was found in relation to negative affect, with greater use of rumination predicting higher levels of negative affect and greater negative affect variability only for those experiencing low levels of COVID-related worries. Taken together, our results suggest that individual differences in emotion regulation strategy use predict affect during COVID, but not in individuals experiencing high levels of COVID-related subjective impacts. These findings are in line with existing research that emphasizes the importance of context in emotion regulation strategy use (Aldao, 2013; Sheppes & Levin, 2013; Sheppes et al., 2014). In particular, our findings contribute to the existing literature on emotion regulation by showing that, with elevated subjective responses to a stressor (e.g., COVID-induced worries and isolation), individual differences in pre-existing emotion regulation may no longer determine affective responses.

Limitations and Future Directions

The present study has several limitations that should be acknowledged. First, our sample was characterized by low ethnic and racial diversity. While the study controlled for age and gender as covariates, other possible confounds such as parental education levels and family socio-economic status were not considered due to low variance. Future studies need to focus on underrepresented groups, especially considering that marginalized groups have disproportionately contracted and have been affected by COVID-19 (Garg et al., 2020; Tal, Adini, Eran, & Adini, 2020; Tirupathi et al., 2020). Second, while daily diaries capture individual experiences with much higher ecological validity than single timepoints using retrospective questionnaire data, we could not capture affect changes throughout the day because we used only a once-a-day assessment. Future research using reports from other sources (e.g., parents) and collecting multiple assessments throughout the day

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are required to further validate our findings and to explore within-day dynamics. Further, the window of measurement varied between the two waves, both in length (i.e., 21 days in Wave 1 vs. 28 days in Wave 2) and in timing (i.e., Wave 1 data collection took place over several months that encompassed both the school year and the summer versus Wave 2 that took place during the early stages of COVID-related closures). While the additional week added to Wave 2 may offset the impacts of possible attrition, different length and timing of measurement may create confounds in analyses comparing between the two waves.

It is worth noting that our study captured youths' initial reactions to COVID-19 and school closures. The initial phase of the pandemic was characterized by the public having limited knowledge about the scope and expected duration of the pandemic, as well as policy and adaptations have yet to be fully put in place. The lack of definitive understanding about the pandemic may have further contributed to heterogeneity in participants' response to the pandemic. It would be important to see how the prolonged disruption to daily lives is affecting adolescents now, about a year into the pandemic. Conducting additional follow-ups is necessary to characterize the long-term sequelae of COVID-19 on youths' emotional development.

Significance

The study contributes to the existing COVID-19 literature and emotion regulation research in multiple ways. First, we utilized two waves of data, collected from the same participants before and during the pandemic, to examine emotion regulation strategies as possible baseline predictors of affect levels and variabilities during COVID. Second, we investigated positive and negative affect separately, putting a special focus on positive affect as a potential protective factor for better psychological outcomes in times of crisis. This is in line with the existing literature on adolescent resilience, suggesting that positive affect may play a significant role in enabling youths to cope with stressors. Finally, we evaluated COVID-related impact by quantifying subjective experiences of social isolation and worries about infection. Such measurement allows assessment of individuals' psychological burden during the pandemic, above and beyond the objective changes in life (e.g., lockdown policy, school cancelation).

Highlighting the significance of pre-existing emotion regulation strategies in youths adapting to future external stressors, our findings have implications for emotion regulation skills training in the context of early intervention and prevention, especially for at-risk youths. Specifically, our finding that the effectiveness of pre-existing emotion regulation strategies is limited when subjective stress is high suggests that integrating distress tolerance and other self-soothing experiential exercises may be particularly useful in regulating stress responses among youth.

Conclusion

The results of the present study revealed that emotion regulation strategies prior to the pandemic contributed to affect changes during the pandemic, but mostly for youths who experienced lower (vs. higher) levels of distress from COVID-related factors. We found that pre-COVID savoring and dampening interacted with isolation in predicting positive affect, whereas pre-COVID rumination and problem-solving interacted with COVID-related worries in predicting negative affect. Our findings call into question the sole focus on negative affect when assessing stress responses, by highlighting the importance of positive affect in stress responding among youths. Our study provides unique understandings of affect during COVID and has direct implications for clinical practice and public health.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1. Demographic Characteristics by Gender for Wave 1 (N = 139)

Table S2. Demographic Characteristics by Gender for Wave 2 (N = 115)

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Table S3. Zero-order Correlations between All Study Variables (N = 115)

Table S4. Hierarchical Regression Analyses for Emotion Regulation Strategies Explaining Negative Affect (Model 1) and Variability (Model 2), Positive Affect (Model 3) and Variability (Model 4) during COVID

Table S5. Hierarchical Regression Analyses for Variables Predicting Negative Affect (Model 1) and Variability (Model 2), Positive Affect (Model 3) and Variability (Model 4) during COVID, Controlling for Gender

Table S6. Hierarchical Regression Analyses for Variables Predicting Negative Affect (Model 1) and Variability (Model 2), Positive Affect (Model 3) and Variability (Model 4) during COVID, Controlling for Age

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