

**PROSPECTIVE RELATIONSHIP BETWEEN AFFECTIVE REACTIVITY TO
DAILY STRESS AND DEPRESSIVE SYMPTOMS**

by

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ABSTRACT

The current study was based on O’Neill, Cohen, Tolpin, and Gunthert (2004) and was designed to evaluate the direction of the relationship between affective reactivity to daily stress and depressive symptoms. College students were assessed at two time periods (time 1 and time 2) with questionnaires measuring their current depressive symptoms and with daily diaries measuring their interpersonal and non-interpersonal stressors and their negative affect (NA) and positive affect (PA). We calculated indices of daily affective reactivity based on the respective within-person relationships between daily affect (NA and PA) and number of daily interpersonal and non-interpersonal stressors. Consistent with O’Neill et al., the results demonstrated that time 1 NA reactivity to daily interpersonal stressors predicted time 2 depressive symptoms. Unlike O’Neill et al., the results also demonstrated the predictive role of time 1 NA reactivity to daily non-interpersonal stressors. The results also suggested that these NA reactivity-depressive symptom relationships are unidirectional. Overall, the findings suggest that NA reactivity to daily stressors is a vulnerability factor for depression, and they highlight the value of a daily diary design in evaluating the antecedents and outcomes of psychopathology.

Chapter 1

INTRODUCTION

Both major (Kendler, Myers, & Zisook, 2008; Monroe & Simons, 1991; Muscatel, Slavich, Monroe, & Gotlib, 2009) and minor stressful life events (Cantanzaro, Horaney, Creasey, 1995; Peeters et al., 2003) have been linked to the development and maintenance of depression. A common pattern in these studies is that interpersonal events are more strongly associated with depression than non-interpersonal events (Bolger, DeLongis, Kessler, & Schilling, 1989; Hammen, 1999; Joiner & Coyne, 1999; Shih, Eberhart, Hammen, & Brennan; 2006). In the current study, we used a daily process design and idiographic indices of daily affect regulation to evaluate the predictive role of affective reactivity to daily interpersonal stressors in the development of depressive symptoms.

Interpersonal sensitivity is a common component in two theories regarding the onset and maintenance of depression. These theories use similar diathesis-stress models of depression, in which preexisting vulnerabilities interact with the occurrence of interpersonal stress. First, Blatt's (1974) psychoanalytic theory proposes that characterological features develop from early adverse childhood experiences. These features include intense fears of abandonment. In the face of an important interpersonal stressor, a vulnerable individual experiences depressive symptoms such as feelings of helplessness. Similarly, Beck's (1983) cognitive theory states that individuals can have a predisposition for "sociality" or social dependency, in which

they place a large investment in positive interactions with others. As such, negative interactions are particularly distressing, which can lead to depressive symptoms.

A common thread in these two theories is that preexisting feelings of dependency render an individual sensitive to negative interpersonal events, which then can precipitate feelings of loss (Beck, 1987; Blatt, Auerbach, & Levy, 1997).

Therefore, when these events occur, negative affect is experienced to the degree that the individual is unable to attain the interpersonal contact he or she seeks (Blatt & Bers, 1993). To summarize, depression can occur when an interpersonally sensitive individual experiences interpersonal stressors and finds it difficult to regulate resulting negative affect.

Several studies have examined the predictive role of interpersonal sensitivity using one-time (cross-sectional) measures of the construct, primarily Beck's measure of sociotropy (Beck, Epstein, Harrison, & Emery, 1983) and Blatt's measure of dependency (Blatt, D'Afflitti, & Quinlan, 1976). One shortcoming of cross-sectional measures of interpersonal sensitivity is that they are not able to directly assess affect regulation. Similarly, these measures assess interpersonal sensitivity by asking how a person *would* typically respond to an interpersonal event. They do not capture how the person *actually* responds to the event. For these reasons, the research literature has provided inconsistent support for the predictive role of interpersonal sensitivity (specifically, sociotropy and dependency) in the development of depressive symptoms (see Coyne, Thompson, & Whiffen [2004] and Coyne & Whiffen [1995] for reviews).

More recently, researchers have employed daily process designs to examine how individuals actually respond to such daily life experiences (Affleck,

Zautra, Tennen, & Armeli, 1999). Specifically, diary designs have been used to examine interpersonal sensitivity by measuring the degree to which daily interpersonal stressors relate to end-of-day affect (Dasch, Cohen, Sahl, & Gunthert, 2008; O’Neil, et al., 2004). This relationship between daily stress and daily affect has been referred to as “affective reactivity.” Bolger and Zuckerman (1995) defined daily affective reactivity as the degree to which daily affect changes in relation to the accumulation of daily stressors. In diary research, reactivity is specifically defined as the slope for the within-person relationship between daily affect and the number of daily stressors. Therefore, a highly reactive person would have a stronger increase in her or his negative affect (NA) in response to stress than one who is less reactive. In the present study, we measured interpersonal sensitivity using this type of within-subject index of the relationship between number of daily interpersonal stressors and daily NA. We then evaluated the predictive role of affective reactivity in the development of depressive symptoms.

Research by O’Neill et al. (2004)

The current study replicates and expands research by O’Neill et al. (2004), who also used a daily process design to develop an index of interpersonal sensitivity as a depression vulnerability factor. Therefore, it is important to highlight some design aspects and results of their study. To examine the relationship between daily affective reactivity and later depressive symptoms, they administered measures to 101 college students at two time points (time 1 and time 2) during a semester. Specifically, at both time 1 and time 2, participants completed a paper and pencil measure of their current depressive symptoms (CES-D; Radloff, 1977). At time 1, they also completed a paper and pencil diary questionnaire at the end of each day for 14 consecutive days. On this

daily measure, participants rated their current negative and positive affect (PA) using the respective PANAS scales of state affect (Watson & Clark, 1994). Each day, they also indicated the occurrence of specific negative events using a checklist of 15 common daily stressors. Events on this list were reliably coded by the researchers as “interpersonal” or “non-interpersonal.” For example, an argument with a friend was coded as an interpersonal stressor, and experiencing difficulty on a school task was coded as a non-interpersonal stressor. From this list of 15 stressors, participants indicated which experienced event was the worst or most stressful of the day. They then rated how stressful this event was, and what coping strategies they used to deal with it.

O’Neill et al. (2004) calculated each participant’s within-person relationship between daily affect (NA and PA) and number of daily interpersonal and non-interpersonal stressors. These calculations yielded four reactivity coefficients representing participants’ daily affective responses to daily stress: NA reactivity to interpersonal stressors, NA reactivity to non-interpersonal stressors, PA reactivity to interpersonal stressors, and PA reactivity to non-interpersonal stressors. These reactivity coefficients were then used as independent variables in regression analyses to predict depressive symptoms at time 2, controlling for depressive symptoms at time 1

O’Neill et al.’s (2004) major findings were that both NA and PA reactivity to daily interpersonal stress predicted a change in depressive symptoms from time 1 to time 2. Specifically, individuals whose NA increased strongly, and whose PA decreased strongly, in response to daily interpersonal stressors, showed a greater increase in depressive symptoms at time 2. However, NA and PA reactivity to non-

interpersonal stress were not significant predictors of change in depression. Thus, their findings suggest the unique role of reactivity to interpersonal (as opposed to non-interpersonal) daily stressors. To better understand why affective reactivity to daily interpersonal stress is a vulnerability factor for depressive symptoms, O'Neill et al. examined the correlations between participants' reactivity slopes and their appraisal and coping ratings for interpersonal stressors that were chosen as the most stressful event of the day. In general, these correlations were only moderately helpful in understanding the basis to daily affective reactivity.

O'Neill et al. (2004) was interesting because they developed a daily measure of interpersonal sensitivity and demonstrated that it could predict a change in depressive symptoms over time. Before their study, most relevant daily diary studies conceptualized affective reactivity as a *dependent* variable, to be predicted (moderated) by individual difference variables, such as personality traits and psychopathology status (Cohen, Gunthert, Butler, O'Neill, & Tolpin, 2005). In contrast, in O'Neill et al., and in the current study, affective reactivity was conceptualized as an *independent* variable to predict later depressive symptoms. A similar approach was taken by Cohen et al. (2008) in their study of the predictive role of daily affective reactivity in cognitive therapy outcome for individuals with major depression.

Direction of the Relationship between Daily Affective Reactivity and Depression

Despite its strengths, an important weakness of the O'Neill et al. (2004) study was that there was no daily diary component at time 2. Therefore, although they could evaluate whether initial (time 1) daily affective reactivity predicted a time 1-time 2 change in depressive symptoms, they could not evaluate whether initial (time 1)

depressive symptoms predicted a time 1-time 2 change in daily affective reactivity. In fact, to our knowledge, no study to date has directly examined daily NA reactivity as an *outcome* of depressive symptoms.

Related research on the residual effects or “scar” of depression suggests that it is indeed important to ask whether depressive symptoms affect subsequent affective reactivity to daily stress. According to Lewinsohn, Steinmetz, Larson, and Frankin (1981), a “scar” is conceptualized as the permanent residual deficits created by an episode of depression analogous to the manner in which a cut leaves a physical scar after it has healed. Relevant to the current study, previous research has examined depression scars with respect to a number of personality and interpersonal variables. Specifically, repeated episodes of depression have been associated with progressive increases in neuroticism (Wilhelm, Parker, Dewhurst-Savellis, & Ashari, 1999) and decreases in self esteem (Shahar & Davison, 2003). After recovering from an episode of depression, individuals report lower levels of social skills and greater interpersonal dependency than those who were never depressed (Rohde et al., 1990). According to Harkness, Monroe, Simons, and Thase (1999), individuals also generate more stressful life events after experiencing a depressive episode than before they were depressed. Zautra et al. (2007) found that chronic pain patients, with a history of recurrent depression, were more stress reactive than those with a history of a single episode or no past depression. Specifically, they found that those with recurrent depression reported a relatively higher increase in pain following a stressful speech task than those with a single episode or no history of depression. In another study using mobile computers to ask participants about their affect and stressful events several times throughout the day, Husky, Mazure, Maciejewski, and Swendsen (2009) found that

men with a history of depression were more affectively reactive to stressful events than those without a prior history.

To summarize, no study to date has directly examined daily affective reactivity as an outcome of depressive symptoms, although related research suggests that following an episode or repeated episodes of depression, individuals report “scars,” such as lower self-esteem and greater dependency. With this literature in mind, the present study examined whether a history of depression and initial depressive symptoms resulted in a subsequent increase in affective reactivity to daily stressors.

Daily Diary Design

There are several advantages in using a daily diary method for this type of research. First, because diaries ask participants to report their recent daily events, they are less vulnerable to recall biases than cross-sectional, retrospective measures (Bolger, Davis, & Rafaeli, 2003). Additionally, repeated measures, such as those administered in a diary study, are essential in evaluating the within-subject relationship between variables such as daily stressors and daily affect (Affleck et al., 1999; Gunthert, Cohen, & Armeli, 1999).

Similarly to O’Neill et al. (2004), the current study used a daily diary design to examine daily events and daily affect. Unlike the former study, which used a paper and pencil diary, this study used an electronic online diary. Online diary questionnaires offer several advantages over paper and pencil forms. First, they reduce data entry error associated with paper and pencil questionnaires. They also include date and time stamps to ensure that each diary is completed at the appropriate time on the correct day. Additionally, they expedite data collection processes in that data are

collected instantly after each diary is completed, which allows researchers to monitor compliance.

Current Study

The current study used a daily diary design to evaluate the direction of the relationship between affective reactivity to daily stress and depressive symptoms. College students completed measures at two points in time, two months apart. At time 1, participants reported their lifetime history of depression. At both times, they completed a measure of depressive symptoms followed by online nightly diaries for seven consecutive days. Consistent with O'Neill et al. (2004), we expected that initial NA and PA reactivity to daily interpersonal stress would predict time 2 depressive symptoms, controlling for time 1 symptoms. In other words, time 2 depressive symptoms would be greater for participants who evidenced, at time 1, greater increases in daily NA, and greater decreases in daily PA, in response to increases in number of daily interpersonal stressors. Consistent with the depression scar literature, we also expected that initial depressive symptoms would (positively) predict time 2 NA reactivity to daily stress, controlling for time 1 reactivity. Additionally, we expected that those with a history of depression (experienced prior to the study) would demonstrate greater time 1 NA reactivity to daily stress.

Chapter 2

METHOD

Participants

Participants were recruited from a fall introductory psychology class. These students were offered extra credit to participate in this study or to complete a short reading and writing assignment of comparable time commitment. One hundred and nine students completed the time 1 questionnaire battery. Of these students, 102 completed at least three online diaries at time 1. At time 2, 98 students completed the questionnaire battery and 96 of them completed at least three online diaries at time 2. Overall, 93 participants completed all four parts of the study necessary for the subsequent analyses. The final sample was predominantly 18 years old (85%), with 13% 19 years old, and 2% 20 or older. Most of the participants (90%) were first year students, with 9% sophomores, and 1% juniors. There were more women (62%) than men. The sample was comprised of mostly Caucasian students (86%), with 4% Asian, 4% mixed or other, 3% Hispanic, 2% African-American, and 1% American Indian.

Measures

Cross-sectional Measures

Depressive symptoms were measured using the 20-item Center for Epidemiological Studies-Depression Scale (CES-D; Radloff, 1977). Each item was rated using a 4-point scale to indicate how often each symptom was experienced

during the past week (from 1 = *rarely or none of the time or less than 1 day* to 4 = *most or all of the time or 5-7 days*). The CES-D has excellent reliability and validity (Turk & Okifuji, 1994). Cronbach's alphas for time 1 and time 2 were .87 and .91, respectively.

Depression history was assessed at time 1 using the lifetime version of the Inventory to Diagnose Depression: Lifetime (IDD:L; Zimmerman & Coryell, 1987). Based on DSM-IV criteria (American Psychiatric Association, 1994), this measure is designed to determine whether an individual has experienced a major depressive episode in her or his lifetime. It does so by asking participants to rate the extent they experienced symptoms (e.g. feeling sad, restless, poor appetite) on a 4-point scale (0 = *not at all*, 4 = *very much so*), and whether they experienced these symptoms for two weeks or more. Evidence for a previous depressive episode followed DSM-IV guidelines based on symptom endorsement. Those with a previous episode were coded as 1 and those without were coded as 0¹.

Diary Measures

Positive affect and negative affect. Like O'Neill et al. (2004), daily affect was measured using the 10-item PA and 10-item NA scales from the Positive and Negative Affect Schedule-Expanded Form (PANAS; Watson & Clark, 1994). Participants indicated on a 5-point scale (1 = *very slightly or not at all*, 5 = *extremely*) the extent to which they were experiencing each of the positive and negative affect items at that time (i.e., state affect). Within-person reliability was computed by transforming item scores into z-scores within each participant. Using these values,

Cronbach's alphas at time 1 were .88 and .78 for PA and NA, respectively. At time 2, they were .86 and .76 for PA and NA, respectively.

Daily negative events. Daily negative events were assessed with the same daily events checklist used by O'Neill et al. (2004). This checklist consisted of 15 stressors involving school, illness, work, extracurricular activities, hassles, negative interpersonal experiences, and negative events experienced by a loved one. Based on O'Neill et al.'s daily event classification, events were categorized as interpersonal stressors (7 items; e.g., "Showed interest in someone and they rejected me") and non-interpersonal stressors (8 items; e.g., "Did poorly on a school task"). Participants indicated which, if any, of these events occurred that day. Separate totals for the number of interpersonal and non-interpersonal negative events were calculated each day².

Daily affective reactivity. The conceptualization and computation of daily affective reactivity were based on Bolger and Zuckerman (1995), as well as more recent studies of daily stress and mood (e.g., Dasch et al., 2008; Nezlek, 2002; Zautra et al., 2005). Specifically, affective reactivity was computed using the following equation for the within-subject relationship between daily NA and daily number of negative events: $NA_{ti} = \pi_{0i} + \pi_{1i}(\text{Negative Events}_{ti}) + e_{ti}$. NA represents negative affect at the end of day t for participant i . π_{0i} is the intercept representing the level of NA at average number of negative events for that person (group mean centered). π_{1i} is the slope coefficient for negative events (that is, the number of units higher the NA score is for every additional unit higher the negative events score is on day t). The within-person error term is represented by e_{ti} . Using this model, a person with high NA reactivity to negative events would show a strong positive within-subject relationship

between number of daily negative events and daily NA. Using Hierarchical Linear Modeling (HLM; Raudenbush, Bryk, & Congdon, 2006), this equation served as a model to compute: (a) NA reactivity to number of daily interpersonal negative events; (b) NA reactivity to number of daily non-interpersonal negative events; (c) PA reactivity to number of daily interpersonal negative events; and (d) PA reactivity to number of daily non- interpersonal negative events.

Our method of computing reactivity differs from that used by O'Neill et al. (2004), who used ordinary least squares (OLS) regression. We used HLM (Raudenbush et al., 2006) to calculate reactivity estimates. This method generates Empirical Bayes estimates of slopes for each individual, which are considered more accurate because they take into account unbalanced repeated measures and are less susceptible to outliers (Raudenbush & Bryk, 2002)

Procedure

In order to replicate O'Neill et al. (2004) and evaluate the relationship between affective reactivity and depressive symptoms, participants were measured at two time points (time 1 and time 2), seven weeks apart. Time 1 occurred one month into the semester and time 2 occurred one week before the Thanksgiving break. These time points were chosen to ensure the maximum amount of time between measurement periods while also avoiding inflated estimates of stress and negative affect during the first and last weeks of the semester.

At time 1, interested students attended a group session during which informed consent was obtained. After providing consent, participants completed paper and pencil questionnaires that requested demographic information, their depression

history (IDD:L), and their current depressive symptoms (CES-D). The CES-D was administered again at time 2 via an online survey.

Following completion of the time 1 and time 2 cross-sectional questionnaires, participants were sent a link, via email, to the online diary questionnaire. Participants were asked to complete the time 1 and time 2 diaries before 8 p.m. and 2 a.m. each evening for seven consecutive days. The daily diary asked participants about their current mood and the daily stressors that occurred that day. To maximize compliance, we sent a reminder email to the participants every day of the study with a link to the diary.

Chapter 3

RESULTS

Participants versus Non-participants

For the reported analyses, we included participants who completed both time 1 and time 2 questionnaire batteries and at least 3 diaries at both time 1 and at time 2 ($N = 93$). One-way ANOVAs showed that participants with complete data did not differ from those without complete data on any variable of interest.

Compliance with Diary Procedure

The mean number of diaries completed at time 1 and time 2 were 6.18 ($SD = 1.05$) and 5.16 ($SD = 1.16$), respectively. The average time of time 1 diary completion was 8:10 p.m. ($SD = 98$ minutes). The average time of time 2 diary completion was 10:04 p.m. ($SD = 103$ minutes).

Descriptive Statistics

Time 1 and time 2 means and standard deviations are presented in table 1

Table 1 Means and standard deviations of major study variables

	Measure	Time1 <i>M (SD)</i>	Time 2 <i>M (SD)</i>
Questionnaire	Depressive Symptoms(CES-D)	37.43 (9.49)	36.37 (10.83)
Daily Stressors	# of Negative Interpersonal Stressors**	0.39 (0.43)	0.25 (0.34)
	# of Negative Non-Interpersonal Stressors	1.32 (.06)	1.34 (0.06)
Daily Affect	Negative Affect	1.55 (0.51)	1.59 (0.49)
	Positive Affect*	2.25 (0.55)	2.14 (0.63)
Reactivity Slope	NA to Non-interpersonal Events	0.14 (0.09)	0.15 (0.13)
	NA to Interpersonal Events	0.22 (0.19)	0.25 (0.17)
	PA to Non-Interpersonal Events	0.14 (0.03)	0.15 (0.08)
	PA to Interpersonal Events	0.12 (0.03)	0.14 (0.03)

Note: All daily variables were aggregated across the 7 days of diary data collection. $p < .05$. ** $p < .01$ for time 1-time 2 t -tests.

Scores on the CES-D, number of daily interpersonal and non-interpersonal stressors, and daily NA and PA were comparable to those reported by O'Neill et al. (2004). Nine participants reported lifetime symptoms indicative of a history of depression. Table 2 shows the time 1 and time 2 correlations between depressive symptoms and the aggregate daily diary variables and the daily reactivity slopes. As is evident from this table, time 1 depressive symptoms were positively related to time 1 average NA, the average number of time 1 interpersonal stressors, and time 1 NA reactivity to both interpersonal and non-interpersonal stressors. Time 2 depressive symptoms were positively related to time 2 NA reactivity to interpersonal stressors.

Table 2 Relationships between depressive symptoms and daily diary variables

Measure	Time 1 Dep. Symptoms	Time 2 Dep. Symptoms
Time 1		
Avg. Negative Affect	.54**	.61**
Avg. Positive Affect	.03	-.01
Avg. # of Interpersonal Stressors	.26*	.36**
Avg. # of Non-interpersonal Stressors	.14	.12
NA Reactivity to Interpersonal Stressors	.49**	.54**
NA Reactivity to Non-Interpersonal Stressors	.41**	.43**
PA Reactivity to Interpersonal Stressors	-.005	.03
PA Reactivity to Non-interpersonal Stressors	.04	.004
Time 2		
Avg. Negative Affect	.10	.19
Avg. Positive Affect	-.001	-.09
Avg. # of Interpersonal Stressors	.19	.13
Avg. # of Non-Interpersonal Stressors	.19	.19
NA Reactivity to Interpersonal Stressors	.25*	.27**
NA Reactivity to Non-Interpersonal Stressors	-.10	-.20
PA Reactivity to Interpersonal Stressors	.07	.04
PA Reactivity to Non-Interpersonal Stressors	.17	.17

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

Paired t -tests were used to determine whether there were changes in participants' scores from time 1 to time 2. Measures obtained from the diaries were aggregated within person over the seven days prior to the t -test analyses. These analyses revealed that from time 1 to time 2, there was no change in participants' depressive symptoms. There was a significant decrease in the number of daily interpersonal stressors, $t(1, 92) = 3.40, p < .01$. Although there was no time 1 – time 2 change in participants' daily NA, there was a significant decrease in their daily PA, $t(1, 92) = 2.60, p < .05$.

To determine whether there was a change in affective reactivity from time 1 to time 2, the data were first structured using a three-level nested format. Daily diary data were nested within time (1 or 2), which was then nested within person. A three-level model was then specified to test if the level 2 variable, time, moderated the daily relationship between the level 1 variables (e.g., daily NA and daily negative events) using the SAS PROC MIXED Procedure (Littell, 1996). Results from these analyses showed that, from time 1 to time 2, there were no changes in NA or PA reactivity to daily interpersonal or non-interpersonal stressors³.

Replication of O’Neill et al. (2004)

Hierarchical regression analyses were initially conducted to replicate O’Neill et al. (2004), who tested time 1 NA and PA reactivity to daily interpersonal and non-interpersonal stressors as predictors of depressive symptoms at time 2. As mentioned previously, they found significant effects for NA and PA reactivity to daily interpersonal stressors, but not to non-interpersonal stressors. It is important to note a few differences between the model used by O’Neill et al. (2004) and that used in the current study. First, O’Neill et al. did not find an effect for neuroticism, and therefore this measure was not included in the current study. Second, in the current study, Empirical Bayes slopes were used instead of less accurate OLS regression estimates, used by O’Neill et al.

Table 3 shows the regression results for NA reactivity to daily stressors, which were partially consistent with those reported by O’Neill et al. (2004).

Table 3 Regression of time 2 depression (CES-D) on negative affective reactivity to daily stressors

Predictor	Daily Stressor Type			
	β	<u>Interpersonal</u> R^2 ch.	β	<u>Non-Interpersonal</u> R^2 ch.
Step 1: Controls		0.47***		0.43***
Sex	-0.44		-0.29	
Time 1 Depression	0.69**		0.75**	
Avg. Daily Stressors	5.22*		0.58	
Step 2: NA Reactivity Slope	13.54*	0.036*	28.62*	0.03*

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

Consistent with O’Neill et al, we found that, after controlling for sex, initial depressive symptoms, and mean number of daily stressors at time 1, NA reactivity to daily interpersonal stressors was a significant positive predictor of time 2 depressive symptoms. Unlike O’Neill et al., we found that NA reactivity to daily non-interpersonal stressors was also a significant positive predictor of time 2 depressive symptoms⁴.

Subsequent hierarchical regression analyses with appropriate controls were conducted to test the independence of the two time 1 NA reactivity indices as predictors of time 2 depressive symptoms. Results revealed that NA reactivity to daily interpersonal stressors uniquely predicted depressive symptoms ($t = 2.34, p < .05$), but NA reactivity to non-interpersonal stressors did not ($t = -0.59, p = ns$). Furthermore, NA reactivity to interpersonal stressors accounted for an additional 3% of variance ($p < .05$).

Table 4 shows the regressions results for PA reactivity to daily stressors, which were inconsistent with those reported by O’Neill et al. (2004), who found that time 1 PA reactivity to daily interpersonal stressors was a significant predictor of time

2 depressive symptoms. However, as is evident from table 4, we found nonsignificant effects for time 1 PA reactivity to both interpersonal and non-interpersonal daily stressors⁵.

Table 4 Regression of time 2 depression (CES-D) on positive affective reactivity to daily stressors

Predictor	Daily Stressor Type			
	β	<u>Interpersonal</u> R^2 ch.	<u>Non-Interpersonal</u> β	R^2 ch.
Step 1: Controls		0.47***		0.43***
Sex	-0.44		-0.29	
Time 1 Depression	0.69**		0.75**	
Avg. Daily Stressors	5.22*		0.58	
Step 2: PA Reactivity Slope	5.02	0.003	-21.07	0.001

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

Overall, we had mixed success in replicating O'Neill et al. (2004). Most importantly, we replicated the significant predictive role of NA reactivity to daily interpersonal stressors. Although we did not replicate the non-significant effect for NA reactivity to non-interpersonal stressors, we did find that reactivity to interpersonal stressors was a unique predictor, whereas reactivity to non-interpersonal stressors was not. Additionally, we did not replicate the significant predictive role of PA reactivity to daily interpersonal stressors⁶.

Depression History as a Predictor of Time 1 Affective Reactivity

Motivated by the depression scar literature, we then evaluated whether participants' lifetime depression history (yes vs. no) was related to their time 1 affective reactivity scores; specifically, their NA and PA reactivity to both daily

interpersonal and non-interpersonal stressors. We conducted separate hierarchical regression analyses in the prediction of a specific time 1 reactivity slope, in which the predictor order was time 1 depressive symptoms, average number of corresponding time 1 daily events, and then depression history. Depression history was not a significant predictor in any of these regression analyses.

Direction of the Affective Reactivity-Depression Relationship

As reported previously, we found that time 1 NA reactivity to both daily interpersonal and non-interpersonal stressors was a significant predictor of time 2 depressive symptoms, after controlling for time 1 depressive symptoms. Our next analyses were designed to examine the direction of the affective reactivity-depression relationship. Specifically, we were interested in testing whether time 1 reactivity predicts time 2 depressive symptoms while simultaneously testing whether time 1 depressive symptoms predict time 2 reactivity. To test these relationships, we used Mplus Version 5.2 (Muthén & Muthén, 2008) to specify a separate model for each NA reactivity index. For the first model, time 2 depressive symptoms and time 2 NA reactivity to interpersonal stressors were both simultaneously predicted by time 1 depressive symptoms and time 1 NA reactivity, as shown in figure 1. The average number of time 1 interpersonal stressors was included as a control variable. Sex was not included as a control variable because it was not a significant predictor in the previous equations.

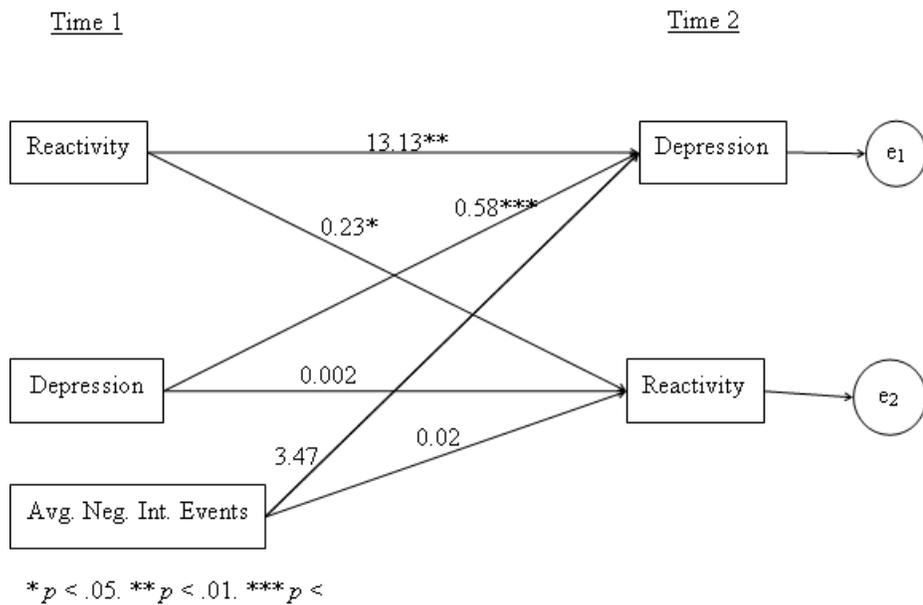


Figure 1 Prediction of time 2 depressive symptoms from time 1 NA reactivity to daily interpersonal stressors

The second model, figure 2, tested the direction of the relationship between NA reactivity to non-interpersonal stressors and depression, and was specified in a similar manner. Both models terminated normally and each demonstrated reasonable fit with the observed data (both CFIs = 1). Results from these models showed that time 2 depressive symptoms were predicted by time 1 NA reactivity to both interpersonal stressors ($\beta = 13.31, z = 2.60, p < .01$) and non-interpersonal stressors ($\beta = 28.48, z = 2.26, p < .05$). On the other hand, neither time 2 reactivity index was predicted by time 1 depressive symptoms. Thus, these findings suggest that the relationship between NA reactivity to daily stress and depressive symptoms is unidirectional.

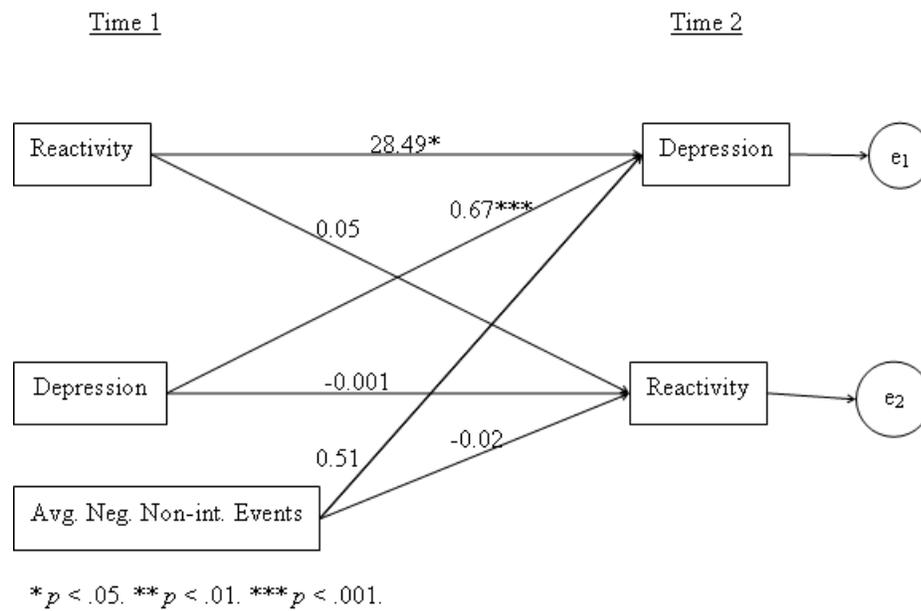


Figure 2 Prediction of time 2 depressive symptoms from time 1 NA reactivity to daily non-interpersonal stressors

Chapter 4

DISCUSSION

Previous research has documented a significant relationship between depression and major life stressors (e.g., Monroe & Simons, 1991) and daily stressors (e.g., Peeters, et al., 2003; Catanzaro, et al., 1995), particularly stressors of an interpersonal nature (e.g., Hammen, 1999). It is thought that interpersonal stressors are especially problematic for individuals who are interpersonally sensitive, that is, individuals who are vulnerable to real or perceived loss and rejection (Beck, 1987; Blatt et al., 1997). A recent study by O’Neill et al. (2004) examined college students’ interpersonal sensitivity at the daily level by creating indices of affective reactivity based on the daily within-person relationship between affect (NA and PA) and number of daily interpersonal stressors. They found that both NA and PA reactivity to interpersonal, but not non-interpersonal, stressors were significant predictors of later depressive symptoms. The current research was designed to replicate and extend this study by O’Neill et al.

Despite the strengths of O’Neill et al.’s (2004) study, it had a few limitations. One limitation is that they failed to include a time 2 daily diary component, and thus were unable to test the direction of the relationship between affective reactivity and depressive symptoms. Research examining the residual (scar) effects of depression suggests that the relationship between affective reactivity and depressive symptoms may be bi-directional. Specifically, research has documented the lingering effects of depression in the form of increases in neuroticism (Wilhelm et al.,

1999), pain reactivity to social stressors (Zautra et al., 2007), affective reactivity to stressful events (Husky et al., 2009), and decreases in self-esteem (Shahar & Davidson, 2003).

A second limitation of O'Neill et al. (2004) is that they used paper and pencil diaries to record daily affect and stressors. Although the researchers made efforts to ensure proper compliance with their study procedure, they could not guarantee that the diaries were completed at the end of every evening, as required.

With the above limitations in mind, the present study examined the direction of the relationship between affective reactivity to daily stress and depressive symptoms. Specifically, we evaluated college students at two time points (time 1 and time 2), two months apart. At time 1, we measured participants' lifetime history of depression (IDD:L). At both time 1 and time 2, we administered a measure of depressive symptoms (CES-D) and seven consecutive nightly electronic diaries that assessed daily affect and the daily occurrence of interpersonal and non-interpersonal stressors. Using HLM software (Raudenbush et al., 2006), we computed each participant's respective within-person relationship between daily NA and PA and daily interpersonal and non-interpersonal stressors, and then used these four reactivity indices as independent variables in the prediction of depressive symptoms.

Based on O'Neill et al. (2004), we expected that time 1 NA and PA reactivity to interpersonal stress (but not non-interpersonal stress) would predict time 2 depressive symptoms. Based on the depression scar literature (e.g., Husky et al., 2009), we predicted that depressive symptoms at time 1 would predict affective reactivity to daily stress at time 2, and that depression history would predict affective reactivity to daily stress at time 1.

Our findings represented a partial replication of those reported by O’Neill et al. (2004). Consistent with O’Neill et al., we found that time 1 NA reactivity to daily interpersonal stressors was a significant predictor of time 2 depressive symptoms. Also consistent with O’Neill et al., we found that time 1 PA reactivity to daily non-interpersonal stressors did not predict time 2 depressive symptoms. On the other hand, O’Neill et al. found that time 1 PA reactivity to daily interpersonal stressors was a significant predictor of time 2 depressive symptoms, whereas the current study did not. Finally, we found that NA reactivity to daily non-interpersonal stressors was a significant predictor of time 2 depressive symptoms, whereas O’Neill et al. did not.

Subsequent analyses using Structural Equation Modeling explored the direction of the relationship between NA reactivity to daily stress and depressive symptoms. From these analyses, we found that the relationship between NA reactivity to daily stress and depressive symptoms was unidirectional: Initial (time 1) NA reactivity to both interpersonal and non-interpersonal stressors predicted later (time 2) depressive symptoms, but initial (time 1) depressive symptoms did not predict later (time 2) NA reactivity. In addition, regression analyses revealed that depression history was not a significant predictor of time 1 affective reactivity.

Reactivity as a Predictor of Depression

Our findings for NA reactivity to daily interpersonal and non-interpersonal stress suggest that heightened NA reactivity to daily stress is a vulnerability factor for depressive symptoms. This conclusion is consistent with the findings of O’Neill et al. (2004), who studied college students, and of Cohen et al. (2008), who studied individuals with major depression. The assumption is that an individual with a steep NA reactivity slope is struggling with negative affect regulation in the face of daily

stress, which renders her or him vulnerable to the development of depressive symptoms (Cohen et al., 2005).

The predictive role of affective reactivity is congruent with biological theories of depression. Specifically, physiological mechanisms could help explain how affective reactivity relates to later depression. For example, the amygdala is involved in emotional responses to perceived stress and precipitates the production of cortisol through its neural connections to the hypothalamus pituitary adrenal (HPA) system (see Gallagher and Chiba, 1996, for a review). Additionally, daily stressors and their associated negative mood states have been associated with increases in secretions of salivary cortisol in both non depressed (Van Eck, 1996) and depressed individuals (Sayal et al., 2002). Furthermore, cortisol interacts with neurotransmitters (e.g., reduced serotonin), neuropeptides (e.g., blunted Y), and brain circuits (e.g., reduced activity in medial prefrontal cortex and increased left hemispheric amygdala activity) that are associated with depressive symptoms (Gold, Drevets, & Charney, 2002; Holsboer, 2000; Shatzberg, Garlow, & Nemeroff, 2002). In light of the current findings, a person who is highly NA reactive to daily stressors is likely to have frequent activation of his or her HPA axis, resulting in chronic elevations of cortisol. Such chronic elevations in cortisol may then disrupt neurological systems to produce depressive symptoms.

Inconsistencies with O'Neill et al. (2004)

There are several possible reasons why we found a significant effect for NA reactivity to daily non-interpersonal stressors, whereas O'Neill et al. (2004) did not. First, we used Empirical Bayes estimates for reactivity slopes, whereas O'Neill et al. used OLS. We used this method because it is a more accurate way to compute

reactivity slopes, and it is possible that errors with OLS slopes obscured the reactivity findings involving non-interpersonal events. With this in mind, we re-ran all of our hierarchical regression analyses, using OLS to compute affective reactivity slopes. Interestingly, when analyzed this way, our results matched those of O'Neill et al, in that time 1 NA affective reactivity to non-interpersonal stressors emerged as a nonsignificant predictor of time 2 depressive symptoms.

Another possibility concerns our classification of daily events. Some events classified as non-interpersonal (e.g., did poorly on a school task) might have been interpreted by some participants as interpersonal ones (e.g., the professor won't like me; parents will be disappointed). We used O'Neill et al.'s event classification (interpersonal vs. non-interpersonal), but it is possible that some students interpreted them differently, and that their interpretations varied as a function of variables related to depression vulnerability (Dasch et al., 2008). Perhaps, in future studies, participants themselves should be asked to classify their experienced events.

Still another possibility is that there may have been participant reporting errors in O'Neill et al. (2004), due to their paper and pencil diary methodology. For example, some of their participants might have completed diaries in the morning instead of the evening. Such errors might have obscured possible effects for reactivity to non-interpersonal stressors.

It should also be noted that both Beck (1983) and Blatt (Blatt et al., 1976) proposed depression vulnerability factors based on sensitivity to achievement failure, broadly defined. Beck referred to this dispositional tendency as autonomy, whereas Blatt referred to it as self-criticism. In general, the depression literature has paid far more attention to their constructs involving interpersonal sensitivity than to their

constructs involving sensitivity to failure/lack of control (Coyne et al., 2004). In any case, because our daily events checklist had only one academic stressor, we could not adequately compute daily affective reactivity to academic (“achievement”) stress.

It is also unclear why we did not find a significant effect for PA reactivity to daily interpersonal stressors, whereas O’Neill et al. (2004) did. Several plausible explanations could account for this difference. First, the current study measured participants on only seven nights. O’Neill et al. measured participants on 14 nights, which may have allowed more accurate indices of daily PA reactivity. A second explanation concerns possible participant reporting errors, as discussed above. Finally, it is possible that PA reactivity to daily interpersonal stressors is not a reliable index of depression vulnerability.

Reactivity as an Outcome of Depression

As suggested by the depression “scar” literature previously described, we expected that both a history of depression and elevated levels of depressive symptoms would lead to higher levels of subsequent affective reactivity. However, SEM analyses suggested that initial (time 1) levels of depressive symptoms were not a significant predictor of later (time 2) NA reactivity to daily stress. Rather, initial NA reactivity to daily stress was a predictor of later (time 2) depressive symptoms. One possible explanation for the nonsignificant predictive role of initial depressive symptoms is that depression scar effects require an actual episode of major depression, not just elevations in depressive symptoms. However, in a separate analysis, we found that lifetime depression history was not a significant predictor of time 1 NA reactivity. Overall, our findings suggest that NA reactivity to daily stress predicts depressive symptoms, but not vice versa.

Limitations and Future Directions

There were several limitations of the current study that warrant discussion. Because only college students were sampled, the results might have limited generalizability. Additionally, time 1 and time 2 were separated by only two months. This short interval was obviously sufficient to demonstrate the predictive role of NA reactivity in the development of depressive symptoms. However, more time might be required to adequately test the predictive role of depressive symptoms in subsequent NA reactivity. In other words, perhaps not enough time had elapsed to demonstrate a “depression scar.”

Only nine participants reported a history of depression (based on the IDD:L). Such a low number might have precluded our ability to find significant relationships involving this variable. A more accurate measure of depression history, such as a structured clinical interview, would have enhanced our ability to find significant effects. In addition, the IDD:L simply measures the presence or absence of a prior episode of major depression. It does not measure the number of previous depressive episodes. Because elevations in reactivity, broadly defined, have been found in those with more than one episode of depression (Shahar & Davison, 2003; Wilhelm et al., 1999; Zautra et al., 2007), it would be beneficial to measure the specific number of depression episodes in older and/or clinical populations in order to more sensitively test the depression scar effect on daily affective reactivity.

We assessed depressive symptoms in a normal rather than a clinical sample. Our study reflects the position that assessment of depressive symptoms along a continuum in a nonclinical sample can contribute to our understanding of psychopathology and daily stress and affect processes (O’Neill et al., 2004). As more daily diary research is conducted with clinical populations (e.g., Cohen et al., 2008;

Peeters et al., 2003), it will be useful to compare these findings with those obtained with nonclinical populations.

All measures were self-report, and thus were influenced by the reporting accuracy of the respondents. Daily diary designs help to improve accuracy of event recall by asking respondents to report at the end of each day, rather than to recall experiences that occurred weeks or months in the past. However, there may still be some error in reporting due to poor recall. Additionally, because measures of affect and stressors were measured at the end of the day, many hours may have passed since those stressors occurred. Therefore, there may have been some distortion in recollection of events confounded by current affective states (Kensinger, 2007; Marco & Suls, 1993). Furthermore, measuring both affect and stressors at the end of the day limits the study's ability to examine the dynamic processes by which daily stressors and affect may have influenced each other. For example, affective states experienced in the morning could have influenced the perception and occurrence of stressors later in the day (Hepburn, Barnhofer, & Williams, 2006; Sahl, Cohen, & Dasch, 2009).

In our assessment of daily stress, we asked whether a type of stressor occurred on a given day, but we did not assess the number of times that stressor type occurred. For example, a person might have had two fights with a close friend on that day, but she or he could only check that relevant item once. In addition, we treated each daily stressor as equal in meaning and impact; we did not attempt to differentiate daily stressors on the basis of subjective or objective (e.g., judge-based) criteria. Many leading life events researchers (Monroe, 2008) advocate the use of objective criteria to assess major life stress, although their use in research on daily stress (hassles) is

infrequent and often impractical. Obviously, our checklist of daily stressors is a crude approximation of participants' stressors that day.

Finally, omission of a measure of neuroticism precluded our ability to test the predictive role of our index of daily affective reactivity after the statistical control of this personality trait, which has been implicated in the daily stress and coping process (e.g., Gunthert et al., 1999). However, in O'Neill et al. (2004), neuroticism did not play a significant role, and their findings for NA and PA reactivity were obtained despite its control. Similarly, Cohen et al. (2008) found nonsignificant relations between a measure of neuroticism and their within-person index of affective reactivity to daily stressors.

Conclusions

Despite these limitations, our study, together with O'Neill et al. (2004), suggest that NA reactivity to daily stress is a vulnerability factor for depressive symptoms. Both studies support the utility of this idiographic (within-subject) measure of "daily affect regulation," broadly defined. Moreover, by including a time 2 daily diary component, we were able to evaluate the direction of the affective reactivity-depressive symptoms relationship. Our findings suggest that this relationship is unidirectional: Reactivity influences depressive symptoms, but not vice versa. Additional research is required to further examine whether depressive symptoms, or a history of depression, leave a scar with respect to individuals' ability to regulate NA in the face of daily stress.

NOTES

1 At time 1 and time 2, participants also completed a measure of perceived social support and a measure of major life events.

2 The daily diary also asked participants to indicate the most stressful event of that day, how undesirable it was, and how they coped with that event. Additionally, the diary included a checklist of positive daily events.

3 To test if the daily relationship between NA and negative interpersonal events changed from time 1 to time 2 (controlling for average negative interpersonal events at both times), we specified the following level 1 equation: $NA_{tji} = \pi_{0ji} + \pi_{1ji}(\text{Negative Events}_{tji}) + \epsilon_{tj}$. NA represents negative affect at the end of day t for participant i . The level-2 model for examining the effect of time on NA reactivity to negative interpersonal events is $\pi_{1ji} = \beta_{10i} + \beta_{11i}(\text{Average Negative Events}) + \beta_{12i}(\text{Time}_{tj})$. Each participant's slope for NA reactivity, π_{1ji} , is predicted by an intercept, β_{10i} ; average negative interpersonal events, β_{11i} ; and time, β_{12i} . The level-3 model accounts for between subject variance in daily NA; however, no predictors were entered at this level. Level-1 predictor variables were centered at the person level, and the level-2 variable, average negative interpersonal events, was centered on each time period's mean. Time was coded zero for time 1 and one for time 2. The coefficient, β_{12} , represents the moderating effect of time (or change from time 1 to time 2) on the relationship between daily NA and daily number of negative events. At level 2, individual differences in intercepts were modeled in a similar manner. These equations were adapted to evaluate time 1 to time 2 changes in NA reactivity to non-interpersonal events, PA reactivity to negative interpersonal events, and PA reactivity to negative non-interpersonal events.

4 Regression analyses using OLS slopes, which were used by O'Neill et al., revealed that NA reactivity to non-interpersonal stressors did not significantly predict later depressive symptoms.

5 Similar non-significant results were obtained with coefficients derived from OLS regressions, which were used by O'Neill et al. (2004).

6 Appraisals and coping strategies as they relate to affective reactivity were not examined due to an insufficient number of days when the worst event of the day was an interpersonal one. Therefore, we could not compare our appraisal and coping correlates of daily affective reactivity with those reported by O'Neill et al.

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