Psychological Medicine, 1997, **27**, 179–190.

Psychosocial sequelae of the 1989 Newcastle earthquake: III. Role of vulnerability factors in post-disaster morbidity

V. J. CARR,[1] T. J. LEWIN, J. A. KENARDY, R. A. WEBSTER, P. L. HAZELL, G. L. CARTER AND M. WILLIAMSON

From the Discipline of Psychiatry, Faculty of Medicine and Health Sciences, University of Newcastle, NSW, Australia

ABSTRACT

Background. This paper examines the contributions of dispositional and non-dispositional factors to post-disaster psychological morbidity. Data reported are from the 845 participants in the longitudinal component of the Quake Impact Study.

Methods. The phase 1 survey was used to construct dimensional indices of threat and disruption exposure. Subsequently, a range of dispositional characteristics were measured, including neuroticism, personal hopefulness and defence style. The main morbidity measures were the General Health Questionnaire (GHQ-12) and Impact of Event Scale (IES).

Results. Dispositional characteristics were the best predictors of psychological morbidity throughout the 2 years post-disaster, contributing substantially more to the variance in morbidity (12–39%) than did initial exposure (5–12%), but the extent of their contribution was greater for general (GHQ-12) than for post-traumatic (IES) morbidity. Among the non-dispositional factors, avoidance coping contributed equally to general and post-traumatic morbidity ($pr = 0{\cdot}24$). Life events since the earthquake ($pr = 0{\cdot}18$), poor social relationships ($pr = -0{\cdot}25$) and ongoing earthquake-related disruptions ($pr = 0{\cdot}22$) also contributed to general morbidity, while only the latter contributed significantly to post-traumatic morbidity ($pr = 0{\cdot}15$).

Conclusions. Medium-term post-earthquake morbidity appears to be a function of multiple factors whose contributions vary depending on the type of morbidity experienced and include trait vulnerability, the nature and degree of initial exposure, avoidance coping and the nature and severity of subsequent events.

INTRODUCTION

An important aspect of research into post-traumatic stress is understanding the processes and factors that made an individual more, or less, vulnerable to the effects of the stressor. One view, articulated some 50 years ago, is that the severity of the stressor is generally insufficient for the development of pathology and that vulnerability is a necessary element (Lewis, 1942). Studies of susceptibility of individuals exposed to life threatening stressors aim to explore mediating or moderating factors involved in the pathway from stressor to response. There are a number of facets to this question: the background of the individual, the nature of the event, dispositional characteristics that mediate responses to stressors, intra- and extra-personal resources that help to moderate the stressor-response pathway, and the response itself.

Since background variables are not subject to the problems of retrospective measurement that frequently confound studies of traumatic stress,

[1] Address for correspondence: Professor Vaughan J. Carr, Discipline of Psychiatry, Faculty of Medicine and Health Sciences, University of Newcastle, Callaghan, NSW 2308, Australia.

there are some data concerning their role as vulnerability factors. Male gender has been variously found to be predictive (Phifer, 1990), protective (Weisaeth, 1989) and to have little influence (Gibbs, 1989) on psychological morbidity. Age was found to be protective by Weisaeth (1989). Family history of emotional problems predicted post-traumatic stress disorder (PTSD) in studies of Vietnam veterans (Emery *et al*. 1991) and in disaster workers (McFarlane, 1988, 1989). Some studies have also found that past history of emotional problems predicted PTSD (McFarlane, 1989; Weisaeth, 1989; Nolen-Hoeksema & Morrow, 1991).

The nature of the stressor event may be seen as intrinsically linked to the development of traumatic stress. The American Psychiatric Association's (APA, 1994) DSM-IV criteria for PTSD constrain the type and severity of the stressor event. The implication is that a stressor of sufficient severity will be traumatic for any individual. However, linked to this is the notion that the response of the individual exposed to the trauma must represent an appropriate level of distress. Thus, both exposure severity and subjective experience should be viewed as aspects of the nature of the event in determining traumatic stress responses (Riggs *et al*. 1992). Furthermore, although the original stressor event is unchangeable, it will have associated secondary 'events' (Carr *et al*. 1997), and the stressed individual's perception of the stressor may change over time (Schwarz *et al*. 1993), Concurrent adverse life events have also been found to predict morbidity following trauma (Green & Berlin, 1987; McFarlane, 1988). Therefore, the evaluation of the role of the event must take into account the dynamic nature of vulnerability by assessing both the primary and secondary events as well as assessing vulnerability within a longitudinal framework.

The propensity of an individual to respond to a stressor with heightened arousal has been labelled as the dispositional characteristic of trait anxiety. Eysenck conceptualized trait anxiety as neuroticism (Eysenck & Eysenck, 1975), which he considered to be stable and resistant to modification. Neuroticism can also be conceived as a mediator of stress responses; thus, Andrews (1991) has argued that it has a significant influence on the development of pathological anxiety. Many studies have found relationships between neuroticism and general psychological morbidity, however, McFarlane (1989) has also reported that neuroticism is a significant predictor of post-traumatic stress. More recently, Breslau *et al*. (1995) have demonstrated links between neuroticism and the likelihood of exposure to traumatic events.

While dispositional variables can be seen as mediating the effects of the stressor event, other variables can be viewed as moderating the effects of the stressor severity, background factors, and mediating variables. Coping style has been found to predict outcome of traumatic stress. Several studies of combat and disaster-related post-traumatic stress have found that worse outcomes were predicted by greater use of avoidance coping (McFarlane, 1989). Similarly, less active problem-oriented coping also predicts poorer outcome (Gibbs, 1989; Fairbank *et al*. 1991). Interestingly, there is some confusion about whether avoidance coping moderates the traumatic stress response independently or in combination with less active problem-orientated coping (Jones & Barlow, 1990). Nunn (1996) argues that greater attention also needs to be paid to the notion of personal resilience, which is assessed, in part, by his new personal hopefulness measure (Nunn *et al*. 1996). Social support has also been found to moderate traumatic stress. Bolin & Klenow (1988) found that disaster survivors had improved recovery if they indicated that they had received support from family and friends. Loss of social support may also be seen as a permanent change in resources (Freedy *et al*. 1992). Defence mechanisms have been proposed as moderators of stressful life events (Vaillant, 1971). Andrews *et al*. (1993) found that defence style (e.g. use of projection) is an important determinant of anxiety and depression. Overall, the literature on vulnerability, while providing indicators for research focus, does not yet allow for definite conclusions to be drawn.

In previous papers (Carr *et al*. 1995, 1997) we have reported the methodology and findings from the Quake Impact Study (QIS), a 2-year, four-phase investigation of the psychosocial effects of the 1989 Newcastle earthquake. The present paper examines three issues relating to

the role of vulnerability factors: (1) the stability of, and inter-relationships between, the chosen dispositional measures, which include both traditional vulnerability factors (e.g. neuroticism) and less well established measures (e.g. personal hopefulness and defence style); (2) the potential for reporting biases that might influence the measurement of moderating and/or outcome variables in the form of associations between the dispositional measures and the scales used for reporting disaster exposure, ongoing disruptions and other life events; and (3) the relative contributions of dispositional and non-dispositional factors to both trauma-related and general psychological distress.

METHOD

Subjects

There were 1089 subjects selected for the longitudinal component of the QIS, comprising a stratified sample of 688 (63%) from the community respondents to the phase 1 survey and 401 (37%) drawn from specifically targeted agencies. The second paper in this series (Carr *et al*. 1997) detailed the recruitment methods and sampling strategies that were used and described the characteristics of respondents and non-respondents. The 845 subjects (78%) who completed at least one of the follow-up surveys (phases 2–4) comprised an equal proportion of males and females (416 *v*. 429) who were, on average, 43·4 years of age at the time of the earthquake.

Instruments and procedure

The phase 1 survey and the major elements in the phase 2–4 surveys have been described previously (see Carr *et al*. 1995, 1997). The instruments of specific relevance here are the 12-item General Health Questionnaire (GHQ-12; Goldberg, 1972) and the Impact of Event Scale (IES; Horowitz *et al*. 1979), which were used in all four surveys, and Billings & Moos' (1981) coping strategies scale which was included at phase 1 and which provides scores on three Method of Coping factors, active–cognitive, active–behavioural and avoidance. In addition, several dispositional measures and items assessing interpersonal relationships, lifestyle factors and psychiatric history were included in the phase 2–4 surveys. The dispositional measures were: the short Eysenck Personality Inventory (EPI; Duncan-Jones, 1983), which measures neuroticism and extraversion; the Hunter Opinions and Personal Expectations Scale (HOPES; Nunn *et al*. 1996), which contains a hope subscale (HS), a despair subscale (DS) and a global personal hopefulness (GPH) scale; and a revised version of the Defense Style Questionnaire (DSQ-40; Andrews *et al*. 1993), which measures three defence factors, usage of mature, neurotic and immature defences. The three dispositional measures were completed on two occasions in order to provide an opportunity to assess their temporal stability and so that aggregate measures could be obtained, thereby reducing the effects of 'measurement errors' due to current state influences. The EPI was completed at phases 2 and 3, the HOPES at phases 2 and 4, and the DSQ-40 at phases 3 and 4. The four QIS surveys were completed, on average, at 27, 50, 86 and 114 weeks post-earthquake.

Data processing – scoring routines and preliminary analyses

Data analyses were undertaken using BMDP statistical software (Dixon *et al*. 1988). Where appropriate, Bonferroni-adjusted error rates were used to control for the number of statistical tests. Weighted threat and disruption exposure scores were calculated for all phase 1 respondents (see Carr *et al*. 1995).

Outcome measures

IES total scores (range 0–75) and the Likert method of scoring the GHQ-12 (range 0–36) were used in all analyses. Following the rationale provided previously (Carr *et al*. 1997), we restricted the major analyses to four outcome measures: average GHQ-12 and average IES scores across phases 1–4 and the rate of decline of GHQ-12 and IES scores over time (i.e. slopes of GHQ-12 and IES scores).

Social relationships, ongoing disruptions and life events

Among the items in the follow-up surveys assessing current interpersonal relationships were ratings of subject's 'overall relationships' with 'family or close friends' and with 'other

https://doi.org/10.1017/S003329179600428X Published online by Cambridge University Press

people (e.g. neighbours, acquaintances or people you work with)'. For both questions, a 5-point scale was used ranging from '1' (Very bad) to '5' (Very good). Responses to these items were averaged across phases 2–4 to produce an index of average social relationships during the post-earthquake period (range 1–5). An index of ongoing disruptions due to the earthquake (range 0–5) and a recent general life events index (range 0–6) were also calculated (see Carr *et al.* 1997).

Preliminary DSQ-40 analyses

A series of principal component analyses was undertaken using 'defence scores' for the 20 defences measured by the DSQ-40; for these analyses, composite DSQ-40 data from phases 3 and 4 were used ($N = 734$). Overall, the pattern of item loadings on the rotated factors was consistent with that reported by Andrews *et al.* (1993) for the mature and immature factors, however, the neurotic factor was not evident in our analyses. In addition, we examined the first principal component after adjusting for defensiveness (i.e. after subtracting each person's mean DSQ rating from their individual item scores). Two clear clusters of defences emerged in this analysis (with loadings $> \pm 0{\cdot}20$): a cluster of seven 'positive' defences (humour, suppression, rationalization, sublimation, anticipation, reaction formation and pseudo-altruism) and a cluster of nine 'negative' defences (projection, passive aggression, somatization, acting out, autistic fantasy, displacement, devaluation, undoing and splitting). Each subject's average rating for the seven defences allocated to the positive cluster (PC_{AV}) and their average rating for the 9 defences allocated to the negative cluster (NC_{AV}) were used to define an overall maturity of defences score (range 1–9), which was equal to $\{PC_{AV} + (10 - NC_{AV})\}/2$.

Selection of a subset of dispositional measures

Nine aggregate dispositional scores were available for each subject, which were obtained by averaging their scores for the two occasions on which each scale was completed (i.e. EPI – neuroticism, extraversion; HOPES – HS, DS and GPH; and DSQ-40 – mature, neurotic and immature factors, overall maturity of defences). Based on an examination of the correlations between these measures and their simple correlations with average GHQ-12 and IES scores, it was decided to restrict the analyses reported in this paper to a subset of four aggregate measures: neuroticism; extraversion; global personal hopefulness; and overall maturity of defences. In effect, findings for the HOPES and DSQ-40 subscales have been omitted.

RESULTS

Stability of dispositional measures

As shown in Table 1, there were no significant differences in mean neuroticism, extraversion and personal hopefulness on the two occasions of measurement, however, there was a small, but significant increase in maturity of defences. The correlations between occasions ranged from 0·67 to 0·74. Thus, there was a substantial degree of stability in the dispositional measures. Each of these measures also correlated significantly with average GHQ-12 and IES scores: neuroticism correlated positively with morbidity, while the other dispositional measures correlated negatively (Table 1). These correlations were generally stronger for the GHQ-12, suggesting that such factors may play a more important role in the development of general psychological morbidity.

In assessing the extent to which the dispositional measures are likely to be trait vulnerability factors, it is useful to compare their stability with that of the morbidity measures. The average correlation among GHQ-12 scores on the four occasions was 0·55, while for the IES it was 0·74, coefficients that are not unlike those in Table 1. Importantly, however, and in contrast to the dispositional measures, there were marked declines in morbidity over time (Carr *et al.* 1997). Interestingly, the average correlations among the morbidity measures, after partialling out the contributions of the dispositional measures, were 0·39 (GHQ-12) and 0·66 (IES). Thus, over and above any predictive value that the dispositional measures may have, morbidity on one occasion is a good predictor of morbidity on other occasions, particularly for the IES. Therefore, not surprisingly, morbidity levels themselves would provide a useful basis for initiating interventions.

Table 1. *Stability of dispositional measures over time and correlations between aggregate dispositional measures and selected outcome measures*

Dispositional measure	Stability of dispositional measure over time: Mean scores: Occasion 1	Mean scores: Occasion 2	Difference between occasions (paired *t* test)	Correlation between occasions	Correlation between aggregate dispositional measure and selected outcome measure ($N = 680$): Average GHQ-12 score	Average IES score
Short Eysenck Personality Inventory (EPI)						
Neuroticism	4·00	3·81	−2·48	0·67***	0·59***	0·49***
Extraversion	4·33	4·28	−0·72	0·69***	−0·26***	−0·10*
Personal hopefulness (HOPES)						
Global personal hopefulness (GPH)	55·69	56·42	1·56	0·71***	−0·48***	−0·37***
Defence style (DSQ-40)						
Overall maturity of defences	6·00	6·08	2·99*	0·74***	−0·39***	−0·24***

Each of the dispositional measures was completed on two occasions (EPI: phases 2 and 3; HOPES: phases 2 and 4; DSQ-40: phases 3 and 4), with aggregate dispositional scores being based on the average of these two occasions. Bonferroni-adjusted error rates were used in assessing the significance of the differences and simple correlations reported in this table ($\kappa = 4$ measures): * $P < 0{\cdot}05$; ** $P < 0{\cdot}01$; *** $P < 0{\cdot}001$.

Table 2. *Correlations among selected aggregate dispositional measures and with earthquake exposure, coping strategies, and recent events and disruptions* (N = 680)

Variable	Aggregate dispositional measure†: Neuroticism (Short EPI)	Extraversion (Short EPI)	Global personal hopefulness (HOPES)	Overall maturity of defences (DSQ-40)
Aggregate dispositional measure				
Extraversion	−0·18***			
Global personal hopefulness	−0·47***	0·47***		
Overall maturity of defences	−0·45***	0·29***	0·55***	
Earthquake exposure				
Threat	0·22***	−0·02	−0·13**	−0·09
Disruption	0·09	0·06	0·07	0·08
Coping strategies				
Active–cognitive strategy	0·03	0·00	0·06	0·16***
Active–behavioural strategy	0·11*	0·02	0·06	0·12**
Avoidance strategy	0·42***	−0·15***	−0·29***	−0·30***
Recent events and disruptions				
Average life events score since quake	0·36***	−0·07	−0·18***	−0·13**
Ongoing disruptions index score	0·23***	0·00	−0·02	−0·04

Bonferroni-adjusted error rates were used in assessing the significance of these simple correlations ($\kappa = 4$ measures): * $P < 0{\cdot}05$; ** $P < 0{\cdot}01$: *** $P < 0{\cdot}001$.

† Scores on these dispositional measures were obtained by averaging the two occasions on which each scale was completed (EPI: phases 2 and 3; HOPES: phases 2 and 4; DSQ-40: phases 3 and 4).

Relationships between dispositional measures, exposure and other life events

The upper portion of Table 2 shows correlations among the aggregate dispositional measures. There were moderate negative correlations between neuroticism and both GPH and maturity of defences, while the latter two measures correlated positively with each other. The lower portion of Table 2 reports correlations between the dispositional measures and earthquake exposure, coping strategies, ongoing disruptions and recent life events unrelated to the earthquake. There was a small positive correlation between neuroticism and exposure to threat and a small negative correlation between GPH and

https://doi.org/10.1017/S003329179600428X Published online by Cambridge University Press

exposure to threat. If these results signify a bias towards reporting stressful events based on a heightened sensitivity to environmental stressors, such sensitivity applies only to threat events and not to initial disruption as there were no significant correlations between any dispositional measure and the latter form of earthquake exposure. However, similar correlations were found in relation to other events in the 2 years after the earthquake. There were significant correlations between life events unrelated to the earthquake and neuroticism, GPH and maturity of defences. If this represents a reporting bias as suggested above, it is quite selective in that significant correlations between these dispositional measures and ongoing disruptions were either absent (i.e. for GPH and maturity of defences) or much reduced compared to other life events since the earthquake (e.g. for neuroticism: $r = 0{\cdot}36$ *v.* 0·23). There were significant correlations between all of the dispositional measures and avoidance coping strategies. In addition, there were small positive correlations between maturity of defences and the more adaptive active–cognitive and active–behavioural coping strategies. A small positive correlation was also obtained between neuroticism and the use of an active–behavioural strategy but this was much less than that obtained between neuroticism and the use of avoidance as a coping strategy ($r = 0{\cdot}11$ *v* 0·42).

Predictors of post-disaster psychological morbidity

In order to estimate the relative contributions of dispositional and non-dispositional factors to post-earthquake morbidity, four six-step hierarchical regression analysis were undertaken, one for each of the four outcome measures. The predictor variables in these analyses were grouped into sets according to their likely (or chronological) order of influence on the outcome measures: background factors (Set A); dispositional characteristics (Set B); lifestyle and personal history factors (Set C); level of earthquake exposure (Set D); coping strategies and initial social support (Set E); and life events, ongoing disruptions and social relationships since the earthquake (Set F).

Table 3 summarizes the results of the regression analyses for the average psychological morbidity measures. Of the background factors (Set A), gender made a small but significant contribution to both average GHQ-12 and average IES scores, while age made a similarly small but significant contribution to average IES scores only. Dispositional characteristics (Set B) contributed 39·0% to the variance in average GHQ-12 scores and 27·3% to the variance in average IES scores. In both instances, the bulk of the contribution was from neuroticism, with GPH contributing additionally to the prediction of average GHQ-12 scores. Within the hierarchical framework, lifestyle factors, including tobacco and alcohol use, psychiatric history and life events prior to the earthquake (Step C) contributed little to the prediction of post-disaster psychological morbidity. Initial earthquake exposure (Set D), after controlling for the influence of dispositional characteristics, accounted for 4·6% and 6·9% of the variance in average GHQ-12 and average IES scores respectively. This contrasts with the figures of 10·5% and 13·0% obtained when dispositional characteristics were not considered (see Carr *et al.* 1997). Avoidance coping strategies contributed about equally to the prediction of average GHQ-12 and average IES scores, but none of the remaining predictors in Set E was significant. Finally, recent events and disruptions (Set F) contributed 8·5% to the variance in average GHQ-12 scores but only 2·9% to average IES scores. The latter contribution was entirely accounted for by ongoing disruptions whereas life events unrelated to the earthquake, ongoing disruptions and poor social relationships all contributed to the variance in average GHQ-12 scores. Overall, the predictor variables entered into these equations accounted for 58·4% of the variance in average GHQ-12 scores and 46·9% of the variance in average IES scores.

In the hierarchical regression analysis with slope of GHQ-12 scores as the outcome variable (overall $R^2 = 0{\cdot}139$), only two predictor variables made a significant contribution, exposure to disruption ($pr = -0{\cdot}18$, $P < 0{\cdot}001$) and avoidance coping ($pr = -0{\cdot}20$, $P < 0{\cdot}001$). That is, subjects with higher initial disruption exposure and/or greater use of avoidance coping tended to report steeper rates of decline in GHQ-12 scores over time. In the corresponding analysis for the slope of IES scores (overall $R^2 = 0{\cdot}088$) only initial disruption exposure

Table 3. *Six-step hierarchical regression analyses assessing the contributions to post-earthquake morbidity of a range of background, dispositional, lifestyle, exposure and related factors. Outcome variables: average GHQ-12 score (Likert method) and average IES score across phases 1 to 4 (N = 640)*

Step	Predictor variables	Average GHQ-12 score		Average IES score	
		ΔR^2	*pr*	ΔR^2	*pr*
1	Set A				
	Background factors ($m = 3$)	0·024** [0·024]	(0·15)	0·039*** [0·042]	(0·20)
	Age		−0·01		0·15** [0·16]
	Gender (Male = −1, Female = 1)		0·15* [0·15]		0·13* [0·13]
	Family history of emotional problems (No = −1, Yes = 1)		0·03		−0·01
2	Set B				
	Dispositional characteristics ($m = 4$)	0·390*** [0·255]	(0·63)	0·273*** [0·123]	(0·53)
	Neuroticism (Short EPI)		0·43***		0·42***
	Extraversion (Short EPI)		−0·08		0·07
	Global personal hopefulness (HOPES)		−0·20*** [−0·30]		−0·12 [−0·24]
	Overall maturity of defences (DSQ-40)		−0·05 [−0·16]		0·01
3	Set C				
	Lifestyle and personal history ($m = 4$)	0·006 [0·017]	(0·10)	0·019* [0·032]	(0·16)
	Regular tobacco usage before quake (No = −1, Yes = 1)		0·03		0·06
	Regular alcohol usage before quake (No = −1, Yes = 1)		−0·06		−0·10
	History of emotional problems (No = −1, Yes = 1)		0·05		0·04
	Major life events during 6 months before quake (0–6)		0·05		0·10
4	Set D				
	Earthquake exposure ($m = 2$)	0·046*** [0·089]	(0·28)	0·069*** [0·123]	(0·32)
	Threat		0·17*** [0·24]		0·29*** [0·34]
	Disruption		0·24*** [0·28]		0·17*** [0·22]
5	Set E				
	Coping and support ($m = 4$)	0·032*** [0·058]	(0·25)	0·039*** [0·069]	(0·26)
	Active–cognitive strategy		−0·01		0·03
	Active–behavioural strategy		0·02		0·05
	Avoidance strategy		0·24*** [0·29]		0·24*** [0·29]
	Current social contacts		−0·01		−0·04
6	Set F				
	Recent events and disruptions ($m = 3$)	0·085*** [0·113]	(0·41)	0·029*** [0·047]	(0·23)
	Average life events score since quake (0–6)		0·18*** [0·21]		0·11 [0·14]
	Ongoing disruptions index score (0–5)		0·22*** [0·24]		0·15** [0·18]
	Average social relationships rating (1–5)		−0·25*** [−0·26]		−0·07
	Squared multiple correlation (R^2)	(0·584) [0·555]		(0·469) [0·436]	

Values are the increment in squared multiple correlation at each step (ΔR^2), and the partial correlations (*pr*) between the predictor and outcome variables; m = the number of predictor variables per step. Bonferroni-adjusted error rates were used in assessing the significance of ΔR^2 ($\kappa = 4$ dependent variables), with Scheffé follow-up tests as appropriate for individual predictor variables: * $P < 0{\cdot}05$; ** $P < 0{\cdot}01$; *** $P < 0{\cdot}001$. See Discussion for a description of the values in square brackets [ ].

was significant ($pr = -0{\cdot}13$, $P < 0{\cdot}05$). While the dispositional variables in Set B made a small contribution in each of these analyses, with ΔR^2 values of 0·031 ($P < 0{\cdot}05$) and 0·020 ($P < 0{\cdot}05$) respectively, none of the individual dispositional measures was significantly associated with the rate of change in morbidity.

Examination of selected interactions

To assess the extent to which there were synergistic relationships between the vulnerability and exposure factors, we undertook a separate set of hierarchical regression analyses using the predictor variables that were associated with both outcome measures (i.e. gender, neuroticism, threat and disruption exposure, usage of avoidance coping). Product variables representing the relevant two-, three- and four-way interactions were included at appropriate steps in the hierarchy (e.g. gender by neuroticism by threat exposure). In general, the interaction terms made a trivial contribution, with the two strongest interactions being: neuroticism by threat in the analysis of average GHQ-12 scores ($F_{(1,639)} = 8{\cdot}98$, $pr = 0{\cdot}12$, $P < 0{\cdot}05$); and neuroticism by avoidance coping in the analysis of average IES scores ($F_{(1,639)} = 11{\cdot}62$, $pr = 0{\cdot}13$, $P < 0{\cdot}01$). In short, the extent of the neuroticism effect on average GHQ-12 scores was more marked for those experiencing higher threat, while the extent of the neuroticism effect on average IES scores was more marked for those with higher usage of avoidance.

DISCUSSION

The tests for stability of the dispositional measures revealed small differences between occasions and moderately high correlations (Table 1), providing some justification for the inference that they were measures of trait characteristics. Nevertheless, the assumption that they are valid indicators of pre-earthquake characteristics can be criticized on the grounds that their measurement took place after the event and may have been influenced by it. In order to reduce the potential impact of such factors (and thereby 'measurement error'), all of the major analyses using the dispositional measures were based on average values for the two occasions of measurement.

The magnitude and direction of the associations between the dispositional measures (Table 2) suggests that each was measuring different but at least partially related trait characteristics. Neuroticism, which is related to trait anxiety (Nunn *et al.* 1996), is taken to indicate vulnerability to experience psychopathological symptoms, whereas GPH is regarded as a measure of positive expectations for the future and reflects resilience (Nunn *et al.* 1996). Overall maturity of defences is an index of the psychodynamic concept of ego defence mechanisms, which reflect cognitive and behavioural action patterns for dealing with stressors; it is also regarded as a resilience factor. In this context, it is worth noting that each dispositional measure correlated with avoidance coping strategies, themselves highly correlated with morbidity at phase 1 (Carr *et al.* 1995), and in directions consistent with their putative roles as vulnerability and resilience factors respectively. It is also of interest that overall maturity of defences correlated positively with the more adaptive, active–cognitive ($r = 0{\cdot}16$) and active–behavioural ($r = 0{\cdot}12$) coping strategies, indicating that the DSQ-40 may be more sensitive to the ways in which individuals respond to stressors.

The correlations between exposure to threat and both neuroticism and GPH (Table 2) are likely to reflect reporting or perceptual bias in the form of an increased tendency to report threat experiences. Alternatively, these traits may reflect a disposition to respond maladaptively to a stressor and thereby to recruit higher exposure (cf. Breslau *et al.* 1995). However, there were no significant correlations between the dispositional measures and exposure to initial disruption. Similarly, only neuroticism was correlated with ongoing disruptions. That there could have been a differential reporting bias for threat experiences should not be ruled out since the threat index (by definition) included several questions about the 'possibility' of danger (e.g. from falling objects, or being trapped), while the disruption index was based largely on the reporting of factual events. Ratings of exposure to non-earthquake related life events were correlated with three of the four dispositional measures (Table 2). Again, this may represent a reporting bias or, perhaps, evidence for a trait-related vulnerability to

experience certain types of (possibly, non-independent) adverse events (cf. Poulton & Andrews, 1992). Alternatively, as Fergusson & Horwood (1987) postulate, there may be a reciprocal relationship between life events and certain personality characteristics.

As predictors of post-disaster morbidity, the dispositional measures were clearly superior to all other predictors (Table 3). However, there were significant associations between morbidity and both gender and age. Being female appears to be a significant vulnerability factor for morbidity generally, which supports Weisaeth's (1989) and others' findings, whereas age may reflect greater vulnerability to post-traumatic stress. Of the dispositional measures, neuroticism clearly had the most predictive power, making an equal contribution to general and trauma-related morbidity, which is compatible with the view of neuroticism as a measure of proneness to psychopathological symptoms. The comparatively greater contribution of dispositional factors to the variance in GHQ-12 scores, and the absence of a contribution from either GPH or maturity of defences to IES scores, suggests that trauma-related morbidity is less influenced by pre-morbid vulnerability factors.

The relative absence of interactions between neuroticism and exposure, and the lack of associations between the dispositional measures and rates of change in morbidity, suggest that the dispositional measures made additive contributions to psychological morbidity. That is, they either raised the overall morbidity threshold (e.g. neuroticism) or lowered it (e.g. hopefulness), with other factors making their own independent contributions (e.g. exposure, ongoing disruptions, coping strategies).

Dispositional characteristics accounted for approximately eight times the variance in general psychological morbidity and about four times the variance in trauma-related morbidity than did initial exposure (Table 3). However, within the context of our hierarchical approach, initial exposure still made a significant contribution to psychological morbidity over the 2 years post-earthquake, that is, after the dispositional factors had been taken into account. In particular, exposure to threat made a larger contribution to trauma-related morbidity ($pr = 0{\cdot}29$) than did exposure to initial disruption ($pr = 0{\cdot}17$), whereas initial disruption made a greater contribution to general morbidity ($pr = 0{\cdot}24$) than did threat exposure ($pr = 0{\cdot}17$).

Even after background, dispositional and initial exposure factors were taken into account, significant contributions to morbidity were made by avoidance coping style and both life events and ongoing disruptions since the earthquake, which is consistent with McFarlane's (1989) findings. Avoidance coping contributed equally to general and trauma-related morbidity suggesting that this variable is not specific to the type of psychopathological response. Whereas only the experience of ongoing disruptions related to the earthquake made a significant contribution to post-traumatic morbidity, life events unrelated to the earthquake, poor social relationships and ongoing disruptions all made a significant contribution to general psychological morbidity (cf. Green & Berlin, 1987; McFarlane, 1988). This suggests that post-traumatic stress symptoms tend to be maintained by events which are related to the initial experience while general psychological morbidity is maintained by a wide range of factors. A note of caution is necessary since the social relationships and life events measures used here were of a primitive nature. The associations observed may have been somewhat different if more extensive instruments had been used.

Vulnerability factors may have direct and indirect influences on outcome. As an illustration, the importance of neuroticism in accounting for a large proportion of the explained variance in GHQ and IES scores could be explored by a number of strategies. First, the effects of neuroticism could either be ignored or partialled out, as if it were a 'nuisance' variable. Alternatively, neuroticism could be seen as having a direct impact on distress, irrespective of any stressor (Ormel & Wohlfarth, 1991). For example, high neuroticism could be associated with ongoing higher distress. A strategy of inclusion/exclusion of neuroticism should help to clarify this. Secondly, the role of neuroticism as a moderator in perception–outcome relations could be explored. In this case, the primary process from stressor to response is seen as appraisal (Lazarus & Folkman, 1984) and neuroticism merely acts to moderate or influence that process. A third approach could involve the

control of neuroticism as a basis for investigating its relevance to the relationships between other variables and measures of outcome (i.e. neuroticism as a mediator, the vehicle between stressor and response). Neuroticism might also form part of a positive feedback process since there is evidence that it is negatively related to the adequacy of coping with life stressors (McCrae & Costa, 1986). This interactive process is worthy of exploration given the importance of ongoing disruptions and life events in predicting the psychological morbidity levels found in our study.

Other formulations of the role of neuroticism are also possible. Duncan-Jones *et al.* (1990) concluded that 'what is measured by neuroticism may not be so much a "personality trait" but rather an account of the subject's stable or typical level of minor psychiatric symptoms' (p. 22). The association with minor psychiatric illness may be 'semi-tautologous: neuroticism is a measure of the subject's characteristic level of symptomatology and the subject's current level of symptoms will tend to reflect his/her characteristic level of symptoms'. In view of the possible confounding effects of having conceptually related predictor and outcome variables, we re-ran the regression analyses omitting neuroticism. Results for the statistically significant predictors in these analyses are shown in square brackets in Table 3. There was a reduction in the variance attributable to dispositional characteristics of 13·5% (i.e. 39·0% to 25·5%) in the GHQ-12 analysis but an overall reduction in explained variance of only 2·9%, with Sets D, E and F showing clear increases in their contribution. With regard to the individual predictors, the overall pattern of significance was similar to the original analysis but with GPH having the highest partial correlation ($pr = -0{\cdot}30$, $P < 0{\cdot}001$) and with overall maturity of defences also making a significant contribution ($pr = -0{\cdot}16$, $P < 0{\cdot}01$). In the corresponding IES analysis, there was also a marked reduction (15·0%) in the variance attributable to dispositional characteristics with only a small overall reduction (3·3%) in explained variance. The pattern of significance was similar to the original analysis (Table 3), however, GPH ($pr = -0{\cdot}24$, $P < 0{\cdot}001$) and recent life events ($pr = 0{\cdot}14$, $P < 0{\cdot}05$) made significant contributions to the prediction of average IES scores. The GPH finding provides further support for Nunn's (1996) claim that personal hopefulness is a useful general resilience factor.

If Duncan-Jones *et al.*'s (1990) formulation of neuroticism is correct then the findings in Table 3 (with neuroticism in Set B) may underestimate the contributions of non-dispositional influences to post-disaster psychological morbidity. For example, the original findings in Table 3 suggest that, on average, initial earthquake exposure contributed approximately 5·8% to the explained variance in typical post-disaster morbidity (i.e. across the GHQ-12 and IES), while more recent events and disruptions contributed, on average, an additional 5·7%. However, with neuroticism omitted from the equation, these values rise to 10·6% and 8·0% respectively. The role of personal hopefulness and avoidance coping strategies may have been similarly underestimated.

The alternative formulation of neuroticism described above poses a puzzle that clearly needs further resolution. On the one hand, neuroticism is an extremely useful substitute for a broad range of psychosocial factors. As reflected by the simple correlations in Table 1, neuroticism alone accounts for approximately 35% of the variance (i.e. r^2) in general morbidity and 24% of the variance in trauma-related morbidity. In each case, this represents more than half of the total explained variance (Table 3). On the other hand, neuroticism may well offer less insight into the paths between vulnerability factors, exposure and psychological response than other dispositional measures (e.g. GPH), since in the present study its omission resulted in only small reductions in overall explained variance. Thus, it appears that the direct path between neuroticism and post-disaster morbidity may be relatively weak, the overlap with characteristic symptomatology accounting for most of the observed associations.

It could also be argued that when neuroticism is excluded the obtained data fit well with an overall cognitive–behavioural formulation: threat exposure contributes more strongly to anxiety (IES); disruption exposure (loss) and secondary, (re-)exposure (i.e. ongoing disruptions and other events) contribute more to the development of depression (GHQ-12); and hopelessness and greater avoidance coping are associated with increased psychological distress.

In such a formulation, personal hopefulness and gender could be viewed as factors that provide input to and/or moderate the appraisal process, with coping strategies moderating the outputs from such an appraisal.

We postulated earlier (Carr *et al*. 1995), based on the findings of Weisaeth (1989), McFarlane (1989) and others, 'that in the Newcastle population maladaptive coping styles, such as avoidance, will be more important determinants of longer term outcome than the level of exposure'. In fact, the evidence points to relatively enduring contributions from both factors. In other words, initial exposure and usage of avoidance coping strategies continue to be important predictors of post-disaster response 2 years after the event, but additional weight needs to be given to ongoing disruptions and subsequent life events as well as to the pervasive influence of vulnerability factors such as level of personal hopefulness, gender and, possibly, neuroticism.

The research reported in this series of papers was undertaken with the support of the NSW Department of Health, the National Health and Medical Research Council and the University of Newcastle. We wish to thank the many organizations and individuals who assisted with the QIS, the residents of Newcastle and Ms Helen Rushworth for her invaluable contribution to data collection and processing.

REFERENCES

American Psychiatric Association (1994). *Diagnostic and Statistical Manual of Mental Disorders*, *4th edn*, *DSM-IV*. American Psychiatric Association: Washington, DC.

Andrews, G. (1991). Anxiety, personality and anxiety disorders. *International Review of Psychiatry* **3**, 293–302.

Andrews, G., Singh, M. & Bond, M. (1993). The Defense Style Questionnaire. *Journal of Nervous and Mental Disease* **181**, 246–256.

Billings, A. G. & Moos, R. H. (1981). The role of coping responses and social resources in attenuating the stress of life events. *Journal of Behavioral Medicine* **4**, 139–157.

Bolin, R. C. & Klenow, D. J. (1988). Older people in disaster: a comparison of black and white victims. *International Journal of Aging and Human Development* **26**, 29–43.

Breslau, N., Davis, G. C. & Andreski, P. (1995). Risk factors for PTSD-related traumatic events: a prospective analysis. *American Journal of Psychiatry* **152**, 529–535.

Carr, V. J., Lewin, T. J., Webster, R. A., Hazell, P. F., Kenardy, J. A. & Carter, G. L. (1995). Psychosocial sequelae of the 1989 Newcastle earthquake: I. Community disaster experiences and psychological morbidity 6 months post-disaster. *Psychological Medicine* **25**, 539–555.

Carr, V. J., Lewin, T. J., Webster, R. A., Kenardy, J. A., Hazell, P. L. & Carter, G. L. (1997). Psychosocial sequelae of the 1989 Newcastle earthquake: II. Exposure and morbidity profiles during the first 2 years post-disaster. *Psychological Medicine*, **27**, 167–178.

Dixon, W. J., Brown, M. B., Engelman, L., Hill, M. A. & Jennrich, R. I. (eds.) (1988). *BMDP Statistical Software Manual*, *Volumes 1 and 2*. University of California Press: Los Angeles.

Duncan-Jones, P. (1983). *Short Stable Measures of Extraversion and Neuroticism for the Australian General Population*. Social Psychiatry Research Unit, Australian National University: Canberra.

Duncan-Jones, P., Fergusson, D. M., Ormel, J. & Horwood, L. J. (1990). *A Model of Stability and Change in Minor Psychiatric Symptoms: Results from Three Longitudinal Studies*. *Psychological Medicine*, *Supplement* 18, Cambridge University Press: Cambridge.

Emery, V. O., Emery, P. E., Shama, D. K., Quiana, N. A. & Jassani, A. K. (1991). Predisposing variables in PTSD patients. *Journal of Traumatic Stress* **4**, 325–343.

Eysenck, H. J. & Eysenck, S. B. G. (1975). *Manual of the Eysenck Personality Questionnaire*. Hodder & Stoughton: London.

Fairbank, J. A., Hansen, D. J. & Fitterling, J. M. (1991). Patterns of appraisal and coping across different stressor conditions among former prisoners of war with and without posttraumatic stress disorder. *Journal of Consulting and Clinical Psychology* **59**, 274–281.

Freedy, J. R., Shaw, D. L., Jarell, M. P. & Master, C. R. (1992). Towards an understanding of the psychological impact of natural disasters: an application of the conservation resources stress model. *Journal of Traumatic Stress* **5**, 441–454.

Fergusson, D. M. & Horwood, L. J. (1987). Vulnerability to life events exposure. *Psychological Medicine* **17**, 739–749.

Gibbs, M. S. (1989). Factors in the victim that mediate between disaster and psychopathology: a review. *Journal of Traumatic Stress* **2**, 489–514.

Green, M. A. & Berlin, M. A. (1987). Five psychosocial variables related to the existence of post-traumatic stress disorder symptoms. *Journal of Clinical Psychology* **43**, 643–649.

Goldberg, D. P. (1972). *The Detection of Psychiatric Illness by Questionnaire*. Oxford University Press: London.

Horowitz, M., Wilner, N. & Alvarez, W. (1979). The Impact of Event Scale: a measure of subjective stress. *Psychosomatic Medicine* **41**, 209–218.

Jones, J. C. & Barlow, D. H. (1990). The etiology of posttraumatic stress disorder. *Clinical Psychology Review* **10**, 299–328.

Lazarus, R. S. & Folkman, S. (1984). *Stress*, *Appraisal*, *and Coping*. Springer: New York.

Lewis, A. (1942). Incidence of neurosis in England under war conditions. *Lancet* (August), 175–183.

McCrae, R. R. & Costa, P. T. (1986). Personality, coping and coping effectiveness in an adult sample. *Journal of Personality* **54**, 385–405.

McFarlane, A. C. (1988). The longitudinal course of posttraumatic morbidity: the range of outcomes and their predictors. *Journal of Nervous and Mental Disease* **176**, 30–39.

McFarlane, A. C. (1989). The aetiology of post-traumatic morbidity: predisposing, precipitating and perpetuating factors. *British Journal of Psychiatry* **154**, 221–228.

Nolen-Hoeksema, S. & Morrow, J. (1991). A prospective study of depression and post traumatic stress symptoms after a natural disaster: the 1989 Loma Prieta earthquake. *Journal of Personality and Social Psychology* **61**, 115–121.

Nunn, K. P. (1996). Personal hopefulness: a conceptual review of the relevance of the perceived future to psychiatry. *British Journal of Medical Psychology* **69**, 227–245.

Nunn, K. P., Lewin, T. J., Walton, J. M. & Carr, V. J. (1996). The construction and characteristics of an instrument to measure personal hopefulness. *Psychological Medicine* **26**, 531–545.

Ormel, J. & Wohlfarth, T. (1991). How neuroticism, long-term difficulties, and life situation change influence psychological distress: a longitudinal model. *Journal of Personality and Social Psychology* **60**, 744–755.

Phifer, J. F. (1990). Psychological stress and somatic symptoms after natural disaster: differential vulnerability among older adults. *Psychology and Aging* **5**, 412–420.

Poulton, R. G. & Andrews, G. (1992). Personality as a cause of adverse life events. *Acta Psychiatrica Scandinavica* **85**, 35–38.

Riggs, D. S., Dancu, C. V., Gershuny, B. S., Greenberg, D. & Foa, E. B. (1992). Anger and post-traumatic stress disorder in female crime victims. *Journal of Traumatic Stress* **5**, 613–625.

Schwarz, E. D., Kowalski, J. M., & McNally, R. J. (1993). Malignant memories: post-traumatic changes in memory in adults after a school shooting. *Journal of Traumatic Stress* **6**, 545–553.

Vaillant, G. E. (1971). Theoretical hierarchy of adaptive ego mechanisms: a 30-year follow-up of 30 men selected for psychological health. *Archives of General Psychiatry* **24**, 107–118.

Weisaeth, L. (1989). A study of behavioural responses to an industrial disaster. *Acta Psychiatrica Scandinavica Supplementum* **355**, 13–24.