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Outside the Eye of the Storm: Can Moderate Hurricane Exposure Improve
Social, Psychological, and Attachment Functioning?

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Abstract

High-intensity disaster can harm psychological functioning. Could moderate-intensity disaster improve psychological and attachment functioning through its effects on social functioning? We used a prospective quasi-experimental cohort design to investigate this possibility among college students. Hurricane cohort participants ($N = 209$) completed assessments before, two weeks, and six weeks after Hurricane Sandy. Two matched comparison cohorts ($Ns > 140$) were assessed four months and one year later. The hurricane cohort, in contrast to matched comparison cohorts, reported increased social support, reduced global distress, reduced negative emotion, and reduced attachment avoidance at the end of the semester. Increased social support mediated the relationship between hurricane cohort and reduced global distress, negative emotion, attachment avoidance, and attachment anxiety, and increased positive emotion and self-esteem at six weeks post-storm. The results suggest moderate disaster exposure can benefit short-term social, psychological, and attachment functioning, underscoring the critical role of the social context in stress adaptation.

Keywords: disaster, social support, attachment, psychosocial gains, prospective

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Destructive hurricanes can inflict psychological harm on people with high levels of exposure (Bonanno, Brewin, Kaniasty, & La Greca, 2010). However, hurricane exposure falls along a continuum, and most people experience moderate-intensity exposure, such as subjective threat, power outages, and disruptions in everyday life. Prior research suggests that low-intensity disaster has modest to minimal effects on psychopathology (Nolen-Hoeksema & Morrow, 1991; Siegel, 2000). At the same time, disaster has marked effects on affiliative, helping, and cooperative behavior (Prince, 1920; Solnit, 2010; Wolfenstein, 1957). Could moderate exposure facilitate the social benefits of disaster while attenuating the psychological costs? In the present study, we examined this possibility in a sample of participants with moderate exposure to Hurricane Sandy, a Category 2 storm that caused widespread power outages, school closings, gasoline shortages, property damage, and over 100 storm-related deaths in the Mid-Atlantic coastal regions of the United States in 2012 (Centers for Disease Control & Prevention, 2013). We used a prospective quasi-experimental cohort design that assessed participants before and after the hurricane and compared them to two matched cohorts. We were particularly interested in identifying changes in social support after the hurricane and whether they were linked to adaptive changes in psychological (global distress, negative emotion, positive emotion, and self-esteem) and attachment functioning (avoidance and anxiety).

Disaster Exposure and Social Support

High-intensity disaster has marked and often favorable effects on the social environment. Historical and sociological accounts describe disaster's aftermath as a "city of comrades" (Prince, 1920), a "post-disaster utopia" (Wolfenstein, 1957), and "a paradise built in hell"

(Solnit, 2010). Indeed, shared aversive experiences enhance the sense of a “common fate” and contribute to stronger bonds among people (Vollhardt, 2009). Consistent with these proposed consequences of disaster, a prospective study of the Topeka Tornado in 1966 found that the tornado-exposed sample reported strengthened social relationships, particularly with family and friends, up to three years after the disaster (Drabek & Key, 1976). Similarly, people assessed before and after the Fukushima nuclear disaster in 2011 valued social connections to a greater extent (Uchida, Takahashi, & Kawahara, 2014) and reported more altruism (Ishino, Kamesaka, Murai, & Ogaki, 2015). Flood exposure has also been linked to greater relationship satisfaction (Fredman et al., 2010), and a school shooting has been linked to increases in perceived support (Mancini, Littleton, & Grills, 2016). These findings suggest that disaster can improve the social fabric.

However, high-intensity disaster can also clearly have negative effects on the social environment. Disasters that result in home destruction, resource loss, dislocation, or rebuilding will disrupt existing social networks, impeding access to close others and increasing risk of psychopathology (Bonanno et al., 2010). As a result, the social environment may eventually undergo “deterioration,” particularly in terms of *perceived support*, the perception that others would be available if needed (Kaniasty & Norris, 2004). For example, survivors of the 1999 Mexican flood with the most extreme exposure also reported the lowest levels of perceived and received social support (Norris, Baker, Murphy, & Kaniasty, 2005). Similar findings emerged after Hurricanes Andrew and Hugo (Norris & Kaniasty, 1996).

What is the impact of moderate-intensity disaster on social and psychological functioning? It is plausible that such disasters could activate the beneficial social consequences of disaster while mitigating the psychological costs. Indeed, various evidence suggests that

normative forms of stress have favorable effects on social perceptions and social behavior. Laboratory manipulations show that social stressors increase trust, trustworthiness, and sharing behavior (von Dawans, Fischbacher, Kirschbaum, Fehr, & Heinrichs, 2012), pain inductions promote social bonding (Bastian, Jetten, & Ferris, 2014), and threat primes increase the accessibility of attachment representations (Mikulincer, Gillath, & Shaver, 2002). Given the importance of social relationships to psychological adjustment (Baumeister & Leary, 1995), these findings suggest moderate disaster exposure could improve psychological functioning through its effects on social functioning.

Disaster Exposure and Attachment Dynamics

In addition to the social environment, disaster may also have effects on attachment dynamics, which are evolved mechanisms to maintain proximity to caregivers when faced with psychological or physical threats (Bowlby, 1980). These dynamics are best described by two overarching dimensions, avoidance, the tendency to mistrust other's good will and to maintain independence from others, and anxiety, the tendency to worry that close others won't be available in times of stress (Hazan & Shaver, 1987). Persons low on these two dimensions are thought to possess a secure attachment orientation (Shaver & Clark, 1994). Although attachment patterns have a clear dispositional component (Donnellan, Burt, Levendosky, & Klump, 2008), numerous studies have confirmed that they also undergo change in response to developmental experiences and major life events (Fraley, 2002; Fraley, Roisman, Booth-LaForce, Owen, & Holland, 2013; Fuller & Fincham, 1995; Lopez & Gormley, 2002). This suggests that environmental experiences, particularly in early adulthood when attachment is more labile, could exert effects on attachment dynamics (Fraley, 2002).

There are a number of reasons moderate disaster exposure could increase attachment security—though, to our knowledge, this question has never been examined empirically. Stress is widely shown to increase affiliative behavior (Taylor, 2006), likely through the release of oxytocin (Cardoso, Ellenbogen, Serravalle, & Linnen, 2013). In the context of disaster, affiliative behavior could be transmitted through cooperative cascades that would be self-reinforcing (Fowler & Christakis, 2010), altering attachment scripts through interactions with the environment. Further evidence suggests that people high in attachment avoidance are particularly susceptible to—and likely to benefit from—the effects of stress-induced oxytocin, because of their dispositional focus on individual agency and self-reliance (Bartholomew & Horowitz, 1991; Bartz et al., 2015). People high in attachment anxiety may also benefit from disaster, insofar as others' affiliative behaviors may assuage ruminative concerns about relationships. These considerations suggest disaster could influence attachment security through changes in perceived social support. In sum, moderate disaster exposure may exert favorable effects on attachment security through alterations in individual and group-level social behavior (Mancini, 2019).

Consequences for Adaptive Psychological Functioning

Adaptive psychological functioning is widely thought to include both negative (e.g., psychopathology; Kotov, et al., 2017) and positive dimensions (e.g., self-esteem and positive emotion; Keyes, 2005). The quality of our relationships has substantial implications for both positive and negative psychological functioning (Diener & Seligman, 2002; Baumeister & Leary, 1995). A particularly important component is our perceptions of the supportiveness of other people. To the degree that people view their relationships as supportive, they are better able to regulate negative emotion (Lakey & Orehek, 2011), experience reduced depression symptoms (Rueger, Malecki, Pyun, Aycok, & Coyle, 2016), and manage stress more adaptively (Cohen &

Wills, 1985). In addition, perceptions of supportiveness should contribute to more secure attachment dynamics, though prior research has focused almost entirely on attachment as a predictor of perceived support (e.g., Collins & Feeney, 2000; Florian, Mikulincer, & Bucholtz, 1995). If perceived social support does increase secure attachment, it would likely also be associated with psychological adjustment, including reduced depression (Burnette, Davis, Green, Worthington, & Bradfield, 2009), a more favorable self-concept (Bartholomew & Horowitz, 1991), and increased positive affect (Mikulincer, Hirschberger, Nachmias, & Gillath, 2001). In short, when people perceive others as more supportive, they should also experience more adaptive psychological and attachment functioning.

Present Study

In the present study, we addressed two primary questions. First, is moderate hurricane exposure associated with adaptive social, psychological, and attachment functioning? To address this question, we assessed a sample of young adults before, two weeks, and six weeks after Hurricane Sandy using well validated measures of global distress, negative emotion, positive emotion, self-esteem, perceived social support, and attachment anxiety and avoidance. We used a “patched-up” quasi-experimental design to compare the prospective hurricane cohort with cohorts of students assessed in subsequent semesters using an identical methodology. Patched-up designs employ successive control groups to address specific viable threats to internal validity (Campbell & Stanley, 1963; Shadish, Cook, & Campbell, 2002). For example, in the present study, students could see improved functioning as they adapt to college (maturation effect) or because of feelings of relief as the semester ends (history effect), irrespective of hurricane exposure. Because a subsequent fall comparison cohort would also be subject to maturation, it would help to address maturation effects. Because a spring comparison cohort would be subject

to end of semester effects, it would help to address history as an alternate explanation. In addition, because cohort designs are inherently well-matched, they help to control selection threats and thus to strengthen causal inferences (Shadish et al., 2002).

A second question was whether improved social support after hurricane exposure is a mechanism of improved psychological and attachment functioning. A mediational framework allowed us to examine whether changes in social support after the hurricane were the mechanism of improved psychological and attachment functioning. In short, we explored the possibility that moderate hurricane exposure could have favorable effects on psychological and attachment functioning through changes in social support.

Method

Participants and procedure. Prospective hurricane-exposed participants were 209 undergraduate and master's psychology students (75.1% female) who completed surveys at three time points during the fall of 2012 for course credit. Comparison cohorts were assessed in the following spring 2013 and fall 2013 semesters using an identical methodology. Participants completed surveys on psychological functioning, attachment dynamics, positive and negative emotion, stressful life events, self-concept, social support and other variables as part of a study of stressful life events during a semester. No psychological or social functioning variables were excluded from the current analysis. A complete list of the variables collected for the larger study is included in the supplemental materials.

All cohorts completed three surveys at roughly monthly intervals in a single semester. The baseline assessment (W1) was completed during a scheduled visit to a laboratory within the first month of the semester. Groups of two to five students completed paper questionnaires individually while seated in separate carrels. Two subsequent surveys (W2 and W3) were

completed online using an emailed link. The W2 and W3 surveys for the prospective hurricane cohort were completed about two weeks later in the semester than the comparison cohorts. The prospective hurricane cohort completed the W2 survey roughly two weeks after the storm (1.5 months from W1) and the final survey about 6 weeks after the storm (2.5 months from W1). All surveys were approved by the [MASKED] University institutional review board.

All participants had to be 18 years of age or older. See Table 1 for participant characteristics by cohort. There were no overall cohort differences in age, ethnicity, or gender (p s > .08) but there were differences by year in school. A follow-up analysis compared the frequency probability for each cell using Haberman's (1978) standardized, adjusted residuals statistic (HAR). This revealed a greater number of graduate students in the prospective cohort sample ($n = 20$, 8.3%) than the comparison cohorts ($ns < 1.4\%$), $HAR = 4.7$, $p < .001$. As a result, all analyses examined graduate student status as a covariate to ensure the robustness of the results.

No eligible participants were excluded from analysis. Our sample size was based on the available participant pool for each semester, but together the samples were sufficient to detect small to medium-sized effects in our mixed-model and mediational analyses at adequate power (> 85%), according to conventional methods (G*Power; Faul, Erdfelder, Buchner, & Lang, 2009; MedPower: Kenny, 2017, February) and Monte Carlo simulations for mediation (Schoemann, Boulton, & Short, 2017). Missing data were as follows: prospective hurricane cohort, 2% at W1 (social support only); 13.4% at W2 (social support, 16.7%); 9% at W3 (social support, 22%). The spring 2013 cohort was missing 7.8% at W2 and 8.5% of participants at W3 (social support was missing for 28.8%). The fall 2013 cohort was missing 8.5% of participants at W2 and 10.7% of participants at W3. Data file for the present study will be made available.

Measures

Sandy exposure. Hurricane-related exposure was measured using a slightly modified 17-item version of the Hurricane-Related Trauma Experiences scale (La Greca, Silverman, Vernberg, & Prinstein, 1996). Participants were asked yes/no questions about specific, observable events during the hurricane, including life-threatening experiences, witnessing others being harmed, significant disruptive consequences of the storm such as home damage, and subjective sense of life threat. These items were summed to obtain a total score of hurricane exposure.

Social support. We used the Interpersonal Support Evaluation List-12 (ISEL-12) to assess the perceived availability of social support (Cohen, Mermelstein, Kamarck, & Hoberman, 1985). The ISEL-12 contains three subscales that assess the perceived availability of other people to talk about problems (appraisal support), to spend time doing things (belonging support), and to provide material aid (tangible support). Questions were responded to on a four-point scale ranging from 1 (definitely false) to 4 (definitely true). Total perceived social support scores were derived by averaging the 12 items. Negatively worded items, which indicated low support, were reverse scored. Internal reliabilities for both 12-item scale across cohorts and measurement occasions was high (all $\alpha_s > .83$).

Global distress. Global distress was measured with a combination of the Depression, Anxiety, and Hostility scales from the Symptom Check List (SCL-90; Derogatis, Lipman, & Covi, 1973). The SCL-90 is a 90-item self-report symptom inventory that measures psychological distress across nine symptom dimensions using a 5-point rating scale. The 29 items from the selected subscales were summed and averaged to form a global distress index.

Internal reliabilities for both 29-item scale across cohorts and measurement occasions was high (all $\alpha_s > .94$).

Positive and negative emotion. We used the 10-item subscales for the Positive and Negative Affect Schedule to measure positive and negative emotion (Watson, Clark, & Tellegen, 1988). We asked participants to rate how frequently they felt positive emotions (“enthusiastic,” “inspired,” “determined”) and negative emotions (“upset,” “scared,” “irritable”) in the past week. Items were rated on a five-point scale from 1 (very slightly or not at all) to 5 (extremely). Internal reliabilities for each 10-item subscale across cohorts and measurement occasions were high (all $\alpha_s > .89$).

Attachment patterns. We used the 36-item Experiences in Close Relationships-Revised (ECR-R) Avoidance and Anxiety subscales (Sibley, Fischer, & Liu, 2005). Using a 7-point Likert type scale (where 1 = strongly disagree and 7 = strongly agree), participants responded to statements regarding how they generally feel in emotionally intimate relationships. Items included statements such as “I worry a lot about my relationships” and “I do not often worry about being abandoned.” Internal reliabilities for avoidance and anxiety subscales across cohorts and measurement occasions were high (all $\alpha_s > .87$).

Self-esteem. We used the 10-item Rosenberg Self-esteem Scale to measure self-esteem (Rosenberg, 1965). Participants responded to statements regarding how they feel about themselves on a 4-point Likert type scale (where 1 = strongly disagree and 4 = strongly agree). Negatively worded items were reversed. Items included statements such as “On the whole I feel satisfied with myself” and “I feel I do not have much to be proud of” (reverse coded). Internal reliabilities for the 10-item scale across cohorts and measurement occasions were high (all $\alpha_s > .88$).

Posttraumatic stress disorder symptoms. We used the Posttraumatic Stress Disorder Checklist Civilian Version to measure posttraumatic stress disorder symptoms (Weathers, Litz, Herman, Huska, & Keane, 1993). This measure consists of 17 items that map on to the DSM-IV symptoms for posttraumatic stress disorder. Participants rated each symptom in relation to their experiences during Hurricane Sandy on a 5-point scale from 1 (not at all) to 5 extremely. Scores were summed for a total score (minimum = 17, maximum = 85). Internal reliability for the 17-item scale was high ($\alpha = .93$).

Data analysis

We had two primary analytic aims: 1) to examine change in social, psychological, and attachment functioning in a prospective hurricane cohort and to compare that change to matched cohorts; and 2) to examine whether change in social support mediated the relationship between moderate hurricane exposure and adaptive psychological functioning.

To address the first aim, we first examined between group differences in a planned contrast weighting the prospective hurricane cohort against the fall 2013 cohort. This allowed us to compare adaptive functioning across two cohorts matched by semester. To examine within-person change, we conducted a series of linear mixed-model models for each variable (social support, attachment avoidance, attachment anxiety, global distress, negative emotion, positive emotion, self-esteem). This allowed us to examine change at the within person level and to compare that change at the between groups level. Mixed models use maximum likelihood techniques to include all participants in the analysis, a crucial advantage over traditional repeated measures analyses of variance (Enders, 2011). Significant interactions were probed using simple effects analyses within each cohort.

To address the second aim, we used a mediation framework. The primary predictor variable was a matched cohort comparison of the prospective hurricane fall cohort in 2012 (dummy coded as 1) and the fall cohort in 2013 (coded as 0). We used social support at W3 as the mediator. Following guidelines for mediation with panel designs (Hayes & Preacher 2010), we controlled both for baseline values of the outcome (global distress, negative emotion, positive emotion, self-esteem, attachment avoidance, and attachment anxiety) and for the mediator (social support), allowing us to assess whether change in the mediator resulted in change in the outcomes. Bootstrapped resampling methods were used to calculate bias-corrected bootstrap confidence intervals for the indirect effect. Bootstrapping approaches yield more accurate estimates of direct and indirect effects in mediational analyses. We used the SPSS dialog PROCESS to generate a 95% confidence interval (CI) for the indirect effect with 10,000 iterations (Hayes, 2012; Model 4 for mediation). When the confidence interval does not include zero, we can reject the null of no indirect effect. To estimate the magnitude of these effects, we calculated the partially standardized indirect effect (Preacher & Kelley, 2011), which expresses the indirect effect in standard deviation units of the dependent variable. To gauge magnitude, we multiplied conventions for small, medium, and large effects, because an indirect effect is the product of two effects (see Kenny, 2020, December 18). This implies that when the predictor variable is dichotomous (a difference effect), we should multiply conventions for Cohen's d by those for r (Cohen, 1992), indicating a small effect would be .02 (.10 x .20), a medium effect .15 (.30 x .50), and a large effect .40 (.80 x .50).

Results

Descriptive analyses. Hurricane cohort participants reported moderate levels of hurricane exposure ($M = 2.89$, $SD = 1.87$, $Median = 3$, $range = 0$ to 10). A small minority

reported life threatening experiences (12.2%), the belief that they might die during the hurricane (10.2%), or significant property loss or disruption (16.8%). Almost all reported school disruptions (91.4%), and most reported power outages (71.4%). Hurricane cohort participants also reported very low levels of PTSD symptoms in response to the storm ($M = 19.76$, $SD = 5.99$, $Median = 17.0$, $range = 17$ to 49), with most reporting no symptoms (53.8%).

Between group cohort differences. As shown in Table 1, planned contrasts weighting the hurricane cohort against the fall 2013 cohort revealed a number of significant differences. Social support at W3 was significantly higher among the hurricane cohort group compared to the fall 2013 cohort ($p < .001$, $d = .49$), corresponding to a medium effect (Cohen, 1992). Similarly, attachment avoidance at W3 was significantly lower among the hurricane cohort than the fall 2013 cohort ($p = .03$, $d = .29$) and attachment anxiety at W3 was also significantly lower among the hurricane cohort ($p = .04$, $d = .24$), corresponding to a small effect size difference. Finally, self-esteem at W3 was higher among the hurricane cohort than the fall 2013 cohort ($p = .04$, $d = .23$), corresponding to a small effect. Although global distress and negative emotion at W3 were both lower among the hurricane cohort, compared to the fall 2013 cohort, these differences were only marginally significant ($p_s < .06$). Together these findings suggested that the hurricane cohort at W3 had an overall profile of adaptive psychological adjustment, relative to the fall 2013 cohort.

Within-person change by cohort. Next we used linear mixed models to examine within-person change across cohorts. These analyses allowed us to examine whether the hurricane cohort showed improved functioning over the semester, relative to matched comparison cohorts. The within-subjects factor was the outcome variable (social support, attachment avoidance, attachment anxiety, global distress, negative emotion, positive emotion, and self-esteem) and the

between-subjects factor was the three category cohort variable (Hurricane Sandy cohort, spring 2013, fall 2013). For each analysis, we used a random intercept and, based on model testing, assumed an auto-regressive (AR1) covariance matrix. Time, Cohort, and their interaction were treated as fixed effects.

Social support. We found that social support tended to increase in the hurricane cohort but to decline in the comparison cohorts (see Figure 1). There was a main effect for time $F(2, 631.21) = 4.32, p = .01$, a significant main effect for Cohort, $F(2, 497.04) = 10.56, p = .0003$, and a significant two-way Time x Cohort interaction, $F(4, 630.53) = 7.54, p < .0001$. To decompose this interaction, we conducted posthoc analyses separately for each cohort (see Figure 1). The hurricane cohort showed a marginal effect of time for social support over the semester, $F(2, 259.99) = 2.82, p = .06$. Pairwise comparisons revealed a significant increase in social support from W1 to W2 ($p = .018$) but no change from W2 to W3 ($p = .30$). By contrast, both the spring 2013 cohort, $F(2, 201.27) = 8.89, p = .0002$, and the fall 2013 cohort, $F(2, 177.04) = 4.53, p = .01$, revealed a decline in social support over the semester.

Attachment avoidance and anxiety. We also found that the hurricane cohort experienced a reduction in attachment avoidance (see Figure 1). There was a marginal main effect for time $F(2, 633.01) = 2.50, p = .08$, no effect for Cohort, $F(2, 506.54) = 1.21, p = .30$, and a significant two-way Time x Cohort interaction, $F(4, 635.13) = 2.79, p = .03$. Posthoc analyses showed a significant effect of time for attachment avoidance for the hurricane cohort, $F(2, 276.05) = 7.02, p = .001$. Pairwise comparisons revealed no change in avoidance from W1 to W2 ($p = .89$) but a significant decrease emerged from W2 to W3 ($p = .002$). By contrast, neither the spring 2013, $F(2, 201.79) = .56, p = .57$, nor the fall 2013 cohort, $F(2, 159.35) = .53, p = .59$, showed an effect of time

For attachment anxiety, there was an overall effect of time during the semester, $F(2, 664.26) = 11.43, p = .0001$, a marginal effect for Cohort, $F(2, 664.26) = 2.42, p = .09$, but no Time x Cohort interaction, $F(4, 668.81) = .09, p = .98$. Thus, attachment anxiety showed a strong tendency to decline over the semester, but, unlike attachment avoidance, this decline did not vary by cohort.

Global distress and negative emotion. Next we found that global distress and negative emotion both decreased in the hurricane cohort but not the comparison cohorts (see Figure 1). Although there was no main effect for time $F(2, 721.11) = 1.27, p = .27$, or Cohort, $F(2, 539) = .81, p = .45$, but there was a significant Time x Cohort interaction predicting global distress, $F(4, 724.54) = 2.87, p = .02$. Posthoc analyses conducted for each cohort (see Figure 1) showed the Hurricane cohort decreased in global distress over the semester, $F(302.19) = 5.08, p = .007$. Pairwise comparisons revealed that global distress declined significantly from W1 to W2 ($p = .012$) and from W2 to W3 ($p = .004$). By contrast, the spring 2013 cohort, $F(2, 201.07) = 1.58, p = .21$, and the fall 2013 cohort, $F(2, 214.83) = 1.63, p = .21$, showed no effect of time.

For negative emotion, there was again no main effect for time $F(2, 699.94) = 1.89, p = .15$, or Cohort, $F(2, 499.45) = 2.07, p = .13$, but there was a significant Time x Cohort interaction, $F(4, 740.54) = 2.88, p = .02$. Posthoc analyses (see Figure 1) showed a significant effect of time for the Hurricane cohort, $F(276.50) = 2.94, p = .05$. Pairwise comparisons revealed a significant reduction in negative emotion from W1 to W2 ($p = .02$) but no change from W2 to W3 ($p = .13$). By contrast, the spring 2013 cohort showed no effect of time, $F(2, 220.14) = 2.01, p = .20$. The fall 2013 cohort did reveal an effect of time, $F(2, 205.33) = 3.03, p = .05$. Pairwise comparisons showed no change from W1 to W2 ($p = .20$) and a significant increase in negative emotion from W2 to W3 ($p = .015$).

Positive emotion and self-esteem. Positive emotion showed a strong tendency to decline over the semester, $F(2, 689.52) = 52.15, p < .0001$, but there was no Cohort, $F(2, 494.62) = 1.47, p = .23$, or Time x Cohort interaction, $F(4, 736.94) = 1.71, p = .15$. Similarly, self-esteem tended to decline over the semester, $F(2, 627.73) = 5.04, p < .007$, but there was no Cohort, $F(2, 502.07) = 1.18, p = .31$, or Time x Cohort interaction, $F(4, 627.73) = 1.58, p = .18$.

Summary. These analyses indicated that within person change varied by cohort for a number of outcomes. Specifically, the hurricane cohort saw beneficial change in social support, global distress, negative emotion, and attachment avoidance, whereas the comparison cohorts did not.

Mediational analyses. Next we examined whether change in social support was a mechanism of improved psychological and attachment functioning. To address this possibility, we conducted longitudinal mediational analyses using the matched cohort as the predictor variable (Hurricane Sandy cohort vs. Fall 2013), W3 social support as the mediator (controlling for W1), and global distress, negative emotion, positive emotion, self-esteem, attachment avoidance, and attachment anxiety as W3 outcome variables (Table 2 summarizes these results). We also tested alternate cohort comparisons in supplemental analyses (see Supplemental Table A).

Global distress W3. We first tested whether social support mediated the association between hurricane cohort and reduced global distress at W3 (see Figure 2). We found evidence that it did. The hurricane cohort, when compared to the fall 2013 cohort, saw reductions in global distress through an increase in social support. The overall mediational model predicting W3 global distress was statistically significant, $F(3, 304) = 50.91, p < .000, R^2 = .33$. Moreover, a significant indirect effect indicated that social support mediated the effect of hurricane cohort on

reduced W3 global distress (indirect = $-.09$, $SE = .029$, 95% CI $[-.16, -.04]$). The partially standardized indirect effect was $-.13$, 95% CI $[-.20, -.05]$, corresponding roughly to a medium effect size. Although the total effect of the hurricane cohort on W3 global distress was not significant ($B = -.07$, $SE = .07$, $p = .32$), a significant total effect is not a requirement for statistical mediation (Pearl, Glymour, & Jewell, 2016; Shrout & Bolger, 2002).

Negative emotion W3. Next we found that social support mediated the association between hurricane cohort and reduced negative emotion at W3. The overall mediational model was statistically significant, $F(3, 304) = 25.41$, $p < .000$, $R^2 = .20$. A significant negative indirect effect indicated that social support mediated the effect of Hurricane cohort on reduced W3 negative emotion (indirect = $-.07$, $SE = .03$, 95% CI $[-.13, -.02]$). The partially standardized indirect effect was $-.10$, 95% CI $[-.03, .15]$, corresponding to a small to medium effect. The total effect of cohort on W3 negative emotion was not significant ($B = -.07$, $SE = .07$, CI $[-.21, .07]$, $p = .31$).

Positive emotion W3. We also found that social support mediated the association between hurricane cohort and increased positive emotion at W3. Specifically, the overall mediational model was statistically significant, $F(3, 304) = 28.41$, $p < .000$, $R^2 = .22$. A significant positive indirect effect indicated that social support mediated the effect of Hurricane cohort on increased W3 positive emotion (indirect = $.09$, $SE = .03$, 95% CI $[.04, .16]$). The partially standardized indirect effect was $.10$, 95% CI $[.03, .15]$, corresponding to a small to medium effect. The total effect of cohort on W3 positive emotion was marginally significant ($B = .16$, $SE = .09$, CI $[-.01, .33]$, $p = .07$).

Self-esteem W3. The analysis of self-esteem replicated the previous findings. The overall mediational model was statistically significant, $F(3, 304) = 53.76$, $p < .000$, $R^2 = .42$. A

significant positive indirect effect indicated that social support mediated the effect of Hurricane cohort on increased W3 self-esteem (indirect = .06, $SE = .02$, 95% CI [.03, .10]). The partially standardized indirect effect was -.09, 95% CI [.04, .17]), corresponding to a small to medium effect. The total effect of cohort on W3 self-esteem was marginally significant ($B = .09$, $SE = .05$, CI [-.02, .19], $p = .09$).

Attachment anxiety and avoidance W3. Two final analyses examined whether social support mediated the effect of hurricane cohort on reduced attachment avoidance and reduced attachment anxiety. We found evidence that it did for both attachment variables. The overall mediational model predicting W3 attachment avoidance was significant, $F(3, 304) = 121.73$, $p < .000$, $R^2 = .54$. A significant negative indirect effect indicated that W3 social support mediated the effect of cohort on attachment avoidance at W3 (indirect = -.07, $SE = .02$, 95% CI [-.13, -.03]). A similar pattern emerged for attachment anxiety. The overall mediational model predicting W3 attachment anxiety was statistically significant, $F(3, 304) = 77.39$, $p < .001$, $R^2 = .43$, and a significant negative indirect effect indicated W3 social support mediated the effect of hurricane cohort on attachment anxiety at W3 (indirect = -.14, $SE = .04$, 95% CI [-.23, -.06]). The partially standardized indirect effect for attachment avoidance was -.07, 95% CI [.04, .17]) and for attachment anxiety was -.11, 95% CI [-.19, -.06]), corresponding to small to medium effect sizes. The total effect of hurricane cohort on W3 attachment avoidance was significant ($B = .21$, $SE = .08$, CI [-.37, -.04], $p = .01$) but the total effect for attachment anxiety was not ($B = -.04$, $SE = .10$, CI [-.25, .16], $p = .67$).

Summary. Together these findings provided consistent evidence that change in social support mediated the effect of hurricane cohort on reduced global distress, reduced negative

emotion, reduced attachment avoidance, reduced attachment anxiety, increased positive emotion, and increased self-esteem.

Robustness checks. To address the robustness of these findings, we conducted a number of additional analyses. A critical concern was whether the findings were robust to alternate operational definitions of hurricane exposure. To address this concern, we first conducted mediational analyses using each possible cohort comparison as a predictor variable. In a spring 2013 vs fall 2013 cohort comparison, the primary mediational findings replicated for all outcome variables, though with slightly smaller magnitudes. Although the fall 2012 hurricane cohort vs the spring 2013 cohort did not yield significant mediational effects, this comparison involved two cohorts that both had relatively recent hurricane exposure, and the direction of effects was identical to the other analyses. See Supplemental Table A for these results.

Second, we examined curvilinear effects of hurricane exposure in a set of analyses confined to the hurricane cohort. Specifically, we used our continuous assessment of hurricane exposure to address the possibility that low or moderate exposure has favorable effects, whereas high exposure has negative effects. Although the hurricane cohort had modest exposure and the range was correspondingly restricted, some participants reported significant exposure, suggesting this variation could be used to examine quadratic effects within the hurricane cohort. To examine this possibility, we first conducted a regression analysis. We found a significant quadratic effect of hurricane exposure on W3 social support, consistent with moderate exposure being associated with the highest level of social support at W3 (see Supplemental Table B and Figures A and B). Next we found evidence that the mediational path from continuous hurricane exposure to social support was nonlinear, with the indirect effect reversing sign at high levels of exposure, suggesting quadratic effects in which low to moderate exposure had favorable effects on

functioning variables whereas high exposure had negative effects. (See Supplemental Tables C and D and Figure C.) Together, these findings provided additional evidence that moderate hurricane exposure has beneficial and high exposure harmful effects on functioning.

A final analysis addressed the possibility that missing data influenced the mediational relationships. We used multiple imputation to generate 10 data sets with complete data and found that the primary mediational findings were robust to missing data, replicating fully in 10 imputed data sets (see Supplemental Table E).

Discussion

The present study used a prospective quasi-experimental cohort design to examine whether moderate exposure to natural disaster can have beneficial effects on psychological and attachment functioning. The results supported this possibility. The reported a significant increase in social support two weeks after the hurricane, and relative to a matched cohort, had more social support across the semester. By contrast, two matched comparison cohorts saw a decline in social support over the semester. Attachment avoidance, global distress, and negative emotion also declined significantly among the hurricane cohort participants, in contrast to the comparison cohorts, which showed no change or worsened functioning. Moreover, social support mediated the effect of hurricane exposure on reduced global distress, negative emotion, attachment avoidance, and attachment anxiety, and increased positive emotion and self-esteem. Similar findings emerged using alternate operational definitions of hurricane exposure.

To our knowledge, no prior research has specifically linked moderate disaster exposure to adaptive social, psychological, and attachment functioning. The current study was guided by a key theoretical insight, increasingly borne out by empirical research, that stressful experiences stimulate social behavior and can potentially improve psychological functioning (Mancini,

2019). Although sociological and historical investigations of disaster have highlighted this possibility (e.g., Solnit, 2010), almost no empirical research has examined it using pre-event and matched comparison group designs. In the present study, we had an unusual opportunity to examine a prospective hurricane cohort in relation to closely matched comparison cohorts. We observed beneficial indirect effects of the hurricane across a range of psychological outcomes that were small to medium in magnitude (Kenny, 2020, December 18), including attachment functioning, which is typically viewed as stable over short time frames. The present findings suggest attachment dynamics may be malleable even in the short term (for a review of these issues, see Fraley & Brumbaugh, 2004).

One lens for viewing these results is a counterfactual model (Pearl, Glymour, & Jewell, 2016; Pearl & Mackenzie, 2018). If Hurricane Sandy had not barreled up the Eastern seaboard of the United States in October 2012, would the hurricane cohort have shown the same pattern of adaptive social, psychological, and attachment functioning? Although a causal effect cannot be established in an observational study, our research design suggests that, in fact, they would not. We assessed functioning from before to after the hurricane, and two closely matched comparison cohorts provided evidence against maturation, history, and selection effects (Campbell & Stanley, 1963). These combined design features, which are rare in disaster research, strengthen the internal validity of the present study, and support that the observed improvements in functioning are attributable to moderate hurricane exposure.

Although the present results are broadly consistent with beneficial effects of disaster (Bonanno et al., 2010; Fritz, 1961; Kaniasty & Norris, 1995; Kaniasty & Norris, 2004; Solnit, 2010; Wolfenstein, 1957), they are at variance with the idea that perceived support deteriorates after disaster, a possibility suggested by prior research (Kaniasty & Norris, 1993; Kaniasty et al.,

1990). One straightforward explanation for this divergence is that prior disaster research has largely focused on more severely exposed samples. Unlike severe exposure, low to moderate exposure may activate the benefits of shared stressors, such as increased affiliative behavior and availability of close others, without exacting the distal consequences associated with them, such as loss of resources and structural impediments in the social environment.

The present findings also extend our understanding of social support and stress adaptation beyond the traditional “buffering” model of social support (Cohen & Wills, 1985). The buffering effect implies a static quantity of perceived social support that is essentially independent of the stressor event. It is appropriately identified in a moderation framework using an interaction term. By contrast, a number of emerging perspectives, such as relational regulation theory and tend-and-befriend (Lakey & Orehek, 2011; Taylor, 2006), view social support as a dynamic quantity that is calibrated according to current needs and environmental inputs. A similar perspective is provided by the idea of “psychosocial gains from adversity,” in which psychological functioning after adversity improves as a result of changes in social behavior and in the social context (Mancini, 2019). These conceptualizations are appropriately identified in a prospective longitudinal framework using repeated measures analyses of social processes.

Two notable findings were that attachment avoidance declined after hurricane exposure and that improved social support mediated the effect of hurricane exposure both on reduced attachment avoidance and reduced attachment anxiety. Although prior research has found that attachment security is responsive to beneficial developmental experiences (Fraley et al., 2013), no prior research, to our knowledge, has linked changes in attachment to stress exposure. One way of interpreting these results is in terms of research on attachment and oxytocin, the primary neurobiological mechanism of affiliative responses to stress (Cardoso et al., 2013; Carter, 2014;

Engelmann, Ebner, Landgraf, Holsboer, & Wotjak, 1999; Neumann, Krömer, Toschi, & Ebner, 2000). Various evidence indicates that oxytocin has favorable effects on affiliative orientation in avoidantly attached people (Bartz et al., 2015), likely because of their dispositionally low levels of communal and social approach behavior (Fraley, Davis, & Shaver, 1998). By contrast, oxytocin can have anxiogenic effects on people high in attachment anxiety, likely because it reduces their sense of agency (Bartz, 2016; Bartz et al., 2015). However, beneficial effects of oxytocin are also dependent on favorable responses from others (Taylor, 2006), suggesting that a more receptive social environment could ease attachment concerns among anxiously attached as well as avoidantly attached individuals. The present findings suggest that improved perceptions of supportive others are a mechanism of improved attachment functioning after exposure to adversity.

Limitations

In the context of these findings, a number of limitations warrant consideration. A key limitation is that these analyses were exploratory and were not preregistered. It will be important to replicate these results in preregistered studies using population-based samples with a range of exposure levels. Although the findings were generally robust to alternate model specifications, emerging in both continuous and categorical assessments of hurricane exposure, some variation in our findings also emerged across model specifications. Another key limitation is that we could not address the long-term consequences of hurricane exposure in a single sample. However, the spring 2012 cohort showed higher levels of social support at W1 (four months after the hurricane) than any other cohort assessment, suggesting they may have also experienced an increase in social support. Attachment avoidance, was also reduced in the spring 2012 cohort at W1, suggesting the effect of the hurricane was maintained. A countervailing strength is that the

effects of the hurricane were assessed within two weeks. Few prior studies have examined the consequences of disaster at such close proximity to its occurrence. We also note that the timing of the W2 and W3 assessments was about two weeks later for the hurricane cohort than for the comparison cohorts. Another important caveat is that the frame for generalization of the present results cannot be extended to more severe disaster exposure. Unlike prior work on deterioration effects (e.g., Kaniasty & Norris, 1993), an additional limitation was that our sample involved college students, which constraints our capacity to generalize to community samples.

Conclusions and Implications

Prior conceptual frameworks have emphasized the potential of acute adversity to undermine perceptions of the supportiveness of close others and to degrade psychological functioning. Although there is ample evidence that natural disaster can have negative psychological effects, most people are psychologically resilient (Bonanno, Westphal, & Mancini, 2011). Moreover, the present findings suggest that some people can directly benefit from adversity's effect on the social environment, and that a critical element of effective coping is an appropriate recalibration of support-seeking and perceptions of support. In the process, adversity may improve functioning simply because it promotes a greater belief in—and greater evidence for believing in—the availability of others.

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Table 1.

Descriptive statistics for prospective hurricane and comparison cohorts

Variable	Prospective Hurricane Cohort Fall 2012 (<i>N</i> = 209)	Spring 2013 (<i>N</i> = 140)	Fall 2013 (<i>N</i> = 153)	Prospective Hurricane cohort Fall 2012 vs. Fall 2013
Demographics				
Age	20.29 (5.29)	19.33 (2.51)	19.20 (1.7)	$t = 1.54, p = .13$
Female	76.2%	67.3%	77.1%	$\chi^2 = .19, p = .38$
Ethnicity				$\chi^2 = 6.01, p = .42$
White	54.6%	53.6%	52.9%	
Black	10.1%	9.8%	15.0%	
Latino	22.9%	20.3%	19.3%	
Asian	4.4%	6.5%	7.1%	
Other	7.9%	9.8%	5.7%	
Year				$\chi^2 = 23.71, p < .001$
Freshman	54.1%	64.1%	57.1%	
Sophomore	13.9%	13.1%	18.6%	
Junior	8.6%	12.4%	12.9%	
Senior	13.9%	10.5%	10.0%	
Graduate	9.8%	--	1.4%	
Social Functioning				
Soc support, W1	3.30 (.48)	3.44 (.43)	3.20 (.53)	$t = 1.98, p = .13$
Soc support, W2	3.36 (.48)	3.30 (.51)	3.16 (.54)	$t = 3.47, p = .001$
Soc support, W3	3.34 (.53)	3.38 (.51)	3.07 (.57)	$t = 4.23, p = .00003$
Att. Avoid, W1	3.78 (1.09)	3.66 (.94)	3.87 (1.11)	$t = -.81, p = .41$
Att. Avoid, W2	3.77 (1.07)	3.69 (.92)	3.87 (1.11)	$t = -.88, p = .38$
Att. Avoid, W3	3.60 (.67)	3.72 (.90)	3.85 (1.01)	$t = -2.16, p = .032$
Att. Anxiety, W1	3.37 (1.21)	3.32 (1.13)	3.56 (1.27)	$t = -1.41, p = .14$
Att. Anxiety, W2	3.21 (1.18)	3.15 (1.04)	3.41 (1.21)	$t = -1.56, p = .12$
Att. Anxiety, W3	3.08 (1.21)	3.10 (1.10)	3.36 (1.17)	$t = -2.08, p = .038$
Psych. Functioning				
Distress, W1	.85 (.66)	.75 (.56)	.94 (.70)	$t = -1.14, p = .26$
Distress, W2	.74 (.61)	.82 (.66)	.85 (.62)	$t = -1.45, p = .15$
Distress, W3	.73 (.69)	.77 (.76)	.88 (.73)	$t = -1.87, p = .06$
Neg. emotion, W1	2.17 (.63)	2.02 (.62)	2.21 (.66)	$t = -.60, p = .55$
Neg. emotion, W2	2.05 (.64)	2.11 (.67)	2.15 (.69)	$t = -1.29, p = .20$
Neg. emotion, W3	2.13 (.68)	2.10 (.74)	2.28 (.71)	$t = -1.89, p = .06$

Table 1. (continued).

Pos. emotion, W1	3.30 (.79)	3.38 (.86)	3.30 (.78)	$t = -.05, p = .96$
Pos. emotion, W2	2.98 (.84)	3.15 (.86)	2.94 (.85)	$t = .30, p = .76$
Pos. emotion, W3	2.96 (.88)	2.95 (.89)	2.88 (.90)	$t = .73, p = .47$
Self-esteem, W1	3.20 (.53)	3.22 (.56)	3.14 (.54)	$t = .84, p = .13$
Self-esteem, W2	3.17 (.55)	3.20 (.54)	3.09 (.55)	$t = 1.26, p = .13$
Self-esteem, W3	3.20 (.51)	3.12 (.56)	3.06 (.71)	$t = \mathbf{2.02}, p = \mathbf{.044}$

Note: Standard deviations in parentheses. Soc = social; att = attachment; neg. = negative; pos = positive. W1 = wave 1; W2 = wave 2; W3 = wave 3. $p < .05$ in **bold**.

Table 2.

Summary of bootstrapped indirect effects in mediational analyses predicting psychological and attachment functioning

Outcome Variable	Indirect effect <i>b</i>	Boot SE	95% CI	Partially standardized indirect effect
Global distress, W3 _a	-.09	.029	-.156, -.043	-.13
Negative emotion, W3 _b	-.07	.028	-.132, -.022	-.10
Positive emotion, W3 _c	.09	.031	.037, .160	.10
Self-esteem, W3 _d	.07	.037	.058, .201	.12
Attachment avoidance, W3 _e	-.07	.028	-.126, -.024	-.11
Attachment anxiety, W3 _f	-.14	.042	-.189, -.053	-.11

Note: Mediational model = X (hurricane cohort vs fall 2013) → M (social support, W3), → Y (outcome, W3). Wave 1 values of the mediator and the outcome variable were controlled. SE = standard error; CI = confidence interval. W3 = wave 3.

_a direct effect, *b* = .03, 95% CI (-.10, .15), *p* = .68. _b direct effect, *b* = .01, 95% CI (-.14, .14), *p* = .98.

_c direct effect, *b* = .08, 95% CI (-.12, .23), *p* = .53. _d direct effect, *b* = .02, 95% CI (-.08, .13), *p* = .66.

_e direct effect, *b* = -.14, 95% CI (-.30, .02), *p* = .10. _f direct effect, *b* = .09, 95% CI (-.11, .29), *p* = .38

a

b

c

d

Figure 1. Patterns of change in a) social support, b) negative emotion, c) global distress, and d) attachment avoidance from W1 to W3 by semester cohort (with standard error bars). Note: W1 = wave 1; W2 = wave 2; W3 = wave 3.

Figure 2. Illustrative mediation model predicting global distress at W3. Covariate (cov) paths are indicated with a dashed line (for ease of presentation, covariate coefficients are omitted). All coefficients are unstandardized. For the path from hurricane exposure to global distress, c represents the total effect (direct + indirect effect) and c' the direct effect.

Note: Hurricane cohort = 1; fall 2013 = 0. W1 = wave 1; W3 = wave 3.

* $p < .05$; *** $p < .001$