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Emotional and Cardiovascular Sensitization to Daily Stress Following Childhood Parental Loss

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Adverse childhood events can influence the development of emotional and physiological self-regulatory abilities, with significant consequences for vulnerability to psychological and physical illness. This study evaluated stress sensitization and inoculation models of the impact of early parental death on stress exposure and reactivity in late adolescence/young adulthood. Ambulatory blood pressure (BP) and diary reports of minor stress were collected every 30 min during waking hours over a 24-hr period from 91 late adolescents/young adults (43 early bereaved, 48 nonbereaved). Across the sample, minor stressors were associated with elevated BP and negative affect. The bereaved group had lower BP than did the nonbereaved group. Within the bereaved group, higher perceived caring from the surviving parent was associated with fewer reports of minor stress and lower stress-related negative affect. Higher perceived parental caring during childhood was associated with lower BP across the sample and more frequent hassles in the nonbereaved group. Findings support both the stress inoculation and sensitization models, suggesting that childhood parental loss and parental caring exert important influences on children's development of stress sensitivity.

Keywords: bereavement, blood pressure, stress inoculation, parental caring

The early death of a parent, experienced by approximately 2.2 million children under the age of 18 (Social Security Administration, 2000), represents a major disruption of a parent–child bond and a significant experience in a child's emotional development. A large number of studies document that early death of a parent places children at higher short- and long-term risk of mental and physical disorder (e.g., Agid et al., 1999; Felitti et al., 1998; Krause, 1998; Mack, 2001). However, several studies have found that childhood parental death is not directly associated with higher risk of depression or other disorders (Kendler, Neale, Kessler, Heath, & Eaves, 1992; Kessler, Davis, & Kendler, 1997; Mireault & Bond, 1992). Many bereaved children demonstrate remarkable resilience (Lin, Sandler, Ayers, Wolchik, & Luecken, 2004), emphasizing the need to identify moderators and processes that underlie short- and long-term adjustment.

Early loss experiences have the potential to impact mental and physical health throughout the lifespan by exerting lasting effects on the development of emotional and physiological responses to stress, including the frequency and magnitude of responses to daily hassles (i.e., minor daily stressors; Brotman, Gouley, Klein, Castellanos, & Pine, 2003; Luecken & Lemery, 2004). Two prevailing models, stress sensitization and stress inoculation, have been proposed to explain the long-term impact of childhood adversity on stress reactivity and vulnerability to depression. The *stress sensitization* model proposes that early adversity lowers the threshold for reactivity to stress, such that even mild stress exposure will result in elevated depressive symptoms. In contrast, the *stress inoculation* model predicts that early adversity results in reduced emotional and biological stress responses, in effect buffering individuals from the depressive impact of later stress exposure. Consistent with calls from developmental researchers to examine the impact of early adversity at multiple levels of analysis (Cicchetti & Curtis, 2007), this study tests the predictions of both models in terms of the frequency of perceived daily hassles and the magnitude of associated emotional and physiological responses.

Several developmental processes may contribute to increased stress exposure in children and adults who experienced the early death of a parent (Bifulco, Bernazzani, Moran, & Ball, 2000; Harris, 2001; Hertzman, 1999; Rutter, O'Connor, & the English and Romanian Adoptees Study Team, 2004; Sandler, 2001). Rudolph and Hammen (1999) suggested that early loss experiences can heighten fears of loss in later relationships, leading to elevated daily stress levels. Neglectful or uncaring parenting following the death can increase the risk of this "continuation of adversity" (Bifulco, Brown, & Harris, 1987; Rutter et al., 2004). The tendency to perceive threat in ambiguous situations may also form the basis for higher perceived stress in daily experiences (Davies & Cicchetti, 2004; Grych, Raynor, & Fosco, 2004; Kliewer, Fearnow, & Walton, 1998).

Early parental death can also affect the magnitude of emotional and physiological responses to daily stressors by impeding or facilitating the child's development of emotion regulation, a central task of development that is heavily influenced by the parent–child relationship (Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001; Eisenberg et al., 2001). Infants and children rely heavily on parental support in managing emotions, through

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parental techniques such as modeling, reinforcement, verbal instructions, direct emotion talk, or parental reactions to the child's expressed emotions (Diener, Mangelsdorf, McHale, & Frosch, 2002; Eisenberg & Fabes, 1994; Kopp, 1989; Lunkenheimer, Sheilds, & Cortina, 2007). Limited parental warmth and elevated family conflict have been associated with poor emotion regulation and maladaptive coping styles (Davies & Cummings, 1994). Children who do not receive support in regulating emotions may develop ineffective coping mechanisms and negative cognitive schemas or belief systems (Davies & Cummings, 1994) that promote exaggerated emotional and physiological reactivity to even minor stressors.

The fact that studies have found support for both the stress sensitization (Rudolph & Flynn, 2007) and stress inoculation (Boyce & Ellis, 2005; Forest, Moen, & Dempster-McClain, 1996) models of early adversity suggests that the occurrence of sensitization versus inoculation is influenced by other aspects of the larger developmental context. For parentally bereaved children, one such factor is the quality of the relationship with the surviving parent, which has consistently been shown to moderate short- and long-term mental health outcomes (Luecken, 2000; Lutzke, Ayers, Sandler, & Barr, 1997) and physiological stress reactivity (Luecken, Rodriguez, & Appelhans, 2005). The early death of a parent provides a powerful context in which a caring surviving parent can shape the child's development of strong emotion regulation skills, resulting in lower emotional and physiological reactivity to later stress (i.e., stress inoculation). In contrast, a neglectful or otherwise emotionally unavailable surviving parent may impede the development of emotion regulation, resulting in exaggerated emotional and physiological reactivity (i.e., stress sensitization). Boyce and Ellis (2005) further theorized that either highly adverse or highly protective childhood conditions promote the elevated stress reactivity (i.e., sensitization) assumed to underlie vulnerability to psychological and physical disorder, whereas moderate stress exposure promotes the development of adaptive stress reactivity.

Previous studies evaluating stress exposure and sensitization have tended to rely on aggregate measures of stress and emotional reactions or have primarily assessed the occurrence of major stressful events following childhood adversity. The current study predicted that childhood parental death in combination with low perceived caring from the surviving parent would be associated with increased exposure to minor stress (hassles). In addition, stress inoculation, evidenced by lower emotional and cardiovascular responses to minor stress, was predicted to be apparent in early-bereaved young adults who experienced a highly caring relationship with the surviving parent. Stress sensitization, evidenced by elevated negative emotional and cardiovascular arousal associated with minor stress, was predicted in participants who experienced low parental caring.

Method

Participants

Demographics. Participants included 91 undergraduate students (ages 18–29; 57 women, 34 men), including 43 from bereaved ("loss") families and 48 from nonbereaved, married ("intact") families (see Table 1). Criteria for the loss group included the death of one residential, biological, married parent prior to the participant's age of 17. Age at the time of parental death ranged from 0–16 years ($M = 8.2$, $SD = 4.9$). At least 2 years had elapsed since the death for all participants. Criteria for the intact group included being raised by two continuously married, residential, biological parents, with no parental loss or divorce. Participants received $75 in compensation for their participation.

Table 1
Sample Characteristics in Terms of Family Status

Variable	Total	Loss	Intact
Gender, *n*			
Male	34	17	17
Female	57	26	31
Age, *M* (*SD*)*	19.6 (2.0)	19.1 (1.4)	20.0 (2.3)
Body mass index, *M* (*SD*)	23.4 (3.5)	23.4 (3.2)	23.5 (3.8)
Ethnicity, *n*			
White, non-Hispanic	69	33	36
African American	2	1	1
Hispanic	11	3	8
Other	9	6	3
Family income, *n**			
Not reported	3	2	1
$0–$44,999	17	15	2
$45,000–$59,999	11	7	4
$60,000–$79,999	11	4	7
$80,000–$99,999	15	7	8
$100,000 and above	34	8	26
Stress proportion, *M* (*SD*)	.19 (.19)	.18 (.19)	.20 (.20)
Daily negative affect, *M* (*SD*)	2.2 (1.6)	2.1 (1.7)	2.3 (1.6)
Daily SBP, unadjusted *M* (*SD*)*	118.1 (10.2)	115.9 (8.6)	120.0 (11.1)
Daily DBP, unadjusted *M* (*SD*)*	68.2 (6.1)	66.8 (5.0)	69.4 (6.7)

Note. SBP = systolic blood pressure; DBP = diastolic blood pressure.
* $p < .05$.

Recruitment and selection criteria. Participants were recruited from introductory psychology classes and advertisements in the student newspaper at a large southwestern public university. Respondents completed a large screening survey, and those who were eligible were invited to participate. Participants were kept blind to the specific reason they were invited to participate, and the experimenter was blind to family experiences until all data were collected. Exclusionary criteria included self-reported illness and use of medications known to affect blood pressure (BP).

Measures

Questionnaires. Parental caring was assessed with the Caring subscale of the Parental Bonding Instrument (G. Parker, 1989; $\alpha = .93$), completed separately for the mother and father. The score for the surviving parent was used for the loss group. For the intact group, analyses used the averaged caring score. To control for current distress, trait anxiety and depressive symptoms were assessed prior to the daily monitoring with the State–Trait Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983; $\alpha = .87$) and the Beck Depression Inventory (Beck, 1996; $\alpha = .89$).

Ambulatory diary measures of stress and emotion. Brief surveys on handheld electronic diaries (Palm M100 or Palm IIIxe model, Palm Inc., Santa Clara, CA) were completed every half hour during waking hours for 24 hr, cued by the inflation of the BP

monitor. For each diary entry, participants indicated (yes or no) if a minor stressful event (e.g., traffic jam, argument with a friend) had occurred in the previous 30 min and rated negative emotions using five items (*hostile*, *irritated*, *jittery*, *nervous*, and *upset*) from the Positive and Negative Affect Scale (Watson & Clark, 1994). Diary entries also collected information on posture and location, caffeine or energy drink use, alcohol use, or smoking. The electronic diary put an unalterable timestamp on all entries.

Ambulatory blood pressure (ABP) monitoring. ABP was assessed on average every 30 min during waking hours with Suntech Oscar II ABP monitors (P. J. Hilton & Associates, Glendora, CA). However, to avoid anticipatory reactions, the precise measurement time randomly varied within a 20-min interval. An unalterable timestamp was recorded for all BP measures. Participants were requested not to exercise or engage in physically exerting activity while wearing the monitor. The monitor did not visually display readings.

Procedure

Participation began between 1–3 p.m. on Monday–Thursday and concluded between 1–3 p.m. the following day. Self-report questionnaires were completed on a laptop computer in the lab. Participants were trained on the procedure for completing diaries on handheld computers, fitted with the ABP monitor, and sent home with written instructions and a phone number to call with any questions. Participants returned approximately 24 hr later.

Data Management

Data from the diary and ABP monitor were merged and matched according to the times recorded on the units. Established procedures were followed for the removal of artifacts and outliers from the BP data (Kamarck et al., 1998; Marler, Jacob, Lehockzky, & Shapiro, 1988), resulting in the removal of 158 records. An additional 130 BP records out of the remaining 2,478 did not have matching diary records. The number of complete entries ranged from 4 to 51 per participant with a mean of 26 ($SD = 7.6$), an approximate overall completion rate of 81%.[1]

Data Analysis

Preliminary demographic comparisons. Family groups were compared on age, gender, income, ethnicity, body mass index (BMI), medication use, and hormonal contraceptive use. Group differences were found only for age, $t(89) = -2.1$, $p = .04$, and income, $t(89) = -5.1$, $p < .01$ (see Table 1). Of the above variables, only gender, BMI, medication use, and age were significantly or near-significantly associated with BP (ps $< .10$). Groups did not differ on parental caring ($p = .89$), number of diary reports completed ($p = .35$), mean alcohol use ($p = .13$), smoking ($p = .51$), caffeine intake ($p = .51$), or number of stressful events ($p = .66$) during the 24-hr period.

Primary analytic strategy. Multilevel linear modeling using SPSS MIXED evaluated individual and group differences in minor stress exposure, negative emotion, and BP throughout the day. The repeated within-day BP or diary measures (minor stress, negative emotion) formed Level 1 or within-person dimensions. Family variables (group, parental caring) served as the Level 2 or between-persons dimensions. Family group was effect coded, with the loss group assigned a value of 1 and the intact group a value of -1. Parental caring was a continuous variable, centered at the grand mean. Time-varying covariates for BP included posture, substance use (caffeine, alcohol, or smoking), and location (home, school, or other). Additional BP covariates included gender, age, BMI, and medication use. Covariates were centered at the grand mean. Consistent with the notation of Raudenbush and Bryk (2002), a β symbol denotes the regression coefficients from the multilevel model. These are unstandardized regression coefficients and should not be confused with beta weights from an ordinary least squares regression. The proportion reduction in variance, pseudo R^2, was calculated as a measure of effect size for multilevel models (Raudenbush & Bryk, 2002). Pseudo R^2 is analogous to R^2, and it represents the amount of variance explained by the model, ranging from 0 to 1. For BP models, the reported pseudo R^2 represents the additional variance accounted for by family (Level 2) variables.

Results

Preliminary Analyses

Multilevel models evaluated the assumption that minor stressors would be associated with higher negative affect, systolic blood pressure (SBP), and diastolic blood pressure (DBP). As expected, reports of minor stress were associated with higher negative affect, $\beta = 2.2$, $t(2198) = 19.6$, $p < 0.001$; SBP: $\beta = 1.8$, $t(2179) = 3.2$, $p = .001$; and DBP: $\beta = 1.0$, $t(2247) = 2.2$, $p = .031$.

Childhood Family Experiences and Daily Stress

The hypothesis was evaluated that perceived parental caring would moderate the impact of early parental death on daily perceptions of minor stress. The Group $\times$ Parental Caring interaction was a significant predictor of minor stress reports, $\beta = -0.007$, $t(83) = -3.15$, $p = .002$, 95% confidence interval (CI) $= -0.011$, -0.0024, pseudo $R^2 = 0.094$ (see Figure 1), and remained significant after controlling for anxiety and depressive symptoms ($p = .006$). The simple slopes were significant (intact: $p = .028$; loss: $p = .033$). Exploratory analyses within the loss group found that age at the time of parental death was not significantly associated with minor stress exposure ($p = .98$) and did not interact with perceived parental caring to predict minor stress exposure ($p = .52$).

Childhood Family Experiences and Daily BP

Next, the hypothesis was evaluated that perceived parental caring would moderate the effect of early parental death on BP. The interaction of group and parental caring was not a significant predictor of SBP ($p = .18$) or DBP ($p = .29$). However, the loss group had lower BP across the 24-hr period than did the intact group; the adjusted SBP means differed by 5.3 mm Hg, $t(83) = -2.65$, $p = .010$, 95% CI $= -4.64$, -0.658, and the adjusted DBP

[1] The expected number of records varied per participant depending on his or her hours of sleep; therefore, the calculation was based on an average of 16 hr of recording, or 32 expected records.

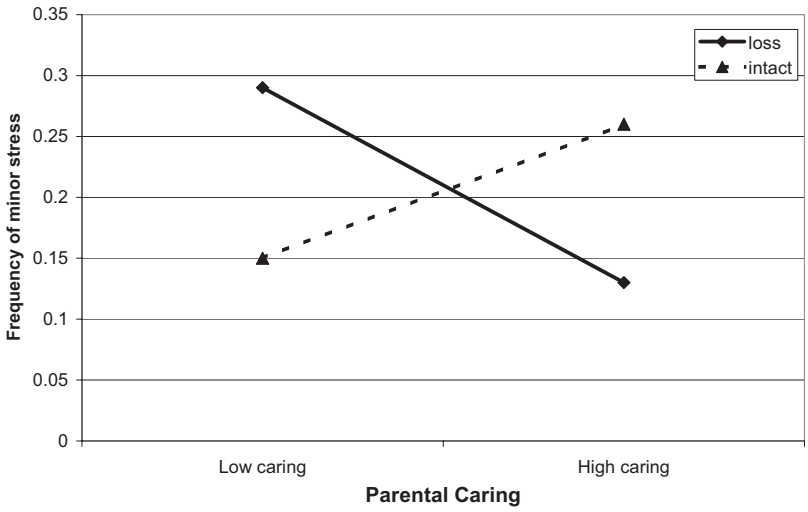

Figure 1. Daily minor stress by family group and parental caring. Frequency of minor stress exposure was calculated by adding the number of 30-min time periods in which participants indicated that something stressful had occurred and dividing by the total number of diary entries completed by the participant. Parental caring was treated as a continuous variable in analyses, but the simple slopes for interaction effects are graphically displayed for parental caring values set at 1 *SD* above (high caring) and below (low caring) the mean, as recommended by Aiken and West (1991).

means differed by 3.0 mmHg, $t(84) = -2.40$, $p = .019$, 95% CI = -2.77, -0.258. Higher perceived parental caring was associated with lower SBP and DBP across both groups: SBP: $\beta = -0.30$, $t(83) = -2.78$, $p = .007$, 95% CI = -0.508, -0.085; DBP: $\beta = -0.14$, $t(84) = -2.04$, $p = .045$, 95% CI = -0.270, -0.003. The pseudo R^2 for the family-level variables was 0.137 for SBP and 0.108 for DBP. Both main effects remained significant after controlling for anxiety and depressive symptoms (family group: SBP, $p = .012$; DBP, $p = .025$; parental caring: SBP, $p = .002$; DBP, $p = .024$). Exploratory analyses of the loss group found that age at parental death was not significantly associated with SBP ($p = .10$) or DBP ($p = .71$) and did not interact with parental caring to predict SBP ($p = .15$) or DBP ($p = .12$).

Childhood Family Experiences and Emotional and BP Reactivity to Minor Stressors

It was predicted that loss participants reporting higher parental caring would show lower negative emotional and BP reactivity to minor stress. The three-way interaction of family group, parental caring, and minor stress was a significant predictor of negative emotion, $\beta = -0.04$, $t(2195) = -3.3$, $p = .001$, 95% CI = -0.068, -0.017, pseudo $R^2 = 0.144$ (see Figure 2), and remained significant after controlling for anxiety and depressive symptoms ($p = .001$). Analyses of simple slopes found that higher perceived parental caring predicted less stress-related negative emotion for participants who had lost a parent ($p = .002$) but was not significant for the intact group ($p = .11$). Exploratory analyses of the loss group found that age at parental death was not significantly associated with emotional reactivity to minor stress ($p = .79$).

The three-way interaction of family group, parental caring, and minor stress was not significant in the prediction of SBP ($p = .86$) or DBP ($p = .22$). Thus, although hassles were associated with elevated BP for the sample as a whole, the magnitude of the relation between hassles and BP did not differ on the basis of childhood family factors.

Discussion

The current results provide evidence that childhood adversity and parental warmth can influence the development of emotional and physiological regulation, indicated here as differences in minor stress exposure and reactivity during daily life in late adolescence/young adulthood. For early-bereaved participants, higher perceived caring from the surviving parent was associated with fewer reports of minor stress and lesser stress-related negative emotion. Parental caring during childhood may have benefited early-bereaved young adults by lowering current actual exposure to minor stress, raising the threshold for appraisals of stress, or supporting the development of adaptive coping skills for regulating stress responses.

For young adults from nonbereaved families, higher perceived parental caring was associated with more frequent reports of minor stress. Evidence from both animal and human studies supports the notion that moderate levels of stress in childhood are associated with better handling of stress in adulthood (Forest et al., 1996; Khoshaba & Maddi, 1999; Levine & Mody, 2003; K. J. Parker, Buckmaster, Schatzberg, & Lyons, 2004). These findings are also supportive of Boyce and Ellis's (2005) theory that both highly stressful (e.g., bereaved with low parental caring) and highly protective childhood environments (e.g., nonbereaved with high parental caring) promote elevated stress reactivity. For those in the loss group, early exposure to a major stressor within the context of a strong and caring relationship with the surviving parent may provide the opportunity for children to develop highly adaptive

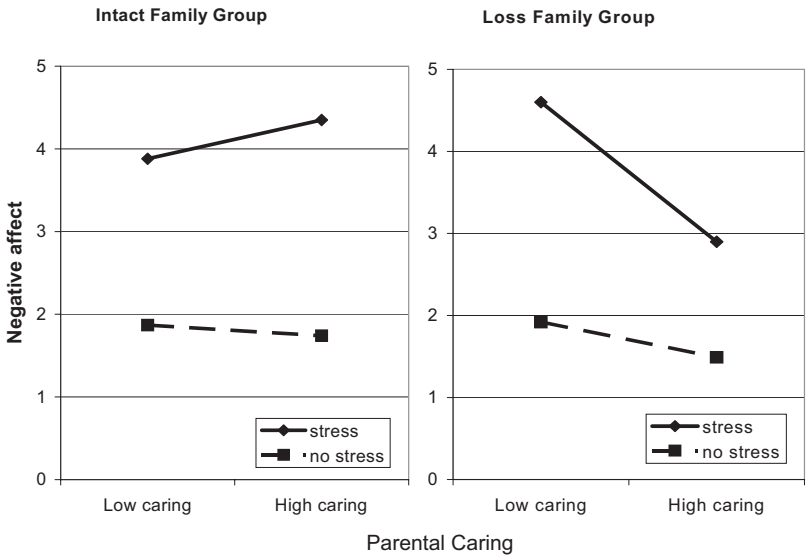

Figure 2. Negative affect during stressful episodes. Parental caring was treated as a continuous variable in analyses, but the simple slopes for interaction effects are graphically displayed for parental caring values set at 1 *SD* above and below the mean, as recommended by Aiken and West (1991).

appraisal and coping skills that benefit them when faced with minor challenges later in life.

Individuals who experienced the early death of a parent had lower BP across the day than did those from nonbereaved families. Given that the groups did not differ in total reports of minor stress across the day and that minor stress was associated with elevated SBP across the sample, lower daily SBP may indicate a resilient physiological profile. However, these findings may also be interpreted within the context of a growing literature linking early adversity to attenuated biological stress response systems (e.g., DeBellis, 2002; Joyce et al., 2007; Tarullo & Gunnar, 2006). Existing literature primarily implicates childhood adversity in attenuated neuroendocrine systems; further investigation into the biobehavioral mechanisms by which the childhood family environment influences daily cardiovascular function is clearly warranted.

Support was also found for the prediction that for early-bereaved young adults, low perceived caring from the surviving parent would be associated with stress sensitization with respect to both perceived stress exposure and associated negative emotional responses. Parental loss coupled with lower caring from the surviving parent may impair the development of adaptive emotion processing, leading to higher stress appraisals, exaggerated negative emotional responses to minor stress, and the later development of emotional disturbance. Results also indicate that the relations between early family adversity and exaggerated negative affective responses to stressors generalize beyond the behavioral science laboratory to in vivo settings.

Childhood family experiences did not predict the magnitude of cardiovascular reactivity to minor stress. Though individuals typically demonstrate both subjective emotional and autonomic responses to stress, these responses are frequently dissociated (Feldman et al., 1999; Schwerdtfeger, Schmukle, & Egloff, 2006). Although previous studies have linked childhood family experiences to cardiovascular reactivity during acute, laboratory-based stress challenges in young adulthood (Luecken et al., 2005), the relations may not be apparent in the context of less intense, minor stressors, or may be limited to certain classes of stress (e.g., social stress).

There were several limitations to the analyses. All subjects were relatively healthy, young adults pursuing a college education. Despite this, clear individual differences in daily stress, negative emotion, and BP were found. The sample represented primarily Caucasian, middle-class families of origin. Caution should be taken in generalizing findings to a broader population. Childhood adversity may be particularly influential for those with fewer financial resources or harsher environmental circumstances. Although the effect sizes in the current study were in the medium-to-large range, replication of these findings with a larger sample size and a more diverse population will be important. Our exploratory analyses did not find effects of child's age at the time of parental death, but there are a number of other contextual factors associated with parental death that may be interesting to consider in future studies with a larger sample, including the cause of the death and remarriage of the surviving parent. The gender of the deceased parent may be particularly fruitful for future exploration given current literature on differential parenting styles and emotion socialization by mothers and fathers in general population samples (Klimes-Dougan et al., 2007; Milevsky, Schlechter, Netter, & Keehn, 2007).

Our measurement protocol represents stress exposure during a 24-hr time period. Although a longer measurement period would have captured a broader array of stressful events, the intent of the study was to evaluate minor everyday events. It is possible that early-bereaved participants reporting a highly caring surviving parent may have been less likely to report minor stress for reasons that were not measured. Our data on minor stressor frequency reflect subjectively perceived stressor exposure. Stress perception

and actual life events have been found to be separate constructs (Lobel & Dunkel-Schetter, 1990). Perceptions of an event as stressful have been shown to better predict physiological and psychological outcomes than objective stressor characteristics (Hojat, Gonnella, Erdmann, & Vogel, 2003; Maes et al., 1997).

Although we used a common, well-validated measure (the Parental Bonding Instrument; G. Parker, 1989), reports of parental caring were retrospective. A large empirical and theoretical literature supports parental caring as a moderator of the impact of parental death. In addition, an extensive literature review found little evidence for inherent inaccuracy of retrospective reports, and recall of emotional childhood experiences is enhanced relative to neutral experiences (Brewin, Andrews, & Gotlib, 1993). The young age of our sample further supports their reports of fairly recent parenting experiences. A common concern is that current stress or distress may bias recall of parental caring; however, the current results remained significant after controlling for current anxiety or depression. Although the "objective" nature of parent–child relationships cannot be verified, the perception of parental caring may be a more meaningful predictor than objective ratings (Luecken & Lemery, 2004). Finally, the cross-sectional nature of the study precludes causal conclusions, and findings should be viewed as preliminary.

In conclusion, the current study supports both stress inoculation and sensitization models of the impact of early parental loss, suggesting that perceived parental caring is an important moderator of both exposure to minor daily stressors and emotional reactivity to minor stress. Increased stress reports and negative emotional reactivity to stress in late adolescence/young adulthood were found in individuals who experienced childhood parental death in combination with lower perceived caring from the surviving parent. Higher perceived caring from the surviving parent was associated with fewer reports of minor stress and lesser stress-related negative affect. For children from bereaved families, family-based early interventions that include a focus on parental expression of affection may benefit children by minimizing the impact of daily hassles on long-term mental and physical health.

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