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Cognitive and Psychosocial Consequences of Hurricanes Katrina and Rita Among Middle-Aged, Older, and Oldest-Old Adults in the Louisiana Healthy Aging Study (LHAS)[1]

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Abstract

This study examined the impact of Hurricanes Katrina and Rita on cognitive and psychosocial functioning among middle-aged (45–64 years), older (65–89 years) and oldest-old adults (90 years and over) in the Louisiana Healthy Aging Study (LHAS). Analyses of pre- and post-disaster cognitive data showed storm-related decrements in working memory for the middle-aged and older adults, but not for the oldest-old adults. Regression analyses confirmed that measures of social engagement and storm-related disruption significantly predicted pre- to post-disaster differences in short-term and working memory performance for the middle-aged and older adults only. These results are consistent with a burden perspective on post-disaster psychological reactions. Implications for current views of disaster reactions are discussed.

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From a historic perspective, older adults are considered an at-risk group and possibly more vulnerable to the impact of natural disasters than younger adults. They may be less likely to receive warning, acknowledge dangerous situations, evacuate, and survive, compared to their younger counterparts. They may also utilize disaster assistance less often and experience more post-disaster disruption and disturbance than younger persons (Kilijanek & Drabek, 1979; Massey, 1997; Phifer, 1990). Whether older adults are more distressed by natural disasters than are other age groups is controversial (Norris & Elrod, 2006; Phifer, Kaniasty, & Norris, 1988). Older adults may be more resilient when faced with extraordinary life events than younger adults. A lifetime of accumulated experience may serve as a psychological buffer that facilitates adaptive coping and promotes resiliency when challenged with a significant environmental stressor.

Prior research has addressed natural disaster effects on adults in their 60s and 70s (e.g., Ferraro, 2003; Krause, 1987; Phifer, 1990; Phifer & Norris, 1989). To our knowledge, no prior research has examined psychological reactions of the oldest-old to natural disasters. This represents a significant gap in the literature because very old adults' reactions may have important practical implications for disaster planning and preparedness, as well as theoretical implications for models of successful aging and environmental stressors.

The Louisiana Healthy Aging Study (LHAS) is an ongoing, interdisciplinary study on the determinants of longevity and healthy aging. When Hurricanes Katrina and Rita hit the Gulf Coast region in 2005, we had a unique opportunity to examine the impact of the storms across several domains of cognitive and psychosocial functioning assessed in the LHAS. Because the LHAS sampling frame encircles a geographic area outside of the severely affected regions, direct trauma exposure was minimal for these participants. Yet, virtually all had children, grandchildren, and in some cases, great-grandchildren, as well as nieces, nephews, and close friends in the affected areas at the time of the storms.

Family and friends from the devastated areas evacuated to Baton Rouge and frequently stayed in LHAS participants' homes for days, weeks, or months at a time in the wake of the storms. Most would agree that witnessing property damage and community destruction experienced by loved ones and friends is disturbing, having the potential for threats to health or lingering psychological effects. In this study, we focus on cognitive and psychosocial indexes of well-being in adults ranging in age from 45 years to over 90 years, using a prospective research design. Prospective designs are desirable, as salient participant characteristics are measured prior to the disaster, which permits meaningful inferences on disaster effects.

Hurricane Katrina made landfall on August 29, 2005, with 1,577 storm-related deaths in Louisiana (Louisiana Department of Health and Hospitals, 2006). In greater Baton Rouge, approximately 80 miles away from the devastated area, tropical storm force winds and flooding pummeled the city. Significant disruptions in the routines of daily living and a dramatically altered life occurred for everyone following the influx of an estimated 200,000 plus evacuees, which made Baton Rouge the state's largest city overnight. Hurricane Rita made landfall on September 24, 2005, affecting primarily the western side of the state and the Texas border. Rita was also a destructive Category 3 hurricane at landfall, yet Katrina has dominated media attention and the popular press. The disproportionate focus on Katrina versus Rita has been termed *Rita amnesia* and likely continues to date (Hancock, 2006).

Theoretical views on disaster effects vary widely, having different assumptions about older adults' post-disaster psychological states. The inoculation hypothesis (Norris & Murrell, 1988) holds that prior experience with natural disasters may serve a protective function for older adults, insulating them from distress and strong emotional reactions to subsequent

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natural disasters. Based on Eysenck's (1983) original inoculation hypothesis, disaster-related stress exposure can increase one's ability to tolerate future stresses. Older people may be more resilient and fare better than expected in the wake of disaster, as a result of previous flood and hurricane experiences.

Prior research has shown minimal stress responses for older adults, consistent with an inoculation perspective (Ferraro, 2003; Knight, Gatz, Heller, & Bengtson, 2000). The maturation hypothesis (Knight et al., 2000) assumes that older people have lessened emotional reactivity to stressful life events, such as natural disasters. Older adults may be less emotionally reactive and more resilient than younger adults because of more mature coping styles. However, the greater wisdom and maturity that can accompany advanced age may result in lower levels of pre-disaster distress generally, as opposed to a reduction in disaster-specific distress after the event. Most would agree that pre-disaster mental health characteristics are an important determinant of post-disaster psychological outcomes. Reduced emotional distress in older adults, then, may be a natural consequence of levels of psychological well-being prior to a natural disaster (Knight et al., 2000).

The burden hypothesis (Thompson, Norris, & Hanacek, 1993) holds that middle-aged persons may be the most affected, compared to other age groups, because of their role as the economic provider with social and financial responsibilities for their families. For some, dual sets of responsibilities associated with caring for dependent children and elderly parents may double the perceived burden (Solomon, Smith, Robins, & Fischbach, 1987). Indeed, there is evidence of emotional distress for middle-aged adults who shoulder a disproportionate share of economic and social responsibility in the post-disaster recovery period, relative to younger and older adults (e.g., Thompson et al., 1993).

In this study, we examined the impact of Hurricanes Katrina and Rita (HKR) on the oldest-old (defined as 90 years and older) and their younger counterparts (age = 45–89 years). Our first aim is to examine changes in well-being before and after the storms, based on available cognitive and psychosocial indicators, and to compare and contrast these changes among persons in these different age groups. Our second aim is to assess storm impact and exposure.

To summarize, we expect minimal pre-disaster to post-disaster differences in the cognitive and psychosocial measures for the older adults, consistent with the inoculation hypothesis (Ferraro, 2003; Norris & Murrell, 1988). In contrast, middle-aged adults are expected to show greater storm-related deficits than the other groups, in line with a burden perspective (Norris & Elrod, 2006; Solomon et al., 1987; Thompson et al., 1993). Such a pattern of outcomes would provide new evidence of variations in well-being in Middle-aged to very old adults in the face of a major environmental stressor with implications for theoretical views of disaster psychological reactions.

Method

Participants and Procedure

Participants were enrolled in the LHAS, an ongoing multidisciplinary study of the determinants of longevity conducted in collaboration with Louisiana State University (LSU) Agricultural and Mechanical College, LSU Health Sciences Center in New Orleans, Tulane University, the University of Alabama at Birmingham, and the Pennington Biomedical Research Center in Baton Rouge. LHAS participants were sampled randomly from the Voters' Registration 2000 files for those age 20 to 64 years and from the Medicare Beneficiary Enrollment Data file of the Center for Medicare and Medicaid Services (CMS)

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for those age 65 years and above for the eight parishes (counties) constituting the Greater Baton Rouge community.

A total of 75 persons were tested within the 8-month period prior to the storms (January 18 to August 23, 2005). These 75 persons were contacted by letter and were invited to participate in the study. Follow-up telephone calls were made shortly after the initial mailing. In all, 66 persons agreed to participate and were tested in the study (88.0% participation rate). Selected pre-disaster measures of cognitive status, self-perceived health, and health-related quality of life were included in the prospective design. Wave 1 testing was completed within the first 4 to 5 months after Rita and Katrina, respectively, to assess immediate storm impact.

We partitioned the sample to represent three age groups. *Middle-aged adults* were between the ages of 45 and 64 years (n = 20, 13 males, 7 females; M = 53.9 years, SD = 5.9). *Older adults* were between the ages of 65 and 89 years (n = 20, 9 males, 11 females; M = 73.8 years, SD = 7.1). *Oldest-old adults* were 90 years of age or older (n = 26, 12 males, 14 females; M = 92.0 years, SD = 1.3 years). All of the participants scored 25 or higher on the Mini-Mental State Exam (MMSE; Folstein, Folstein, & McHugh, 1975) at the time of original testing and were free of neurologic impairment as a result of stroke or adult dementia. The participants were compensated $20 each for their voluntary participation.

Participants were tested individually in their home or in the laboratory at LSU in two sessions that lasted approximately 60 to 90 min each. Younger participants were tested in a single session, if desired. The same invariant order of administration of the dependent measures was used across the one- and two-session formats.4 Mental health measures (anxiety, depression, post-traumatic stress disorder [PTSD]) were included to assess psychological distress as a result of the storms and their aftermath. LHAS participants did not show a significant rise in depression, anxiety, or PTSD after the hurricanes, as reported in Cherry, Galea et al. (2008).

Dependent Measures

Cognitive measures—A short form of the Wechsler Adult Intelligence Scale (WAIS) vocabulary subtest was given as a measure of verbal intelligence (Jastak & Jastak, 1965) prior to the storms. We readministered the MMSE (Folstein et al., 1975) to assess potential post-disaster changes in cognitive status. The Forward and Backward Digit Span (FDS and BDS, respectively) measures from the WAIS-R (Wechsler, 1981) and the Size Judgment Span (SJS) task (Cherry, Elliott, & Reese, 2007) were readministered to assess possible changes in short-term memory and working memory capacity.

Storm impact measures—We developed a structured storm impact questionnaire with four modules to assess hurricane impact, modeled after a similar instrument used to assess the psychological sequelae of the 2004 Florida hurricanes (Acierno et al., 2007). The *storm exposure and threat to self and family/property module* includes questions that assess evacuation status and fear for safety of self, friends, or family. The *storm-related disruption and stressors module* includes questions about environmental/property issues (i.e., experienced power loss or property damage) and the types of disruption created by the storms. The *social support module* assesses the availability of help, if needed, before and after the storms, charitable giving, volunteer work done for others, and other psychosocial issues (e.g., housed displaced family members or other evacuees; helped evacuees in other ways, such as volunteering or assisting with relief efforts). Finally, the *lifetime exposure to*

[4]Details on the LHAS hurricane study materials and procedures are described more fully in Cherry, Galea, and Silva (2008).

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potentially traumatic events module assesses participants' exposure to other extraordinarily stressful or disturbing events, such as previous disaster experiences, serious accidents in an automobile or at work, physical attacks experienced, and military combat.

Results

Overview of Analyses

One-way ANOVAs and chi-square tests of independence (when indicated) were conducted on the participant characteristic data, with age group as a factor. Univariate comparisons were conducted for the FDS, BDS, and SJS measures before and after the storms. Responses to the structured storm questionnaire were examined by module (collapsing across age group) to assess storm impact and threat to self, family, and property; storm-related disruption; social support; and lifetime exposure to trauma. Mixed models were used to examine participant characteristics and storm experience variables that may explain the difference in cognitive performance measures before and after the storms.

Participant Characteristics

Table 1 presents a summary of the individual-difference and social activity characteristics of the sample. An ANOVA on the vocabulary scores yields a significant main effect of age group, $F(2, 62) = 3.33$, $p < .04$ ($MSE = 50.42$), favoring older adults. Analyses of the MMSE scores with age group and time of testing yield only a significant age group effect, $F(2, 63) = 10.87$, $p < .001$ ($MSE = 3.62$). Means for the middle-aged (28.60) and older adults (28.85) exceed the mean of the oldest-old adults (26.50), although their scores were still well above what is typically considered indicative of cognitive impairment. A higher percentage (46.2%) of the oldest-old adults reported being a high school graduate or less, as compared to middle-aged (30.0%) and older adults (15.0%), although these differences were not statistically significant, $\chi^2(4, N = 66) = 5.82$, $p = .21$.

Participants were active in the community. Most reported membership in clubs and social organizations, with a numerically higher percentage (38.5%) of the oldest-old adults reporting membership in four or more clubs and social organizations. However, no significant age group difference occurred for participation in clubs and social organizations pre-HKR ($p = .35$) and post-HKR ($p = .70$).

Regarding the number of hours per week spent outside of the home, a smaller percentage (30.8%) of the oldest-old spent more than 19 hours outside of their homes, compared to middle-aged (55.0%) and older adults (65.0%) pre-HKR; this was a marginally significant difference, $\chi^2(2, N = 66) = 5.79$, $p = .06$. However, a higher percentage (80.0%) of the middle-aged adults reported spending more than 19 hours outside the house after the storms, compared to the other age groups. A significant trend was observed between age group and the time spent outside the house, Mantel-Haenszel's χ^2 $(1, N = 66) = 12.30$, $p < .01$.

Participants rated their satisfaction with social support they receive for dealing with day-to-day problems. Analyses of the social support ratings yield a significant age group effect, because of the middle-aged adults whose social support ratings were lower than the other groups' ratings (ps = .03 and .02, for pre-HKR and post-HKR, respectively). Participants indicated whether they had a *confidant*, described as someone to whom they can talk about issues that concern them. Analysis of the confidant ratings yielded a nonsignificant age group effect both before ($p = .64$) and after the storms ($p = .20$).

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Cognitive Measures

Means appear in Table 2. Analyses of the digit-span measures yield nonsignificant age group and time of testing effects for both FDS and BDS (all *p*s > .16). Analyses of the SJS data yield a significant age group main effect, $F(2, 60) = 16.40$, $p < .001$ ($MSE = 0.87$), with combined means pre-HKR and post-HKR favoring the middle-aged adults ($M = 4.45$), who performed better than the older adults ($M = 3.86$) and the oldest-old adults ($M = 3.33$). Importantly, pairwise comparisons confirm that the three age groups were empirically distinguished on the SJS task, as all mean differences were significant (all *p*s < .05). The main effect of time of testing also significant, $F(1, 60) = 17.41$, $p < .001$ ($MSE = 0.32$), with post-HKR performance lower than pre-HKR performance (*M*s = 3.66 and 4.10, respectively).

Interpretation of these effects is qualified by a significant Age Group × Time of Testing interaction effect, $F(2, 60) = 4.04$, $p = .02$ ($MSE = 0.32$). The interaction effect occurred because the drop in SJS performance from pre-HKR to post-HKR was significant for the middle-aged and older adults (*p*s < .01), but not for the oldest-old adults ($p = .79$). Taken together, these findings suggest that the storms had relatively little effect on the oldest-old adults, although the two younger groups performed more poorly on the SJS task in the post-disaster period by comparison.

Storm Impact Measures

Table 3 presents the results of the structured storm questionnaire. The first two modules pertain to participants' and their close friends'/family members' experience with the storms. Of the 66 respondents, only 4 reported having no family or friends living in the storm-affected areas at the time of the hurricanes. Thus, we coded the *not applicable* response option on items pertaining to family/friends for these persons as no response (i.e., 0) in the analyses that follow.

Storm exposure and threat to self, family, and property—Only 12% of participants evacuated from their homes as the result of either storm, despite the observation that nearly half of them experienced some winds/potential flooding and that one third of participants reported property damage. Nevertheless, the majority of participants reported little to no fear of injury/death (88%) and considered themselves *fairly safe*/*very safe* (97%). Additionally, the majority of participants (65%) had family/friends who evacuated from the storm, as well as family/friends who experienced property damage (67%).

Storm-related disruption—Although more than 90% of participants reported loss of electricity service and 24% lost telephone service, only 6% of participants were displaced from their homes as a result of the storm, as compared to 58% of their family/friends. The damage or loss of property (e.g., household contents, sentimental possessions, automobiles) was reported by 10% or less of the participants. The loss of trees and crops was reported among 29% of participants. Close to 50% of participants reported that their family/friends lost household contents, and 36% lost sentimental possessions.

Storm-related stressors—Table 4 presents 11 storm-related stressors by the level of stress experienced. Most participants experienced no stress or little stress among these common post-disaster stressors. The most commonly reported stressor was “trouble getting around town,” which 57% of participants reported as *moderately stressful* to *extremely stressful*. Additionally, 39% of participants reported that “trouble communicating by telephone or e-mail” was *moderately stressful* to *extremely stressful*, while 21% reported that “trouble getting gasoline” and “changes in the workplace” were *moderately stressful* to

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extremely stressful. Another 20% of participants reported having to "cancel planned events/ activities" and "housing evacuees in home" as *moderately stressful* to *extremely stressful*.

Social support—Participants' perceived social support and charitable work done for others appears in the upper panel of Table 5. Pairwise comparisons (*t* tests) confirm that perceived social support did not differ before and after the storms. For charitable work done for others, the middle-aged and older adult groups reported greater amounts of volunteer work for others and charitable giving after the storms, compared to before the storms, consistent with a burden perspective. These findings are also consistent with prior statistics from the American Red Cross, which reported that a majority of their disaster volunteers were over the age of 55 (Lopes, 1998, as cited in Oriol, 1999).

The oldest-old adults did not differ in charitable work for others before and after the storms. Perhaps the oldest-old adults had fewer opportunities to provide storm-related assistance because they were not actively participating in the workforce at the time of the storms. That is, work-related assistance opportunities, such as helping coworkers and their families or participating in employee-organized disaster-relief events, would be limited for the oldest-old adults, compared to their younger counterparts. It is also possible that the oldest-old adults may have had safety concerns related to the substantial numbers of evacuees in the community and corresponding traffic dilemmas, which severely disrupted everyday life and complicated daily routines for people of all ages after the storms (Cherry, Allen, & Galea, 2009).

Previous research has shown that many factors influence an older individual's choice to volunteer, such as sociodemographic characteristics (e.g., age, gender, income, educational level, occupation), health, lifestyle, and environmental setting (for a discussion, see Choi, 2003). Given that the nonagenarians in this study were healthy and most were actively involved in the community prior to the storms, it seems likely that environmental concerns or other constraints could be responsible for their lack of increased participation in charitable work after the storms.

Finally, 40% of the middle-aged participants reported having worked in the shelters or provided disaster-relief assistance to evacuees or medical/military personnel involved with the relief effort. Only 10% of the older adults worked in the shelter, and none of the oldest-old participants were involved in the relief effort. A chi-square test confirms a significant difference, $\chi^2(2, N = 66) = 14.66$, $p = .0007$.

Lifetime exposure to trauma—The lower panel of Table 5 presents prior trauma experiences, such as natural disaster, serious accident, attacked by weapon, attacked without weapon but with intent to kill/injure, military combat or war zone, and whether the experience resulted in fear for life/safety. Other than natural disasters (e.g., hurricane, major earthquake, flood, tornado), very few participants reported other trauma experiences. Roughly 85% and 80% of middle-aged and older participants, respectively, had previous experience with other natural disasters, compared to 58% among the oldest-old participants. There were no overall significant differences across three age groups regarding the experience of natural disaster ($p = .08$). However, the oldest-old participants reported significantly less ($p = .02$) experience with traumas from natural disasters, compared to the other two younger groups combined.

For the oldest-old adults, 42% reported experience with serious accidents and 55% reported fear for life or safety. Serious accident experience was reported among 35% of both of the younger participant age groups. Very few participants reported experiencing being attacked

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or experience in a military combat or war zone. There were no significant findings across age groups for these traumatic event experiences.

Factors Associated With Changes in Cognitive Performance Measures

Factors that may be associated with changes in short-term and working memory were examined first with stepwise (forward selection) regression models to identify a useful subset of predictors associated with the differences in these cognitive measures before and after the storms. Personal characteristics and storm stressors that had the highest R^2 were selected. At each step, the candidate variable that increased R^2 the most was selected. We stopped adding variables when none of the remaining variables were significant. Once the set of variables was identified for each cognitive performance measure, the variables were then fitted in multiple regression models.

As can be seen in Table 6, housing evacuees in one's home (beta = 0.59, $p = .04$), experiencing changes in one's workplace or job-related duties (beta= −0.46, $p = .11$), and participating in clubs and social organizations (beta = 0.61, $p = .003$) were found to be associated with the changes in FDS before and after the storms, $F(3, 59) = 5.27$ ($R^2 = .21$). No factor among personal characteristics or storm stressor was associated with the difference in BDS before and after the storms. For the change in SJS scores before and after the storms, the model suggested that age group (beta = 0.40, $p = .06$) and trouble communicating via telephone or e-mail (beta = 0.38, $p = .003$) were associated with a positive change in SJS score before and after the storms, adjusting for educational level.

Discussion

The purpose of the present study was to assess storm-related changes in well-being, based on available cognitive and psychosocial indicators in three age groups using a prospective design. Three main findings emerged from the analyses. First, storm-related deficits in cognitive function were observed for middle-aged and older adults, but not for the oldest-old adults. Second, analyses of the storm impact data confirm the occurrence of property damage, loss of utilities, and other disaster-related stressors across the sample. Third, regression analyses reveal that social engagement and storm-related disruption significantly predicted pre- to post-disaster differences in short-term and working memory among the middle-aged and older adults. These findings and their implications for current views of post-disaster reactions will now be discussed in greater detail.

Psychological Well-Being Before and After the Storms

Historically, older adults have been considered an at-risk group, less likely to survive a natural disaster and more likely to experience disturbances in post-disaster life than younger people (Massey, 1997; Phifer, 1990), although not all researchers agree (Norris & Elrod, 2006). From a public health perspective, the majority of reported Katrina-related deaths were, in fact, people over the age of 60 years (Sharkey, 2007), which is consistent with historical views. However, Katrina-related deaths may be more an indication of evacuation dilemmas and failed attempts to shelter in place than a picture of differential vulnerability among the older adult segment of the population.

With respect to cognitive and psychosocial indicators of well-being that were used in the present study, analyses by age group reveal similarities from pre- to post-disaster assessment, with a few noted exceptions. On the cognitive measures, storm-related declines in working memory span were observed. Critically, the significant Age Group × Time of Testing interaction effect indicates that storm-related deficits in SJS performance were confined to the middle-aged and older adult groups, consistent with a burden perspective

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(Solomon et al., 1987; Thompson et al., 1993). Previous disaster research has shown that adults over 55 years of age suffer psychological distress (Krause, 1987; Phifer, 1990). Our findings extend earlier reports by providing new evidence of storm-related declines in working memory for middle-aged and older adults who ranged in age from 45 to 89 years (see Table 2). The finding that the oldest-old adults did not differ in working memory from pre- to post-disaster testing is intriguing and implies that they may be more psychologically resilient than are their younger counterparts.

On the psychosocial measures, all of the participants were generally active in the community, and the storms apparently did not prompt a reduction in membership in clubs and social organizations for any age group. Before the storms, middle-aged (55.0%) and older adults (65.0%) reported spending 19 hours or more per week outside of their homes more often than did the oldest-old adults (30.8%). After the storms, middle-aged adults' estimates of 19 or more hours spent outside of the house increased significantly (80.0%), exceeding that of the older (45.0%) and oldest-old (26.9%) adults, whose estimates dropped somewhat, relative to their pre-storm ratings. Middle-aged adults' satisfaction with social support for dealing with day-to-day problems was also lower than the other age groups, although this result occurred both before ($p = .03$) and after ($p = .02$) the storms, indicating lower satisfaction in general (Table 1).

The cognitive and psychosocial data presented here imply that the oldest-old adults are resilient in the wake of disaster. One explanation for the present outcomes is that personal losses were modest and community destruction was minimal in the greater Baton Rouge area. Phifer and Norris (1989) found that exposure to personal losses and a high level of community destruction predicted increases in negative affect for 2 years after the southeastern Kentucky floods of 1981 and 1984, suggesting enduring psychological distress for adults over the age of 55 (see also Krause, 1987).

Other evidence has shown that older adults are minimally affected by natural disasters in terms of psychological functioning and self-perceptions of health (Ferraro, 2003; Ferraro, Morton, Knutson, Zink, & Jacobson, 1999). Norris and Murrell (1988) found that older adults with previous flood experience did not show increased anxiety responses after the southeastern Kentucky flood of 1984, whereas older adults with minimal prior flood experience showed much stronger effects. These findings were corroborated in a later study in which Phifer and Norris (1989) found that prior flood experience enhanced adaptation to the 1984 flood. Taken together, these findings imply that older adults may be more resilient to the negative effects of a natural disaster than previously assumed, and they suggest that a lifetime of accumulated experience may provide a psychological buffer that acts to reduce or minimize negative post-disaster outcomes.

Storm Impact and Predictors of Changes in Well-Being

Our second aim was to examine storm impact using a structured storm questionnaire that assesses storm exposure and threat, storm-related disruption, social support, and lifetime exposure to potentially traumatic events. Very few participants evacuated from their homes, although nearly half of them experienced some winds and flooding, and one third experienced property damage. In contrast, about two thirds of the sample had family or close friends who evacuated as a result of the storm and experienced property damage. Nearly all (90.9%) reported loss of electricity and 24.2% reported lost telephone service, yet only 6.1% were displaced from their homes as a result of the storm, compared to 65.1% of their family and friends. Nearly half reported that their family or friends lost household contents and one third had lost sentimental possessions. Together, these findings indicate mostly peripheral storm-related damage and losses for this sample, as would be expected in a geographic

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region approximately 80 miles away from the devastated areas, yet far greater devastation, by comparison, for their family and friends.

Analyses of storm-related stressors reveal that more than half of the sample rated “trouble getting around town” as *moderately stressful* to *extremely stressful* (57.6%), while fewer participants (39.4%) rated “trouble communicating by telephone or e-mail” as *moderately stressful* to *extremely stressful*. Approximately 20% of the sample reported moderate to extreme stress for having to cancel planned events/activities, housing evacuees in their homes, trouble getting gasoline, and changes in workplace activities (Table 4).

With respect to perceived social support, participants' ratings were relatively high and did not change from pre- to post-disaster assessment. Other evidence has shown that high perceived social support in the pre-disaster period serves a protective function against psychological disorders (e.g., Acierno et al., 2007), promotes well-being, and reduces post-disaster psychological distress (e.g., Kaniasty, Norris, & Murrell, 1990; Norris & Kaniasty, 1996). Perhaps participants' perceived social support buffered their experience of disaster-related stressors in the present study. Interpretative caution is warranted, however, as storm exposure was minimal, and there was no evidence of adverse mental health outcomes in the sample (i.e., no elevated anxiety, depression, or post-traumatic stress; Cherry et al., 2008).

Finally, it is worth noting that middle-aged and older adults reported significantly more charitable work for others after the storms than before the storms, whereas the oldest-old adults did not differ across the two assessments. Middle-aged adults were also 4 times more likely than older adults to work in the shelters and to provide disaster-relief assistance, consistent with a burden perspective on post-disaster psychological reactions (Thompson et al., 1993). The oldest-old adults were not directly involved in disaster-relief assistance, although one 95-year-old participant prepared and sent a pot of red beans and rice to feed evacuees who were sheltered at her church in the wake of the storms.

The results of the multiple regression analyses indicate that certain cognitive and storm experience variables predicted differences in the short-term and working memory measures (Table 6). Short-term memory (indexed by FDS), housing evacuees in one's home ($p = .04$), and participating in club and social organizations ($p = .003$) were significantly associated with differences in FDS scores before and after the storms, while experiencing changes in workplace or job-related duties ($p = .11$) was marginally significant. For working memory (indexed by SJS), older participants and those who experienced trouble communicating via telephone or e-mail had higher SJS scores after the storm, compared to the score when tested before the storm (*p* values were .003 and .06, respectively).

Study Limitations

Several methodological limitations of the study warrant mention. First, the LHAS participants are active, community-dwelling adults who are physically and psychologically capable, which necessarily prompts concerns about selection bias in the direction of vitality and representativeness of the sample. The storms may have negatively affected the more vulnerable or frail elderly adults. LHAS participants also live within a 40-mile radius of Baton Rouge proper, by definition. While hit by Hurricanes Katrina and Rita, this area was not among the most devastated areas in the Gulf Coast region. Perhaps persons from greater New Orleans or the Mississippi coast would have responded differently.

Second, the sample size was modest, because of the limited number of LHAS participants who were eligible for recruitment from the 8-month pre-disaster testing period. Third, some participants were tested in the lab, while others were tested in their homes. Variations in the experimental setting across participants may have affected their responses, although

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heterogeneity in the circumstances under which participants are tested is desirable from an external validity point of view. That is, one could argue that the present outcomes may have greater generalizability and, thus, more real-world relevance because the results were not obtained strictly in an artificial laboratory setting.

Finally, this study was conducted within the first 6 months of the storms to assess immediate impact. Psychological reactions to disaster may change over time, reflecting incubation effects. Follow-up assessments beyond the first few months would be desirable to address this concern.

In closing, a reasonable concern has been whether hurricanes and other natural disasters negatively impact elderly persons' health and quality of life. This growing population has been stereotyped as an at-risk population when it comes to recovery from natural disasters (Massey, 1997). To our knowledge, this study is the first to examine the effects of a natural disaster on psychological well-being in the oldest-old adults. We found that they were resilient to the aftermath of the hurricanes, while middle-aged adults and, in some cases, older adults appeared to be more affected, by comparison. Our findings add to a small but growing body of research that seeks to understand how older adults react to and recover from exposure to traumatic natural events. Future research to explore the generality of these findings seems warranted.

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Table 1

Participant Characteristics and Social Engagement Before and After the Storms

	Middle-aged adults (*N* = 20)		Older adults (*N* = 20)		Oldest-old adults (*N* = 26)	
	M	***SD***	***M***	***SD***	***M***	***SD***
Age	53.9	5.9	73.8	7.1	92.0	1.3
Vocabulary	24.89	7.86	26.20	7.03	21.04	6.55
MMSE						
Pre-HKR	28.60	2.44	28.85	1.31	26.50	1.82
Post-HKR	28.60	1.75	28.85	1.63	26.96	1.51
			N (%)			
Educational level						
≤High school graduate	6 (30.0%)		3 (15.0%)		12 (46.2%)	
College	11 (55.0%)		15 (75.0%)		12 (46.2%)	
Graduate school	3 (15.0%)		2 (10.0%)		2 (7.6%)	
Clubs and social organizations						
None						
Pre-HKR	2 (10.0%)		1 (5.0%)		3 (11.5%)	
Post-HKR	0 (0.0%)		1 (5.0%)		2 (7.7%)	
1 to 3						
Pre-HKR	13 (65.0%)		16 (80.0%)		13 (50.0%)	
Post-HKR	14 (70.0%)		12 (60.0%)		14 (53.9%)	
>4						
Pre-HKR	5 (25.0%)		3 (15.0%)		10 (38.5%)	
Post-HKR	6 (30.0%)		7 (35.0%)		10 (38.5%)	
Hours per week outside home						
≤19 hours						
Pre-HKR	9 (45.0%)		7 (35.0%)		18 (69.2%)	
Post-HKR	4 (20.0%)		11 (55.0%)		19 (73.1%)	
>19 hours						
Pre-HKR	11 (55.0%)		13 (65.0%)		8 (30.8%)	
Post-HKR	16 (80.0%)		9 (45.0%)		7 (26.9%)	

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	Middle-aged adults (*N* = 20)		Older adults (*N* = 20)		Oldest-old adults (*N* = 26)	
	M	***SD***	***M***	***SD***	***M***	***SD***
Social support[a]						
Very satisfied						
Pre-HKR	11 (55.0%)		17 (85.0%)		24 (92.2%)	
Post-HKR	10 (50.0%)		14 (70.0%)		24 (92.3%)	
Fairly satisfied						
Pre-HKR	7 (38.9%)		3 (15.0%)		1 (3.9%)	
Post-HKR	9 (45.0%)		5 (25.0%)		2 (7.7%)	
A little satisfied						
Pre-HKR	0 (0%)		0 (0%)		1 (3.9%)	
Post-HKR	1 (5.0%)		0 (0%)		0 (0%)	
Confidant						
Yes						
Pre-HKR	18 (90.0%)		19 (95.0%)		23 (88.5%)	
Post-HKR	18 (90.0%)		20 (100.0%)		22 (84.6%)	

Note. MMSE = Mini-Mental State Exam (Folstein et al., 1975). HKR = Hurricanes Katrina and Rita.

[a]No one reported *not satisfied at all* for the question regarding overall support from other people dealing with personal or day-to-day problems.

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Table 2

Short-Term and Working Memory Characteristics Before and After the Storms

	Pre-HKR		Post-HKR		
	M	*SD*	*M*	*SD*	*p*
FDS					
Middle-aged	6.22	0.96	6.00	1.15	.69
Older	5.74	1.08	5.78	1.23	.89
Oldest-old	5.56	1.27	5.48	1.38	.70
BDS					
Middle-aged	4.67	1.38	4.53	1.49	.93
Older	4.21	1.33	4.40	0.91	.58
Oldest-old	3.94	1.20	4.08	1.43	.43
SJS					
Middle-aged	4.81	0.77	4.08	0.99	.01
Older	4.13	0.62	3.58	0.71	.002
Oldest-old	3.35	0.60	3.31	0.90	.79

Note. HKR = Hurricanes Katrina and Rita; FDS = Forward Digit Span from the Wechsler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981); BDS = Backward Digit Span from the WAIS-R; SJS = Size Judgment Span (Cherry et al., 2007).

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Table 3
Storm Exposure, Threat, and Storm-Related Disruption

	Self		Family/friends[a]	
	N	%	*N*	%
Storm exposure and threat to self, family, and property				
Evacuate				
No	58	88	23	35
Yes	8	12	43	65
Present for winds/major flooding				
No	38	58	40	61
Yes	28	42	26	39
Property damage				
No	45	68	22	33
Yes	21	32	44	67
Fear of injury/death				
No	43	65	35	53
A little	15	23	15	23
Moderately	7	11	10	15
Extremely	1	1	6	9
Actual safety				
Very safe	39	59	25	38
Fairly safe	25	38	30	45
Not too safe	2	3	8	12
Not safe at all	0	0	3	5
Storm-related disruption				
Displaced from home				
No	62	94	28	42
Yes	4	6	38	58
Loss of services				
Electricity				
No	6	9	8	12
Yes	60	91	58	88
Telephone				
No	50	76	31	47
Yes	16	24	35	53
Damage or losses				
Household contents				
No	59	89	34	52
Yes	7	11	32	48
Sentimental possessions				
No	65	98	42	64
Yes	1	2	24	36

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	Self		Family/friends[a]	
	N	%	*N*	%
Automobiles, trucks				
No	66	100	55	83
Yes	0	0	11	17
Pets				
No	66	100	64	97
Yes	0	0	2	3
Crops, trees				
No	47	71	42	64
Yes	19	29	24	36

[a] *Not applicable* or *do not know* responses were coded as *no* for participants who reported having no family/friends in the affected areas or did not know of their family's/friends' experiences at the time of the interview.

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Table 4

Storm-Related Stressors

		Not stressful		Moderately stressful		Extremely stressful	
Stressor	***N***	***N***	**%**	***N***	**%**	***N***	**%**
Cancel planned events/activities							
No	35						
Yes	31	18	27	10	15	3	5
Relatives/friend refused to evacuate							
No	60						
Yes	6	2	3	3	5	1	2
Housed evacuees in home							
No	38						
Yes	27	14	22	9	14	4	6
Provide assistance to evacuees							
No	45						
Yes	21	15	23	6	9	0	0
Lose food in refrigerator or freezer							
No	42						
Yes	24	13	20	10	15	1	2
Trouble getting gasoline							
No	47						
Yes	18	4	6	8	12	6	9
Trouble meeting medical/health needs							
No	62						
Yes	4	0	0	3	5	1	2
Cancel medical treatments							
No	58						
Yes	8	5	8	1	2	2	3
Trouble communicating via telephone or e-mail							
No	33						
Yes	33	7	11	22	33	4	6

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		Not stressful		Moderately stressful		Extremely stressful	
Stressor	***N***	***N***	**%**	***N***	**%**	***N***	**%**
Trouble getting around town							
No	18						
Yes	48	10	15	28	42	10	15
Changes in workplace							
No	48						
Yes	18	4	6	12	18	2	3

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Table 5

Social Support Before and After the Storms and Lifetime Exposure to Trauma

	Middle-aged adults				Older adults				Oldest-old adults			
	N	%	*M*	*SD*	*N*	%	*M*	*SD*	*N*	%	*M*	*SD*
Type of support[a]												
Someone to help you[b]												
6 months before the storms			12.70	3.16			13.70	2.49			11.73	3.31
Since the storms			12.55	3.09			13.65	2.74			11.96	3.19
t test for pre/post storm difference			0.48				0.77				0.47	
Charitable work you may do for others[c]												
A typical year before the storms			5.05	1.73			4.95	2.11			4.35	1.94
Since the storms			5.65	1.69			5.20	2.07			4.31	2.28
t test for pre/post storm difference			0.02				0.02				0.83	
Work in the shelters or provide disaster relief			1.15	1.04			0.50	0.83			0.04	0.20
Type of trauma												
Other natural disaster												
No	3	15			4	20			11	42		
Yes	10	50			12	60			12	46		
Yes, with fear for life/safety	7	35			4	20			3	12		
p value for difference[d]							.08					
Serious accident												
No	13	65			13	65			15	58		
Yes	4	20			3	15			5	19		
Yes, with fear for life/safety	3	15			4	20			6	23		
p value for difference[d]							.84					
Attacked with a gun, knife, or other weapon												
No	17	85			18	90			21	81		
Yes	3	15			0	0			4	15		
Yes, with fear for life/safety	0	0			2	10			1	4		
p value for difference[d]							.69					

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	Middle-aged adults				Older adults				Oldest-old adults			
	N	**%**	***M***	***SD***	***N***	**%**	***M***	***SD***	***N***	**%**	***M***	***SD***
Attacked without weapon, but intent to kill/injure												
No	18	90			18	90			23	84		
Yes	1	5			1	5			2	8		
Yes, with fear for life/safety	1	5			1	5			1	4		
p value for difference[d]							.98					
Military combat or war zone												
No	18	90			18	90			22	84		
Yes	1	5			0	0			2	8		
Yes, with fear for life/safety	1	5			2	10			2	8		
p value for difference[d]							.81					

[a] Items were rated on the following scale: 0 = *none of the time;* 1 = *some of the time; 2 = most of the time*; 3 = *all of the time*.

[b] Based on the sum of scores of a five-item questionnaire.

[c] Based on the sum of scores of a three-item questionnaire.

[d] Chi-square test for difference across age groups combining the response “Yes” and “Yes, with fear for life/safety” because of the small cell size.

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Table 6

Factors Associated With Changes in Short-Term and Working Memory Characteristics Before and After the Storms

	Regression coefficient	*p*	*F*	R^2
Difference in FDS			5.27	0.21
House evacuees in your home	.59	.04		
Experiencing changes in your workplace or job-related duties	−.46	.11		
Participating in clubs and social organizations	.61	.003		
Difference in SJS			4.03	0.17
Trouble communicating via telephone or e-mail	.40	.06		
Age group	.38	.003		
Educational level	.24	.15		

Note. No apparent association among factors examined in the difference in BDS before and after Hurricanes Katrina and Rita. FDS = Forward Digit Span from the Wechsler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981); BDS = Backward Digit Span from the WAIS-R; SJS = Size Judgment Span (Cherry et al., 2007).