*Empirical Article*

Clinical Psychological Science
2016, Vol. 4(3) 401–417

DOI: 10.1177/2167702615601001
cpx.sagepub.com

# Can People Benefit From Acute Stress? Social Support, Psychological Improvement, and Resilience After the Virginia Tech Campus Shootings

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**Abstract**
People's responses to acute stress are largely thought to comprise four prototypical patterns of resilience, gradual recovery, chronic distress, and delayed distress. Here we present evidence of an additional response pattern: psychological improvement. Female survivors of the Virginia Tech shootings ($N = 368$) completed assessments before the shootings and at 2, 6, and 12 months post-shooting. Latent growth mixture modeling revealed distinct trajectories of resilience, chronic distress, delayed distress, continuous distress, and improvement. Although resilience was the most common pattern (56%–59%), a trajectory of substantial improvement in anxiety and depression symptoms also emerged among 13.2% and 7.4% of the sample, respectively. In support of this pattern, improvement was distinctively associated with marked increases in perceived social support and gains in interpersonal resources. Findings suggest a more complex understanding of the impact of mass trauma and a key role for dynamic changes in social support following acute stress.

**Keywords**
trauma, improvement, social processes, latent growth mixture models, resilience

Received 3/19/15; Revision accepted 7/22/15

Could the acute stress of a traumatic event actually promote psychological health? Previous research has focused almost exclusively on the potential of traumatic experiences to initiate a process of posttraumatic growth (Tedeschi & Calhoun, 2004). However, the possibility that people can experience *psychological improvement*—a reduction in preexisting distress—as a direct consequence of a traumatic event has been ignored, perhaps understandably. Indeed, on its face, the prospect seems absurd. Yet a growing literature has documented that stressful experiences, as well as painful ones, promote various beneficial social outcomes. For example, inducing stress in a laboratory increases trust, trustworthiness, and sharing behavior (von Dawans, Fischbacher, Kirschbaum, Fehr, & Heinrichs, 2012) and also improves social cognition (Smeets, Dziobek, & Wolf, 2009). Furthermore, painful experiences, when shared with others, can serve as "social glue," prompting a greater sense of solidarity and bonding (Bastian, Jetten, & Ferris, 2014). These controlled laboratory experiments dovetail with a considerable literature on the aftermath of mass traumas. After such events, there is a collective and immediate outpouring of support, both emotional and material, to help survivors cope with the disaster (Norris et al., 2002; Solnit, 2009). These effects, well documented in the historical and sociological literatures, have been variously described as a "post-disaster utopia" (Wolfenstein, 1957), "a paradise built in hell" (Solnit, 2009), and a "city of comrades" (Prince, 1920). Consistent with laboratory research, postdisaster communities have been characterized by a high degree of internal solidarity, an increase in

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helping behaviors, and a reduction in conflict among survivors (Solnit, 2009).

Strengthened social relationships are a key resource in times of acute stress. Indeed, the perceived absence of supportive relationships is one of the strongest predictors of posttraumatic stress disorder (Brewin, Andrews, & Valentine, 2000). Perceptions of support appear to diminish the sense of threat following a potentially traumatic event, protecting against depression, anxiety, and posttraumatic stress disorder symptoms (Charuvastra & Cloitre, 2008). However, in addition to buffering the effects of stressful events, strong social relationships are directly associated with well-being (Argyle, 2001; Diener & Seligman, 2002). For example, using the present data, we have previously reported that supportive social relationships, measured prior to a traumatic event, predicted anxiety and quality of life following exposure to the trauma (Grills-Taquechel, Littleton, & Axsom, 2011). However, the influence of positive changes in social support that occur in response to a traumatic event has not been well explored. That is, social support may not only protect people from pathological reactions to stressful events but also may exert positive effects on well-being through improved social relationships. If this is the case, then the prosocial effects of an acute stressor may, in some cases, result in improved psychological functioning. Although this possibility has been advanced previously (e.g., Updegraff & Taylor, 2000), psychological improvement has been substantially neglected as a possible outcome; almost no previous investigations have examined it directly using prospective (pre-event) data.

## Methodological Issues

There are at least two key reasons for the neglect of improvement as a possible response to acute stress. The first is that to document improvement, researchers must assess exposed persons before the acute stressor occurs. However, such pre-event assessments are rare in trauma research, and the considerable majority of prior research is instead based on data collected after a traumatic event has occurred. This is problematic for a number of reasons. In the absence of pre-event assessments, it is impossible to determine the precise impact of a mass trauma or other acute stressor on people's functioning. For example, although the most common reaction to mass trauma is a resilient one (Bonanno, Brewin, Kaniasty, & La Greca, 2010), it is possible that some people who appear resilient have actually seen *improvements* in their functioning as a result of the acute stressor and are thus not properly described as resilient. Although improvement seems contradictory to our understanding of traumatic events, it cannot be logically excluded without pre-event data.

A second key factor is that the vast majority of prior research has focused on the average response to acute stress, and, on average, people will experience an increase in distress following a traumatic event (Bonanno et al., 2010). As a result, the possibility of improvement or of other responses will necessarily be obscured in studies that examine average longitudinal responses to acute stress (Bonanno & Mancini, 2012). Until recently, the capacity to address this shortcoming was limited. Early efforts to distinguish longitudinal patterns of adjustment relied on rudimentary statistical techniques (e.g., arbitrary cut points to distinguish one pattern from another). However, the development and growing use of methods such as latent growth mixture modeling, which identifies patterns of change based on distributional properties and empirical criteria (Muthén, 2004), has stimulated a wealth of research on distinct trajectories of adjustment after exposure to acute stress (Bonanno, Westphal, & Mancini, 2011).

## Prior Evidence of Improved Functioning After Acute Stress

Using these new techniques and leveraging data collected *before* the marker event, researchers have, in fact, documented improvement, particularly among military samples. It is interesting that these improvement patterns have been neglected by the researchers themselves, often relegated to a few sentences in the discussion section of the article or ignored entirely (Mancini, 2014). For example, in a study of U.S. military personnel deployed to Kosovo, Dickstein and colleagues identified a group of soldiers with high levels of posttraumatic stress disorder symptoms before deployment and a sharp reduction during and after their deployment (Dickstein, Suvak, Litz, & Adler, 2010). They described this pattern, which characterized 9% of the sample, as "unrealized anxiety" and considered it a reflection of a "stress-reactive disposition." Among Danish soldiers deployed to Iraq (Bo Andersen, Karstoft, Bertelsen, & Madsen, 2014), an improvement trajectory ("low-fluctuating") was also identified in 7.5% of the soldiers, though the authors did not discuss the pattern in the article. Another study using earlier waves of these data also identified a group of soldiers who experienced distinct patterns of "temporary benefit" from their combat experiences (Berntsen et al., 2012). Still another example is found in Bonanno and colleagues' (2012) examination of trajectories of adjustment among U.S. soldiers deployed to Iraq and Afghanistan. They found an improvement trajectory from before to after deployment among 9% of the sample. And most recently, Nash and colleagues (2014) found a marked improvement pattern (9.0%) among one cohort of Marines

deployed to Afghanistan. Consistent with the role of social factors, the authors speculated that improvement in predeployment distress may be, in part, a consequence of "unit cohesion." Nevertheless, in spite of growing evidence for this pattern, it has been neglected as a phenomenon in its own right, and theories as to why people might experience improvements in psychological adjustment following an acute stressor are generally absent.

On the other hand, theorists in the area of posttraumatic growth have long argued for the possibility of "positive psychological change experienced as a result of the struggle with a highly challenging life circumstance" (Tedeschi & Calhoun, 2004, p. 1). The idea of posttraumatic growth bears superficial parallels to the improvement pattern. However, the proposed improvement trajectory is fundamentally distinct from posttraumatic growth for two key reasons. First, posttraumatic growth depends on people's perception that they have experienced growth, which, some evidence suggests, reflects a motivated positive illusion rather than an objective improvement in functioning (e.g., Frazier et al., 2009; McFarland & Alvaro, 2000). Second, it hinges on the idea that growth results from one's "struggle" (Tedeschi & Calhoun, 2004). By contrast, the improvement trajectory is derived from objective change on an index of psychological functioning and does not imply a preceding period of elevated distress. The person who improves does not experience a long-term benefit from being traumatized but rather immediate improvements that are conditioned by the stressful event itself.

## Group Versus Solitary Exposure

Under what circumstances is improvement possible? Although improvement has been documented following divorce and bereavement (Bonanno et al., 2002; Mancini, Bonanno, & Clark, 2011), we propose that there is a critical difference between experiencing an isolated and highly threatening acute stressor as an individual (e.g., sexual assault) and as a group (e.g., a school shooting, military deployment, or terrorist attack). When an acute stressor is experienced by a group, the stressor will mobilize cooperative, mutually supportive, and potentially synergistic prosocial behaviors among exposed persons and increase the sense of connectedness to others (Hawdon & Ryan, 2011). These positive social effects may not only mitigate distress but also directly contribute to well-being (Hawdon, Räsänen, Oksanen, & Ryan, 2012).

## Present Study

In the present study, we examined the possibility that mass trauma can promote psychological improvement for some survivors. We tested this hypothesis among a sample of female students who were exposed to an exceptionally stressful event, the Virginia Tech campus shootings, the most deadly civilian shooting in U.S. history. The attack lasted for more than 2 hours and resulted in the deaths of 33 people (including the gunman) and the wounding of 25 others (Associated Press, 2007). Classrooms were locked down and the entire campus immobilized during and for some time after the shootings. Despite the enormity of the shootings, the event was isolated and short-lived. The shooter no longer posed a threat in the days and weeks that followed. Thus, although students, faculty, and staff undoubtedly had to contend with a deep sense of loss and an increased sense of vulnerability following the shootings, they also potentially experienced a changed social landscape, characterized by an increased sense of connectedness, trust, and cooperation.

Indeed, the intense media attention to the event also brought a tremendous outpouring of support from across the nation and worldwide, as well as led to strong feelings of pride, solidarity, and collective mourning within the community. For example, a memorial was quickly erected on campus, and gifts and messages were left for the individuals killed and wounded. In the months following, a memorial fund was established for the victims and their families, and a university-wide initiative of service to the community was established. These efforts to memorialize the dead and provide support to the living are widely found after mass traumas. After 9/11, for example, people throughout New York City lit candles outside of their homes, and makeshift memorials could be found throughout the city. We hypothesized that this increased sense of social connection could ameliorate preexisting distress and result in improved psychological functioning.

To test this possibility, we utilized data from a longitudinal study of college women who were exposed to the VT campus shootings (Littleton, Axsom, & Grills-Taquechel, 2009). Participants in this study were drawn from a multiuniversity study of sexual victimization that was ongoing at the time of the campus shootings. Thus, information about participants' psychological adjustment prior to the shooting was available, as was information from post-shooting assessments at 2, 6, and 12 months. Because of this longitudinal prospective design, we could directly assess change (or lack of it) following the shooting. We measured psychological adjustment using assessments of anxiety and depression, reasoning that they would capture general elements of distress in response to the shootings (e.g., Marshall, Schell, & Miles, 2010). To model anxiety and depression over time, we employed latent growth mixture modeling (LGMM), a technique that groups individuals into unique patterns of intraindividual change and provides empirical criteria (model fit) for determining the legitimacy of these patterns (Muthén,

2004). We conducted separate analyses for anxiety and depression, but we expected that participants would be grouped into similar patterns for both outcomes.

Based on previous research and theory (Bonanno & Mancini, 2012), we also anticipated a number of distinct response patterns. The shootings left survivors with a clear risk of posttraumatic stress disorder. Thus, we expected that some would show a marked stress response, with an elevation in anxiety and depression symptoms following the shootings and a persistent course. Despite the clear risk, it is well established that resilience is the modal response to acute stress (Bonanno et al., 2011), and we therefore expected most of the sample to demonstrate low levels of depression and anxiety both before and after the shootings. Most relevant to our focus, we expected that some participants would improve in their anxiety and depression symptoms and that this improvement would be related to gains in social relationships, which we indexed by using measures of perceived social support and interpersonal resource gain (Hobfoll, Tracy, & Galea, 2006). We expected that improved participants, relative to other trajectory patterns, would report marked increases in perceived social support from before to after the shootings and a greater degree of interpersonal resource gain after the shootings. We further expected that these gains would not simply be a consequence of lower levels of exposure to the shootings, because the presence of acute stress is key to these prosocial outcomes.

## Method

### *Participants*

Participants were 368 women who completed at least one of two online surveys administered at 2 and 6 months post-shooting regarding adjustment following the VT campus shooting. Participants were drawn from a sample of 843 female VT students who had completed a multiuniversity survey of sexual victimization during the same academic semester as the shooting or the previous academic semester. Participants were 19.4 years of age on average ($SD$ = 1.3 years, range = 18–27 years) when they completed the initial survey. In all, 86% characterized their ethnicity as White/European American, 5% as Asian American, 3% as Black/African American, 2% as Latina, and 2% as multiethnic; a further 1% did not indicate their ethnicity or marked other. There were few differences between women who completed the first post-shooting survey and those who did not (Littleton et al., 2009), with women who completed the survey being slightly older, $t(831) = 3.16$, $p < .005$, $d = 0.23$, and reporting somewhat less social support, $t(840) = 3.09$, $p < .005$, $d = 0.22$, than noncompleters of this survey. We also compared differences between participants who completed all four assessments and those with at least one missing assessment. According to independent samples $t$ tests and chi-square analyses, participants who completed each wave of data collection, as compared with those who missed at least one wave, did not differ in age ($p = .53$), White ethnicity ($p = .52$), baseline social support ($p = .94$), baseline anxiety ($p = .97$), baseline depression ($p = .13$), anxiety trajectory ($p = .38$), or depression trajectory ($p = .61$).

### *Procedure*

Complete study procedures have been detailed elsewhere (e.g., Littleton, Axsom, & Grills-Taquechel, 2011). To summarize, women, 18 years and older, initially received course credit to take part in a multiuniversity online survey of women's negative sexual experiences. As part of this survey, measures were completed regarding current depressive and anxiety symptoms and social support. At approximately 2 and 6 months post-shooting, all VT women with a valid email address ($n = 820$) were sent an email inviting them to participate in an online survey related to risk and resilience following the shooting. A total of 368 people (44.8%) responded to at least one of these two post-shooting surveys and were also invited via email to complete a 12-month post-shooting survey. Participants were given the choice to be compensated with a gift card or a donation to the VT shooting memorial fund for each completed survey and were entered in a drawing to receive a larger monetary compensation for the 12-month survey (the shooting memorial fund was closed at the time of the 12-month survey). Based on the available sample, response rates to each survey invitation were as follows: 2 months, 81.4% ($n = 298$), 6 months, 71.6% ($n = 263$), 12 months, 70.1% ($n = 258$). All surveys were approved by the university institutional review board, and the post-shooting surveys were approved by a university committee developed to ensure ethical conduct in shooting-related research.

### *Measures*

***Anxiety symptoms.*** To assess the affective dimension of anxiety, participants completed the five-item Emotional subscale of the Four Dimensional Anxiety Scale (Bystritsky, Linn, & Ware, 1990), which assesses current (state) anxious affect (e.g., "feeling uneasy," "feeling nervous," "feeling irritable"). For each item, participants indicated how often they have felt in the described manner in the past week on a 5-point scale bounded by 1 (*not at all*) and 5 (*extremely*), and scores are summed to derive a subscale total. Prior research supports the measure's internal consistency and validity (Bystritsky et al.,

1990; Stoessel, Bystritsky, & Pasnau, 1995). In the current study, Cronbach's alpha for the Emotional subscale at each assessment ranged from .85 to .86.

***Depressive symptoms.*** To assess depressive symptoms, participants completed the Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977). The CES-D is a 20-item, self-report measure of primarily the affective component of depressive symptoms (e.g., "I felt sad"). For each item, individuals indicated how often they had felt that way in the past week on a 4-point scale bounded by 0 (*rarely or none of the time/less than one day*) and 3 (*most or all of the time/5–7 days*). Scores are summed and can range from 0 to 60 with scores of 21 or above suggestive of clinical levels of current depression in college samples (Shean & Baldwin, 2008). Prior research supports the measure's internal consistency, test–retest reliability, and validity (Radloff, 1977; Weissman, Sholomskas, Pottenger, Prusoff, & Locke, 1977). Cronbach's alpha in the current sample across assessments ranged from .87 to .92.

***Exposure, loss, and perceived threat.*** Several items were administered to evaluate participants' level of exposure to the shooting, loss of loved ones in the shooting, and perceived threat during the shooting incident. These items were administered at the 2-month post-shooting survey or at the 6-month post-shooting survey for participants who did not complete the 2-month survey. Participants completed several yes/no questions regarding their direct exposure to several aspects of the shooting (e.g., if they were on campus during the shooting, if they heard gunfire). Scores on these questions were summed to create an overall index of exposure. In addition, participants were placed into a high exposure group if they were in one of the buildings where the shooting occurred, heard gunfire, or saw individuals who had been wounded or killed. Participants were also asked if they knew anyone who was killed in the shooting (yes/no item) and, if so, to indicate their relationship with that person. Participants who indicated that a shooting victim was a friend or close friend, as opposed to reporting a more casual relationship with a victim (e.g., acquaintance, classmate, friend of a friend, professor), were categorized as having lost a friend in the shooting (*friend loss*). Finally, participants completed 5-point scale items regarding the extent they believed that their own life (*self-threat*) and that of loved ones were in danger during the shooting incident (*other-threat*). This scale was bounded by 0 (*not at all/no chance you or others would be killed*) and 4 (*completely/felt convinced you or others would be killed*). Responses at or above the midpoint of the scales for other- and self-threat were recoded into binary variables (0 = *no threat*, 1 = *threat*).

***Interpersonal resource gain.*** Participants were administered 27 items from the Conservation of Resources Evaluation (Hobfoll, 2001) to assess resource loss and gain following the shooting. Items were selected based on prior research following mass trauma (e.g., Hobfoll et al., 2006). For the 2-month post-shooting survey, participants were asked the extent to which they had lost or gained each resource since the shooting, and for the subsequent assessments they were asked how much they had lost or gained each resource since the previous assessment. Ratings were made on a 5-point scale anchored by –2 (*great deal of loss*) and 2 (*great deal of gain*). A gain score was created by recoding responses as 2 (*great deal of gain*), 1 (*some gain*), and 0 (*no gain*). Principal axis factoring of these items resulted in three interpretable factors: sense of self/optimism gain, interpersonal resource gain, and self-control gain. In the current study, summed scores from the nine-item Interpersonal Resource Gain subscale were examined (e.g., intimacy with one or more family members, time with loved ones). Cronbach's alpha for this subscale across assessments ranged from .83 to .86.

***Social support.*** The Multidimensional Scale of Perceived Social Support (MSPSS; Zimet, Dahlem, Zimet, & Farley, 1988) was administered to assess perceived social support. The MSPSS is a 12-item measure of perceived social support adequacy with three scales assessing support from family, friends, and a significant other. A sample item is, "There is a special person around when I am in need." For each item, individuals indicate the extent to which they agree with the statement on a 7-point Likert-type scale bounded by 1 (*very strongly disagree*) and 7 (*very strongly agree*). In the present study, a mean item score for the overall measure was calculated to evaluate overall perceived social support. Prior research supports the internal consistency and factor structure of the measure (Zimet et al., 1988). Cronbach's alpha of the scale in the current sample ranged from .93 to .96.

## *Data analysis*

LGMMs were conducted with Mplus 7.11 to identify discrete growth trajectories (or classes), and a robust full-information maximum-likelihood estimation procedure was employed to handle missing data (Enders, 2001; Graham, 2009). The percentages of missing data for post-shooting surveys were 19.6% (2 months), 29.4% (6 months), and 30.0% (12 months). LGMMs use empirical criteria to identify distinct trajectory patterns. Although a substantial improvement over prior methods, mixture models nevertheless possess limitations that must be borne in mind when developing the analysis plan. One significant limitation is that the models may not

accurately describe real mixture distributions but instead diagnose nonnormality that can result from various factors, including measurement error. To address the potential for arbitrary trajectory solutions, two separate LGMMs were conducted on different dependent measures (anxiety and depression scores). If similar trajectory solutions emerged for both dependent measures, that would cross-validate the results for each dependent measure. In addition, we made specific a priori predictions with respect to auxiliary information (the hypothesized relationship of trajectory pattern to social relationship variables), which would provide additional support for the model. In determining the optimal trajectory solution, conventional indices were relied on to determine the relative fit of different multiclass models, but theoretical interpretability and trajectory distinctiveness were also used as criteria for model selection. Finally, standard techniques were used to maximize the likelihood of identifying the optimal trajectory solution, including varying the number of random starting values and employing the optseed procedure to ensure that the best log-likelihood value was replicated (Jung & Wickrama, 2008).

Analyses were conducted in three steps. First, simple growth models were used to determine the growth parameters for the LGMMs (Jung & Wickrama, 2008). Second, successive class models were compared, starting with one and adding additional classes (Muthén, 2004). Modification indices were inspected to determine whether to retain the default specifications of Mplus on correlated residuals, error variances, residual variances, and covariances across measurement occasions. In the third step, post hoc analyses were conducted using the anxiety and depression class variables. The focus of these analyses was the relationship of trajectory assignment to social relationship variables. But we first used chi-square analyses to examine whether the anxiety and depression trajectory analyses assigned participants to similar trajectory patterns. Next we examined whether participants who showed different patterns of adjustment also showed different patterns of change in perceived social support from pre-shooting to 12 months post-shooting. One important issue for these analyses was missing data for the repeated measures outcome (perceived social support). Analyzing only participants with complete data (i.e., all four waves) would sharply reduce our sample and potentially introduce biases (Enders, 2011). Thus, we conducted two sets of repeated measures analyses. We analyzed participants with complete data using repeated measures ANOVA, and we used linear mixed models, which use maximum likelihood estimates to accommodate missing data. To further examine interpersonal factors and trajectory assignment, we next examined self-reported gains in interpersonal resources by trajectory grouping. We report complete data for these analyses because maximum likelihood, which could be used in a dummy-coded regression analysis, would provide identical estimates to complete data analysis (Allison, 2001). A final analysis explored whether trajectory assignment was associated with measures of exposure using chi-square and one-way ANOVA analyses.

## Results

### *Adjustment trajectories*

Measures of anxiety and depression were collected before the shooting and at 2, 6, and 12 months post-shooting. To identify patterns of change in depression and anxiety symptoms, one-class models with intercept-only, linear-only, and linear and quadratic growth parameters were compared using log-likelihood chi-square testing to assess the fit of different model parameters. For both anxiety and depression models, a linear and quadratic model provided superior fit, according to log-likelihood ratio chi-square testing ($p_s < .01$). Consistent with recommendations for model testing (Jung & Wickrama, 2008), one- to five-class unconditional models (i.e., no covariates) were compared. An ideal model was considered to be one with lower values for the Akaike (AIC), sample-size-adjusted Bayesian (SSBIC), and Bayesian (BIC) information criterion indices, higher entropy values, and significant $p$ values for the parametric bootstrapped likelihood ratio rest (BLRT; Nylund, Asparouhov, & Muthén, 2007) and the Lo–Mendell–Rubin likelihood ratio test (LMR). The totality of these indices, in combination with the interpretability and theoretical coherence of a given class solution, guided the final model selection (Muthén, 2003).

***Anxiety trajectories.*** To identify anxiety trajectories, we compared one- to five-class models with linear and quadratic growth parameters. Based on model testing, we fixed the variances for the slope and quadratic parameters to zero but allowed the intercept variance to be freely estimated. Information criterion and other indices showed improved fit going from two (AIC = 6339.07, BIC = 6385.96, SSBIC = 6347.89, entropy = .71, LMR $p = .14$, BLRT $p < .001$, smallest class = 21.8%) to three (AIC = 6321.64, BIC = 6384.17, SSBIC = 6333.40, entropy = .70, LMR $p = .14$, BLRT $p < .001$, smallest class = 10.7%) to four classes (AIC = 6297.25, BIC = 6375.41, SSBIC = 6311.96, entropy = .70, LMR $p = .02$, BLRT $p < .001$, smallest class = 8.0%). A five-class solution produced a class with 0.03% of participants and thus was not considered. The four-class solution was interpretable and consistent with theoretical expectations; thus, it was selected as optimal. A log-likelihood ratio chi-square test confirmed that the four-class quadratic model showed superior fit to a linear-only model ($p < .001$). Next, a conditional model was tested in which demographic covariates were allowed to predict

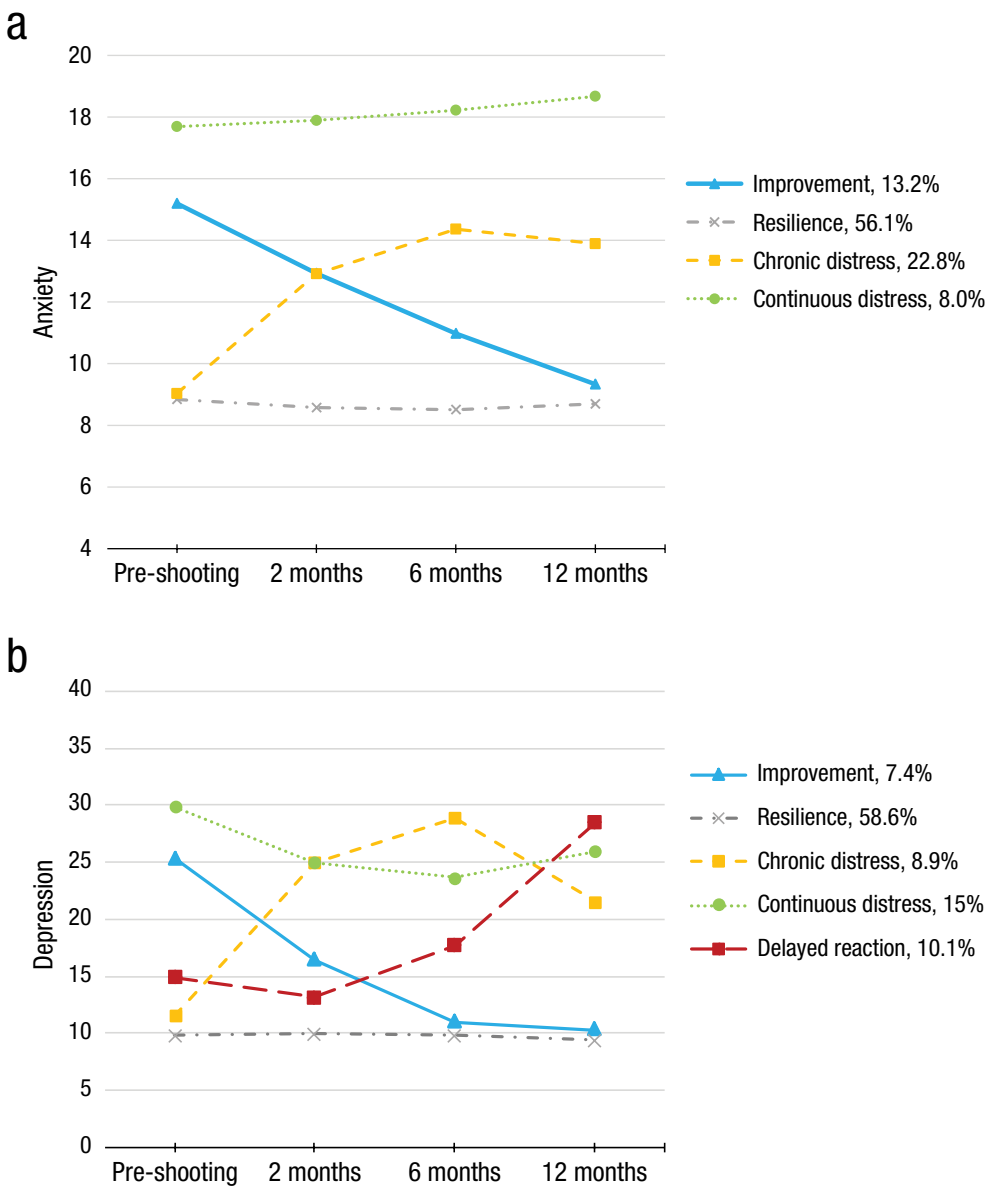


**Fig. 1.** Anxiety (a) and depression (b) trajectories.

the growth parameters and trajectory class designation. However, the inclusion of covariates resulted in unstable models that either did not converge or could not be replicated using the optseed procedure (Jung & Wickrama, 2008). As a result, the unconditional model was used in all subsequent analyses.

As shown in Figure 1, the four-class trajectory model consisted of people who reported (a) low initial levels of anxiety and no change across time (*resilience*; 56.1%), (b) low levels of anxiety before the shooting and a sharp increase to 12 months post-shooting (*chronic distress*; 22.8%), (c) high levels of anxiety both before and after the shooting (*continuous distress*; 8.0%), and (d) high levels of anxiety before the shootings and a sharp decrease directly following and continuing to 12 months post-shooting (*improvement*; 13.2%). These results provided support for the idea that people can report improvements after acute stress. To extend the analyses to an additional and highly relevant dimension of adjustment, an identical analysis using depression as the repeated outcome measure was conducted.

***Depression trajectories.*** Model-fitting procedures were again used to compare one to five class models. The variances for the slope and quadratic parameters were again fixed to zero and the intercept variance freely estimated. Information criterion and other indices showed improved fit going from two (AIC = 8458.75, BIC = 8505.65, SSBIC = 8467.57, entropy = .68, LMR $p$ = .13, BLRT $p < .001$, smallest class = 28.9%) to three classes (AIC = 8406.71, BIC =

**Table 1.** Growth Parameter Estimates for Anxiety and Depression Models

| Parameter | Anxiety trajectories | | | Depression trajectories | | |
|---|---|---|---|---|---|---|
| | Intercept | Slope | Quadratic | Intercept | Slope | Quadratic |
| Class | Est. (95% CI) | Est. (95% CI) | Est. (95% CI) | Est. (95% CI) | Est. (95% CI) | Est. (95% CI) |
| Resilience | 8.84*** (8.36, 9.33) | –0.37 (–0.98, 0.24) | 0.11 (–0.08, 0.29) | 9.79*** (8.79, 10.80) | 0.25 (–0.84, 1.34) | –0.13 (–0.50, 0.24) |
| Improvement | 15.20*** (13.54, 15.59) | –2.41† (–4.62, –0.20) | 0.15 (–0.50, 0.81) | 26.81*** (23.49, 30.12) | –12.80** (–20.76, –4.87) | 2.44 (0.08, 4.80) |
| Chronic distress | 9.54*** (8.57, 10.52) | 4.32*** (2.51, 6.14) | –0.96** (–1.52, –0.39) | 9.86*** (7.29, 12.44) | 20.72*** (16.18, 25.27) | –5.61*** (–7.18, –4.03) |
| Continuous distress | 17.69*** (16.03, 19.35) | –0.14 (–1.82, 1.87) | 0.06 (–0.05, 0.59) | 29.92*** (26.77, 33.07) | –6.74** (–10.70, –2.79) | 1.80* (–0.38, 3.22) |
| Delayed | — | — | — | 14.89*** (10.78, 18.99) | –4.81 (–11.05, 1.43) | 3.12*** (0.74, 5.49) |

Note: CI = confidence interval; est. = estimate.
†$p = .07$. *$p < .05$. **$p < .01$. ***$p < .001$.

8469.24, SSBIC = 8418.48, entropy = .78, LMR $p < .001$, BLRT $p < .001$, smallest class = 11.7%). Although the four-class solution showed a slight decrement in fit according to the Bayesian index and the LMR, there were small improvements in the other measures of fit (AIC = 8397.66, BIC = 8475.82, SSBIC = 8412.37, entropy = .79, LMR $p = .21$, BLRT $p < .001$, smallest class = 5.6%) when compared with the three-class solution. The five-class solution also produced a slight decrement in fit according to the Bayesian and lower levels of entropy, but improvements according to the other indices (AIC = 8383.60, BIC = 8477.39, SSBIC = 8401.25, entropy = .75, LMR $p = .12$, BLRT $p < .001$, smallest class = 7.4%) The functional forms of the trajectories were again examined. The three-, four-, and five-class models all identified a resilient trajectory, an improvement trajectory, and a chronic distress trajectory, but the five-class model also identified a delayed distress trajectory. Because of the theoretical relevance of this pattern and its distinctiveness from the other patterns, we selected the five-class quadratic model for depression. Log-likelihood ratio chi-square testing confirmed that the quadratic model provided superior fit over a linear-only model ($p < .001$). As with the model for anxiety, inclusion of demographic covariates either resulted in a nonidentified model or failed to improve model fit, and thus an unconditional model was selected as optimal.

As shown in Figure 1, the depression trajectories were strikingly consistent with the anxiety trajectories, in terms of both their functional form and their prevalence. The largest group consisted of persons with low levels of depression and who showed no change from pre-shooting to 12 months post-shooting (*resilience*; 58.6%). The second most prevalent pattern consisted of people with elevated levels of depression that declined after the shooting but remained elevated relative to the sample (*high continuous distress*; 15%). As with the anxiety analyses, a clear chronic distress emerged in which there was a sharp increase in depression after the shootings that continued to 6 months and abated at 12 months (*chronic distress*; 8.9%). Moreover, a delayed reaction in which initial modest elevations got substantially worse also emerged (*delayed reaction*; 10.1%). Finally, and consistent with the anxiety analyses, some participants saw a substantial decrease in depression that remained lower at 12 months post-shooting (*improvement*; 7.4%).

***Growth parameters for depression and anxiety.*** Table 1 shows growth parameter estimates. As expected, the improvement group showed a negative slope for depression and anxiety symptoms ($p_s \leq .07$) and no quadratic effects, indicating a linear decrease. By contrast, the resilient group showed no linear or quadratic change, indicating a stable level of anxiety and depression symptoms over time. The anxiety and depression chronic distress groups revealed significant positive slopes ($p_s < .001$) that were modified by significant negative quadratic effects ($p_s < .01$), indicating that the rate of increase subsided over time and was concave. The delayed reaction group also revealed a quadratic effect ($p = .03$), but it was positive, indicating that the rate of growth was convex and accelerated over time, as would be expected. The continuous distress group for depression symptoms also revealed a negative slope ($p = .005$) and a positive quadratic effect ($p = .04$), indicating that the rate of change also decreased and became convex.

***Concordance of trajectory patterns.*** Although the models for anxiety and depression symptoms each produced four similar trajectory patterns, it was unclear that

class membership was concordant across the adjustment trajectories. Thus, chi-square analyses were used to compare the probability that participants were classified into the same trajectory for anxiety and depression models. This analysis revealed a significant, nonrandom distribution across the outcome patterns, $\chi^2(9, N = 368) = 235.76$, $p < .001$. Follow-up analyses of individual cells compared the frequency probability for each cell relative to chance using Haberman's (1978) standardized, adjusted residuals statistic (HAR). Across 66.4% of the sample, there was concordance for trajectory assignment for both anxiety and depression symptoms. More than half of the sample (51.4%) were classified as *resilient* on both outcome measures, a percentage substantially in excess of chance probability, HAR = 10.9, $p < .001$. Persons classified as *improved* on both outcome measures also occurred in excess of chance (3.0%), HAR = 5.5, $p < .001$, as did persons classified as continuous distress (6.0%), HAR = 8.9, $p < .001$ and as chronic distress (6.0%), HAR = 8.0, $p < .001$. Finally, persons classified in the delayed depression trajectory were significantly more likely to be classified in the chronic distress trajectory for anxiety (3.0%), HAR = 3.1, $p < .01$, a result that suggests that the five-class depression model split the chronic distress group into two distinctive and theoretically relevant patterns.

## *Is improvement associated with changes in social relationships?*

Across the two outcome measures of functioning, depression and anxiety, a clear trajectory of improvement was identified. According to the hypothesis that acute stress may have prosocial effects, participants who improved were expected to report improved social relationships. To address this question, two relevant measures of social relationships were examined in relation to anxiety and depression trajectory patterns: perceived social support and interpersonal resource gain.

### *Anxiety trajectories and change in social support*

*Repeated measures ANOVA on complete data.* A repeated measures analysis of variance (ANOVA) with perceived social support as the within subjects factor and anxiety trajectory as the between-subjects factor was conducted (see Table 2 for means and standard deviations at each wave). This analysis revealed that social support increased reliably over time, $F(2.80, 483) = 4.19$, $p = .007$, $\eta_p^2 = 03$. However, the main effect was qualified by a two-way Time × Anxiety Trajectory interaction, $F(8.39, 483) = 2.31$, $p = .02$, $\eta_p^2 = .04$, indicating this change in social support varied according to trajectory. To clarify this further, we conducted simple main effects analyses. The anxiety improvement group demonstrated a substantial and significant increase over time in social support, $F(3, 13) = 9.63$, $p = .001$, $\eta_p^2 = .69$, which represented a large effect, according to conventional criteria (J. Cohen, 1988). The resilient group also showed an increase over time in social support, $F(3, 93) = 4.18$, $p = .01$, $\eta_p^2 = .12$, but the magnitude of this effect was much smaller. Neither the continuous distress nor the chronic distress group showed significant change ($p_s < .26$).

*Linear mixed model on all data.* Next we replicated this analysis in a linear mixed model using the same within-subjects (perceived social support) and between-subjects (anxiety trajectory) factors. Mixed models use maximum likelihood estimates to account for missing data and therefore allow all participants to be included in the analysis. This is particularly important in longitudinal analyses, because eliminating incomplete cases can introduce various biases (Enders, 2011). We used a random intercept model and, based on model testing, assumed a Toeplitz covariance matrix. Time, anxiety trajectory class, and their interaction were treated as fixed effects. Consistent with the repeated measures ANOVA, this analysis revealed an almost identical main effect for time $F(3, 743.27) = 4.02$, $p = .007$, as well as a two-way Time × Anxiety Trajectory interaction, $F(9, 740.97) = 1.90$, $p = .06$, though the interaction was now marginal. When we conducted analyses separately for each anxiety trajectory, we again replicated the finding that the anxiety improvement group showed a marked increase in social support, $F(3, 78.37) = 8.96$, $p < .001$, as did the resilient group, $F(3, 433.03) = 5.87$, $p = .001$. By contrast, the chronic distress, $F(3, 127.93) = 1.32$, $p = .27$, and the continuous distress, $F(3, 65.53) = .43$, $p = .73$, groups showed no change in social support. Figure 2a shows the predicted means by anxiety trajectory and measurement occasion.

### *Depression trajectories and change in social support*

*Repeated measures ANOVA on complete data.* We applied the same analytic strategy to the depression trajectories to assess the consistency of our findings. A repeated measures analysis of depression trajectories showed a main effect of time, $F(2.79, 447.23) = 2.71$, $p = .05$, $\eta_p^2 = .02$, and a significant two-way Time × Depression Trajectory interaction, $F(11.18, 447.23) = 2.47$, $p = .005$, $\eta_p^2 = .06$. Consistent with the results for anxiety, a simple main effect of time also emerged for the depression improvement group, $F(3, 21) = 9.07$, $p = .001$, $\eta_p^2 = .56$, and the resilient group, $F(2.46, 312) = 3.81$, $p = .02$, $\eta_p^2 = .04$, but not for the delayed or chronic distress groups ($p_s > .20$). It was somewhat surprising that the continuous distress group for depression also experienced an increase in social support, $F(3, 72) = 4.75$, $p = .004$, $\eta_p^2 = .17$.

**Table 2.** Descriptive Statistics by Anxiety Trajectory Class

| Variable | Improvement[a] | Resilience[b] | Continuous distress[c] | Chronic distress[d] | $F$ or $\chi^2$ |
|---|---|---|---|---|---|
| Demographics | | | | | |
| Age | 19.50 (1.40) | 19.21 (1.18) | 19.71 (1.74) | 19.73 (1.52) | 3.68* |
| White ethnicity (%) | 92.9 | 88.8 | 85.7 | 77.0 | 8.22* |
| Exposure measures | | | | | |
| Self threat (%) | 28.1 | 31.5 | 62.5 | 39.1 | 10.05* |
| Other threat (%) | 87.5 | 74.2 | 100.0 | 84.4 | 11.62* |
| Friend loss (%) | 31.0 | 26.5 | 41.4 | 37.8 | 5.22 |
| High exposure (%) | 26.2 | 30.5 | 41.4 | 27.0 | 2.40 |
| Exposure sum | 4.90 (3.05) | 5.02 (2.83) | 6.00 (3.13) | 5.76 (2.58) | 2.15† |
| Functioning measures | | | | | |
| Anxiety, pre-shooting | 16.09 (2.19) | 8.91 (2.62) | 18.06 (2.82) | 9.48 (2.60) | 179.35*** |
| Anxiety, 2 mths | 13.53 (3.60) | 8.48 (2.41) | 17.83 (2.88) | 13.53 (3.60) | 113.85*** |
| Anxiety, 6 mths | 11.77 (2.51) | 8.54 (2.66) | 17.80 (2.68) | 15.07 (2.89) | 127.07*** |
| Anxiety, 12 mths | 9.30 (2.62) | 8.61 (2.25) | 18.04 (2.51) | 14.22 (2.54) | 157.93*** |
| Depression, pre-shooting | 23.67 (8.12) | 11.13 (6.66) | 30.31 (9.73) | 13.82 (8.73) | 71.68*** |
| Depression, 2 mths | 18.93 (10.28) | 9.91 (6.46) | 24.87 (8.77) | 19.03 (9.59) | 44.06*** |
| Depression, 6 mths | 15.70 (6.97) | 9.89 (6.93) | 24.30 (7.29) | 24.00 (8.69) | 61.87*** |
| Depression, 12 mths | 12.07 (7.64) | 10.45 (7.55) | 27.83 (7.44) | 22.75 (8.76) | 58.35*** |
| Social support, pre-shooting | 5.34 (1.07) | 5.79 (1.14) | 5.13 (1.12) | 5.50 (1.29) | 4.35** |
| Social Support, 2 mths | 5.79 (1.18) | 5.93 (1.04) | 5.07 (1.40) | 5.63 (1.19) | 4.65** |
| Social Support, 6 mths | 5.83 (1.12) | 6.12 (0.88) | 5.42 (1.01) | 5.59 (1.32) | 5.71*** |
| Social Support, 12 mths | 6.11 (1.19) | 5.98 (0.95) | 5.27 (1.15) | 5.32 (1.34) | 7.58*** |
| Interpersonal gain, 2 mths | 7.22 (4.63) | 6.43 (4.54) | 6.04 (3.91) | 5.25 (3.99) | 1.71 |
| Interpersonal gain, 6 mths | 7.40 (4.09) | 5.91 (4.13) | 5.05 (3.51) | 4.52 (3.77) | 3.54** |
| Interpersonal gain, 12 mths | 6.78 (5.52) | 5.78 (4.21) | 4.17 (2.98) | 4.63 (3.60) | 2.74* |

Note: Mths = months. Values are means, with standard deviations in parentheses, unless otherwise indicated.
[a]*n*s range from 27 to 42. [b]*n*s range from 147 to 223. [c]*n*s range from 20 to 29. [d]*n*s range from 51 to 74.
†$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

*Linear mixed model on all data.* We used the same random intercept model for depression. This analysis again showed a strong main effect of time, $F(3, 727.15) = 4.12$, $p = .007$. However, in contrast to the repeated measures analysis for depression, the two-way Time × Depression Trajectory interaction was not significant, $F(12, 731.86) = 1.51$, $p = .12$. Although this result was unexpected, we suspected that the relatively smaller sample of depressed improved participants, compared with the anxiety improved group, and the increased degrees of freedom necessitated by the five-class depression model may have weakened the power of the analysis to detect the interaction effect.

***Composite improvement trajectory.*** To address these issues, we created a composite of the anxiety and depressed improvement trajectories. A composite would increase the sample of improved participants and provide a more robust measure of improvement. This approach also allowed us to isolate the trajectory of primary interest and to reduce the degrees of freedom in our analysis. Membership in this composite improvement trajectory was established by a simple decision rule of either being a member of the depression or the anxiety trajectory or both. This resulted in 14.9% of the sample being classified as improved. We used the composite trajectory as the between-subjects factor (1 = *improved*, 0 = *all others*) in a final repeated measures analysis.

We proceeded directly to the linear mixed model. We used the same random intercept model, with time, composite improvement trajectory, and their interaction treated as fixed effects. This analysis showed a strong main effect of time, $F(3, 748.83) = 9.25$, $p < .001$. More important, the two-way interaction of Time × Composite Trajectory interaction was highly significant, $F(3, 748.83) = 4.85$, $p = .002$, indicating that change in social support varied according to whether the person was classified as improved. Figure 2b shows the predicted means by trajectory and measurement occasion.

***Reported gains and losses in interpersonal resources.*** To further explore the relationship of improvement to social relationships, we investigated self-reported gains in interpersonal resources. Again, it was

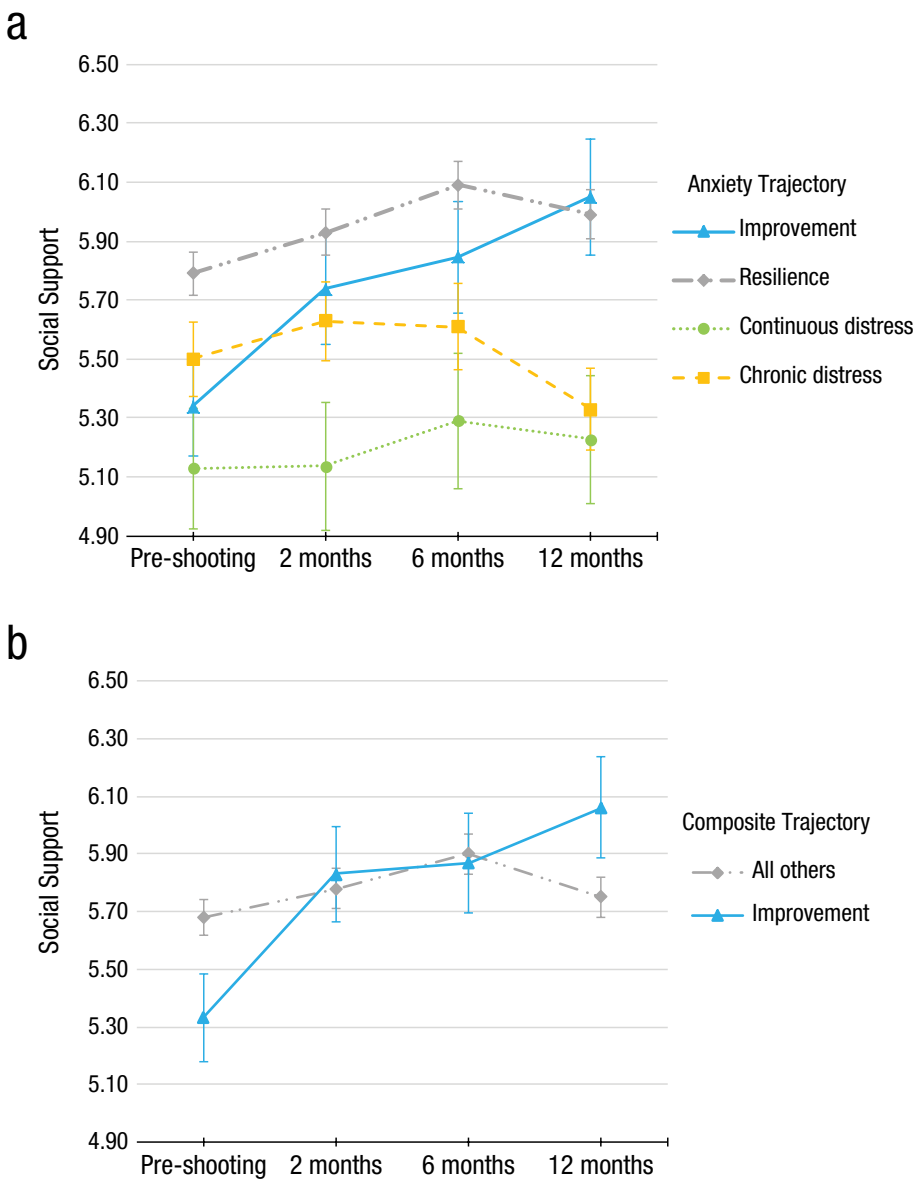


**Fig. 2.** Change in social support by (a) anxiety trajectory and (b) composite improvement trajectory. Error bars show 95% confidence intervals.

expected that individuals in the improvement group, when compared with the other trajectory patterns, would report more gains in interpersonal resources at each wave of data collection. To address this question, interpersonal resource gains at 2, 6, and 12 months post-shooting were examined across the anxiety and depression trajectories and their composite. As shown in Table 2, omnibus tests for the anxiety trajectories revealed that there was significant group variation in interpersonal gains at 6 months, $F(3, 261) = 3.54$, $p = .015$, and at 12 months, $F(3, 253) = 2.74$, $p = .04$. Pairwise comparisons showed that, at 6 months post-shooting, the improvement group ($M = 7.40$, $SD = 4.09$) reported more interpersonal gains than the chronic distress group ($M = 4.52$, $SD = 3.76$, $d = 0.73$) and the continuous distress group ($M = 5.05$, $SD = 3.51$, $d = 0.61$). Moreover, at 12 months post-shooting, the improvement group reported more interpersonal resource gains ($M = 6.77$, $SD = 5.52$) than the continuous distress group ($M = 4.16$, $SD = 2.98$, $d = 0.58$) and marginally more than the chronic distress group ($M = 4.63$, $SD = 3.60$, $d = 0.46$).

Analyses on the depression trajectory variable revealed a similar, though somewhat attenuated, pattern of results. Omnibus tests for the depression trajectories revealed marginal effects at 2 months, $F(4, 290) = 2.10$, $p = .08$, and at 6 months, $F(4, 261) = 2.06$, $p = .09$, and a significant effect at 12 months, $F(4, 256) = 6.10$, $p < .001$. Pairwise comparisons revealed that the improvement group reported more interpersonal gains at 12 months ($M = 7.65$, $SD = 6.0$) than the continuous distress group ($M =$

3.98, $SD = 3.55$, $d = 0.74$) and the delayed reaction group ($M = 2.71$, $SD = 2.49$, $d = 1.07$). No pairwise differences emerged at 2 and 6 months for the depression trajectories. A final step was to compare the composite improvement trajectory against all others. This analysis was consistent with previous results. The composite improvement group reported marginally more interpersonal gains at 6 months ($M = 6.94$, $SD = 4.3$) than all other trajectories ($M = 5.55$, $SD = 4.0$, $d = 0.33$), $t(260) = 1.90$, $p = .058$, and significantly more interpersonal gains at 12 months ($M = 6.86$, $SD = 5.4$) when compared with all other trajectories ($M = 5.25$, $SD = 3.92$, $d = 0.34$), $t(255) = 2.15$, $p = .03$. These results further indicated that improvement after an acute stressor is associated with perceived gains in social relationships and that the magnitude of this difference, when compared with groups who did not improve, is medium to large (J. Cohen, 1988).

### *Does improvement depend on low levels of exposure?*

A final focus was the potential role of exposure in the improvement trajectory. Did survivors who improved simply have less exposure to the shootings than other participants? As shown in Table 2, chi-square analyses were used to compare categorical exposure variables with the probability of membership in a given anxiety trajectory. For self-threat, there was a significant, nonrandom distribution across the anxiety trajectories, $\chi^2(3, N = 368) = 10.05$, $p = .02$. This analysis revealed that only the continuous distress group was significantly more likely to report a sense of self-threat, HAR = 2.9, $p < .01$. None of the other trajectories showed a significant relation to self-threat. A similar result emerged for other-threat. The continuous distress group was significantly more likely to report a feeling of other-threat (100%), HAR = 2.6, $p < .01$, and the resilient group was significantly less likely to report a feeling of other-threat (74.2%), HAR = –3.0, $p < .001$. But the improvement and other groups did not show a significant relationship to other-threat. The summed exposure variable showed a marginal omnibus effect, but pairwise comparisons showed no significant differences across groups ($p_s > .19$). Neither friend loss nor being categorized as high exposure differed across the four outcome trajectories ($p_s > .15$). When we replicated these analyses using depression trajectory as the grouping variable, we found an almost identical pattern of results. There were no group differences for high exposure, summed exposure, friend loss, or other threat ($p_s > .10$). Self-threat did differ across depression trajectories, $\chi^2(4, N = 368) = 15.83$, $p = .003$, with resilience being less likely (29.8%), HAR = –2.6, $p < .001$ and chronic distress being more likely (68%), HAR = 3.6, $p < .001$, to report self-threat. In sum, across exposure measures, the improvement group did not differ from the other trajectory groups, indicating that their level of exposure was roughly comparable to the other groups.

## Discussion

A wealth of evidence demonstrates that people cope with acute stress in diverse ways (Bonanno, 2004). Most people manage even the most severe stressors relatively well, maintaining daily routines, seeing friends and family, and experiencing positive emotions in spite of adversity (Bonanno et al., 2011). Others experience acute psychopathology (including depression, posttraumatic stress disorder, and complicated grief) or delayed reactions that may require intervention, whereas still others experience subclinical levels of distress that may take some time to abate (Bonanno et al., 2011; deRoon-Cassini, Mancini, Rusch, & Bonanno, 2010). It has been predominantly assumed that these patterns comprise the universe of possible reactions. Conversely, the possibility that traumatic events, in some cases, may promote adjustment has rarely been considered, in spite of the fact that acute stress has more complex effects than has previously been understood (Updegraff & Taylor, 2000).

In the present study, a unique prospective dataset of individuals exposed to the Virginia Tech campus shooting was used to test the possibility that some individuals might experience psychological improvement following a mass trauma. Although most individuals showed a resilient response (56% to 59%), displaying low levels of anxiety and depression both before and after the shooting, some exhibited chronic distress and others a pattern of continuous high distress. We also identified a subset of individuals who experienced a delayed reaction in depression symptoms (showing an initial pattern of consistently low depression levels that increased from 2 to 12 months following the shooting). These reactions and their prevalence were squarely consistent with previous empirical and theoretical work on reactions to mass trauma and acute stress (Andrews, Brewin, Philpott, & Stewart, 2007; Bonanno et al., 2011).

More remarkable, however, were the findings that some participants showed substantial improvements in depression and anxiety. These individuals had elevated levels of depression and anxiety *before* the shooting and experienced a marked reduction soon *after*. These reductions were sustained a year after the shooting, suggesting the positive effects were relatively long-lasting. No prior research, to our knowledge, has empirically documented such a reaction pattern among survivors of a mass trauma. The improvement pattern was associated with substantial increases in perceived social support and gains in social resources, as predicted by the idea that acute stress promotes stronger social relationships (von Dawans et al.,

2012) and altruistic behavior (Vollhardt, 2009). The prevalence of improvement (7% to 13%) was also consistent with previous research on military samples (Bo Andersen et al., 2014; Bonanno et al., 2012; Dickstein et al., 2010; Nash et al., 2014), and did not appear to be simply a consequence of low exposure. Moreover, irrespective of adjustment trajectory, there was an overall increase in perceived social support.

These findings provide new knowledge on the nature of adjustment to acute stressors. The improvement trajectory, which has little precedent in prior theorizing on trauma and has received minimal attention in the previous studies that have identified it (Bo Andersen et al., 2014; Bonanno et al., 2012; Dickstein et al., 2010; Nash et al., 2014), appears to represent a new way of understanding people's responses to mass trauma. A key point is that improvement is distinct from posttraumatic growth, the dominant framework for understanding positive psychological change following traumatic events (Tedeschi & Calhoun, 2004). Improved participants showed immediate reductions in preexisting distress soon after the shootings, as opposed to long-term benefits from being traumatized.

Nevertheless, there were some suggestive parallels to posttraumatic growth. For example, we found evidence of perceived gains in interpersonal resources, a key domain of posttraumatic growth (Tedeschi & Calhoun, 1996). An important point of difference, however, is that these gains were concentrated among improved participants and were absent among those with chronic distress, as would be expected from traditional accounts of posttraumatic growth (Tedeschi & Calhoun, 2004). In contrast to theories of posttraumatic growth, our findings therefore suggest that elevated and persistent distress is an impediment to rather than a catalyst of growth.

Improvement has been observed previously in response to individual-level acute stressors, notably bereavement and divorce (Bonanno et al., 2002; Mancini et al., 2011; Schulz et al., 2001), but we believe that a key aspect of a mass trauma is that it afflicts large numbers of people at once and therefore can mobilize mutually supportive and cooperative behaviors on a broad scale. By contrast, individual-level traumas, such as rape or assault, would afford limited such opportunities and, in fact, at times could increase one's alienation from others (Brewin, 2003). Thus, mass traumas provide a unique opportunity for shared painful experience (Bastian, Jetten, Hornsey, & Leknes, 2014) and mutually reinforcing prosocial behaviors (von Dawans et al., 2012) that can, in turn, ameliorate preexisting distress and promote well-being (Argyle, 2001; Hawdon et al., 2012). Indeed, the broad impact of shared human experience has likely been underestimated (e.g., Boothby, Clark, & Bargh, 2014). The present findings suggest that the distinction between solitary and shared experience is worthy of far greater scrutiny than it has received.

Our findings suggest potential modifications to the dominant frameworks on social support and responses to acute stress in at least two ways (e.g., Charuvastra & Cloitre, 2008; S. Cohen & Wills, 1985). First, they question the idea that mass traumas typically result in deterioration in social support, particularly when the disaster is human-induced, as some theorists have suggested (e.g., Kaniasty & Norris, 2004). Second, the results suggest that social support is a dynamic and changing quantity, responsive to environmental conditions, as opposed to a static quantity that is drawn on in times of need and buffers our distress (S. Cohen & Wills, 1985), which has been the traditional way social support that has been viewed. Unfortunately, the vast majority of research on social support is conducted *after* an acute stressor has occurred and thus cannot document changes in social support. Given that we found increases in social support, the current findings suggest that people are not merely passive recipients of social support but instead may actively seek to shape their social environments in accordance with their immediate needs (Taylor, 2006). Indeed, among individuals who improved in anxiety and depression, the effect size increase in social support was impressively large, whereas it was smaller for persons identified as resilient. In this sense, social behavior may be properly viewed as a homeostatic mechanism whose regulation is controlled, like temperature or appetite, by the individual (Taylor, 2006). When this regulation is effective, individuals may be able to protect themselves from the harmful effects of acute stress.

Moreover, this regulation may not only buffer distress, it may also directly promote improvements in psychological functioning. Existing theories offer little explanation for this possibility. Why, then, would a subset of participants improve in their psychological functioning after the shooting? One possibility, of course, is that the observed improvement trajectory merely reflects the variable course of anxiety and depression symptoms generally. We cannot preclude this possibility with the present data. However, note that the improvement group, when compared with resilient individuals, reported high levels of depression and anxiety before the shooting and low levels of social support. As their distress improved, their social support did as well. Although this relationship is correlational, we would argue that the mobilization of supportive relationships served not only to protect them from distress but also to enhance well-being generally. Indeed, strong and active social relationships have a robust relationship to well-being, and are likely a sine qua non of happiness generally (Diener & Seligman, 2002). After mass traumas, communities tend to bind, grievances

tend to be forgotten, and feelings of solidarity and common purpose tend to increase (Solnit, 2009), all of which may contribute to well-being. As discussed earlier, the prospective nature of our research design allowed us to document these positive changes in social support.

A complementary explanation for improvement is found in research and theory on affect regulation after painful experiences (Bastian, Jetten, Hornsey et al., 2014; Leknes, Brooks, Wiech, & Tracey, 2008). The pain of a mass trauma may have the ironic effect of disrupting a preexisting syndrome of distress by providing a sense of relief from current stressors. As Fritz (1961/1996) observed decades ago, disasters "provide a temporary liberation from the worries, inhibitions, and anxieties associated with the past and the future because they force people to concentrate their full attention on immediate moment-to-moment, day-to-day needs" (p. 61). Consistent with this perspective, recent research has demonstrated that relief from pain has potent effects on mood, stimulating increased positive and decreased negative affect (Franklin, Lee, Hanna, & Prinstein, 2013), and may therefore counteract preexisting negative mood states, as well as promoting social behaviors and more adaptive coping associated with positive emotion (Bonanno, 2004).

In the context of these findings, it is important to note a number of limitations to the present study. A principal limitation is that the sample was composed only of women. Thus, the present results cannot be generalized to men. However, recent research has found that men also respond to acute stress with increased sharing and cooperative behaviors (von Dawans et al., 2012) and thus may also experience psychological benefits. Moreover, research conducted with military samples, which are largely men, have provided consistent evidence of psychological improvement among a subset (usually 8% to 12%) of deployed soldiers (Bo Andersen et al., 2014; Bonanno et al., 2012; Dickstein et al., 2010; Nash et al., 2014). Another limitation is that our sample consisted of traditional-aged college students, was largely White, and differed slightly in baseline social support from the larger pool of potential participants. The broader generalization of these findings to more diverse samples is an important topic for future research.

An additional limitation is that the relationship between adjustment trajectory and change in social relationships is correlational. Although we believe there is a compelling rationale for a causal relationship, our research design does not permit such an inference. As a result, the direction of the relationship between social factors and adjustment is unclear; nor can we rule out the possibility that a third variable is responsible for the observed association. Nevertheless, on the basis of the theoretical rationale, we would argue that mutually reinforcing prosocial behaviors induced by the acute stress of the shootings led to improvements in psychological health among a subset of survivors with high pre-event distress. Indeed, individuals who did not see improvements in social relationships reported either worsening psychological symptoms or a continuation of existing distress. Nevertheless, however plausible this rationale, it cannot be ruled out that reductions in anxiety and depression led to increased social behavior. Finally, we cannot rule out that the observed trajectories reflect normative patterns of adjustment to college and are unrelated to the shootings, though, given their enormity, this possibility seems unlikely.

The improvement pattern has a number of theoretical and clinical implications. One clear implication is that social factors are critical in the aftermath of an acute stressor. Although this is certainly not new knowledge, the present findings suggest that improving people's capacity to increase their stock of social resources—after a mass trauma—can have potent effects that are both ameliorative (in the case of the improvement trajectory) and stress-buffering (in the case of the resilient trajectory). The difference between this perspective and previous work on social support (e.g., S. Cohen & Wills, 1985) is to some extent a matter of emphasis. The present findings suggest that it is not just preexisting social resources but the recruitment and utilization of existing *and* additional resources that is critical. This was particularly evident, for example, in the sharp distinction between the improvement and continuous distress trajectories. At baseline, both groups reported high levels of distress and low levels of social support. However, at 12 months, the improvement group had seen dramatic changes and was eventually indistinguishable from the resilient group in their social and psychological functioning. By contrast, the continuous distress group showed no change in their social relationships and remained mired in a syndrome of distress. A better understanding of why the two groups saw such sharply diverging trajectories is a critical topic of future research. At a minimum, however, the present research strongly suggests that a promising target of intervention is the mechanisms and perceived availability of social support. The most robust effects appear to occur for interventions that target cognitions about social relationships (Masi, Chen, Hawkley, & Cacioppo, 2011). Persons with more acute initial stress reactions and with vulnerabilities to a perceived lack of social support (e.g., persons high in anxious or avoidant attachment; Shallcross, Howland, Bemis, Simpson, & Frazier, 2011) may therefore benefit from interventions that include a focus on social cognitions. By the same token, given that the majority of the sample were resilient or improved, the present findings further underscore the dangers of blanket early interventions designed to forestall posttraumatic

stress disorder reactions (Lilienfeld, 2007). Indeed, the improvement trajectory offers a remarkable demonstration of natural recovery processes.

Jean Rhys (1966), in her novel *Wide Sargasso Sea*, wrote, "When trouble comes they say close ranks." In the present study, we found that survivors of the Virginia Tech shootings who drew closer to others also experienced psychological improvement. The potential for acute stressors to catalyze positive psychological change and repair psychological distress, a process very different from posttraumatic growth, merits more empirical scrutiny than it has received.

## Author Contributions

A. D. Mancini developed the manuscript concept, performed the data analyses, and had primary responsibility for drafting the manuscript. H. L. Littleton and A. E. Grills developed the larger study design, supervised data collection, and contributed revisions to the manuscript. H. L. Littleton drafted a section of the manuscript. All authors approved the final manuscript for submission.

## Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

## Funding

This study was supported by National Science Foundation Grant BCS-0737940.

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