# Psychological Responses to Outbreak of Severe Acute Respiratory Syndrome: A Prospective, Multiple Time-Point Study

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**ABSTRACT** This study examined anxiety and coping responses to the outbreak of severe acute respiratory syndrome (SARS) in Hong Kong. Trait anxiety, situation-specific coping strategies, and coping flexibility were proposed as predictors of state anxiety during the early phase of the SARS epidemic. Seven-two Hong Kong undergraduates (31 men, 41 women) participated in a prospective, multiple time-point study. Participants' trait anxiety and coping flexibility had been assessed in an earlier study. Five months later, they reported their anxiety and coping at each of the four time points during the outbreak. Results revealed fluctuations in state anxiety across time points. Results from hierarchical linear modeling showed that trait anxiety as well as the situation-appropriate coping

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The authors would like to thank Boris Choy, Chu-kwan Wong, Christina Tsang, Hoi-ying Kwong, and Rachel Wong for research assistance. Thanks also go to all participants, including those who took part in the elicitation studies, for their time and effort.

Preparation of this article was supported by Research Grants Council's Competitive Earmarked Research Grant HKUST6047/02H and Direct Allocation Grant DAG02/03.HSS10.

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*Journal of Personality* 73:1, February 2005

DOI: 10.1111/j.1467-6494.2004.00310.x

strategies of avoidance and personal hygiene practice accounted for changes in state anxiety.

> Psychological fear is more fearful than the disease [severe acute respiratory syndrome] itself.—
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> Zhong Nanshan, Director, Guangzhou Respiratory Research Centre, China (as cited in Liu, 2003)

In March 2003, an unknown kind of pneumonia began to plague the international community. The disease was termed severe acute respiratory syndrome (SARS) by the World Health Organization. SARS is possibly caused by a new coronavirus rather than by bacteria, the cause of common pneumonia (Drosten et al., 2003; Ksiazek et al., 2003; Parry, 2003). More than 8400 people in the world have been infected by SARS, and more than 800 have died (World Health Organization, 2003). Hong Kong has had the second highest number of probable cases of SARS. This study examined how people in Hong Kong responded to the SARS epidemic.

## Hong Kong Residents' Reactions to SARS Outbreak

To cope with the SARS epidemic, the Department of Health of Hong Kong launched a publicity campaign to inform the public about the disease. Apart from providing information about SARS, the campaign also included dissemination of precautionary measures, such as urging people to wear face masks, to pay more attention to personal hygiene, and to enhance their physical well-being. Hong Kong residents began to adopt some of these precautionary measures. The most common ones included wearing face masks in the street and at work, seeking information and monitoring up-to-date news about SARS, and avoiding crowded areas (see Cheng, 2004).

Despite the seemingly widespread anxious response to SARS, not everyone experienced the same extent of anxiety (see Cheng, 2004; Cheng & Tang, 2004). Population surveys (Chow, 2003; Lam et al., 2003; Tang & Wong, 2003) showed that about 70% of respondents in Hong Kong expressed concerns about the SARS outbreak. However, only half of the respondents worried that they might be infected by SARS (Tang & Wong, 2003). There were also individual

differences in coping responses to prevent a SARS infection. Around 20% of respondents reported that they would avoid going to shopping malls, and about the same percentage reported that they would dine out less often (Chow, 2003). Approximately 30% of the respondents reported that they would adopt the preventive measures recommended by the Department of Health (e.g., wearing face masks, cleansing hands after sneezing). About 80% of the respondents thought that face masks were unnecessary, and 15% said that they would not wear a mask under any circumstances.

Apart from individual differences in anxiety and coping responses, it is also important to note the *changes* in coping responses over time. The survey findings mentioned above showed that less than 30% of respondents adopted the preventive measures recommended by the Department of Health. Most of them did not wear a face mask. It is noteworthy that these surveys were conducted in the period between March 17 and March 22, that is, before the occurrence of a mass infection at a housing estate in Hong Kong on March 28. As shown in another population survey conducted between March 29 and April 2 (Lam et al., 2003), immediately after the mass infection was reported, around 90% of respondents reported that they had adopted the preventive measures, and almost all the respondents (98%) reported having worn a face mask. About 50% of the respondents reported that they dined out less often.

Three interesting conclusions can be drawn from these survey findings. First, although people may be facing the same dread and unknown health risk, not all of them experience the same extent of anxiety or adopt the same number of coping strategies. Considerable individual differences in anxiety and coping responses are seen. Second, although individual differences in anxiety and coping responses can be major in certain circumstances, they can also be minimal in others (e.g., after the mass infection). Third, survey findings obtained at different time points showed that coping responses may change drastically after the occurrence of certain critical events, thus indicating that coping responses can fluctuate across situations and over time.

Because the aforementioned surveys are cross-sectional in design, a number of questions remained unanswered, including the following: Can people's anxiety be predicted by certain stable personality characteristics? Which situation-driven responses influence changes in anxiety over time? Can existing theories of anxiety

and coping account for people's reactions in a real-life public health crisis? The present study was conducted to address these unexplored issues.

## Theoretical Perspectives in Explicating Individual Differences in Anxiety

The state-trait approach is a major theoretical perspective on anxiety. This approach has a significant impact on anxiety research (e.g., Anton & Klisch, 1995; Gupta, 1989). In the state-trait theories of anxiety (Cattell, 1963; Spielberger, 1972), anxiety is conceptualized as a complex construct that comprises both a transitory state and a personality trait. The transitory state, or as it is more commonly termed, *state anxiety*, refers to a condition that varies in strength over time. State anxiety is evoked in situations perceived by individuals as threatening. The amount of state anxiety experienced is a function of the extent of perceived threat. The personality trait, or as it is more commonly termed, *trait anxiety*, refers to individual differences in proneness to experience state anxiety in threatening situations. Such anxiety-proneness is relatively stable over time. The state-trait theories of anxiety related individual differences in anxiety to personality dispositions. Trait anxiety is proposed as a predictor of state anxiety. Compared to individuals lower in trait anxiety, individuals higher in trait anxiety are speculated to experience greater state anxiety in threatening situations.

Although threatening situations elicit anxiety among most individuals, the heightened anxiety levels may remain high for some but subside for others. The construct of coping has been considered an important mediator that accounts for the stress-anxiety relationship (e.g., Folkman & Lazarus, 1988; Krohne, 1986). In the transaction theory of coping (Lazarus & Folkman, 1984), coping is considered as an ongoing process that occurs within the interface of changing personal and situational demands. Coping is conceptualized as a state-like, situation-specific response for meeting the unique demands of distinct stressful situations. This theory provides a detailed account of how individuals change their behaviors when handling different types of situations. Situation-specific coping is proposed to play a role in mitigating anxiety in the coping process.

Individuals may attempt to master a stressful event, but their coping efforts are not necessarily effective in mitigating anxiety.

Lazarus and Folkman (1984) put forward a goodness-of-fit hypothesis in their theory to explain coping efficacy. Effective coping involves a good "fit" or match between situational characteristics and the nature of coping strategies. Individuals who deploy coping strategies that meet specific situational demands are said to experience adaptive outcomes in stressful encounters. Because the environment is ever changing, the construct of coping flexibility (see e.g., Cheng, 2003; Watanabe, Iwanaga, & Ozeki, 2002) was proposed to reflect situation-appropriate coping in changing times. Coping flexibility is conceptualized as the ability to distinguish among different situations and to switch strategies to meet changing situational demands (see e.g., Cheng, 2001; Schwartz & Daltroy, 1999). The construct has been found to be inversely related to anxiety (e.g., Kaluza, 2000; Lester, Smart, & Baum, 1994; Mattlin, Wethington, & Kessler, 1990; Watanabe et al., 2002). Individuals who are more flexible in coping, compared to those who are less flexible in coping, tend to experience less anxiety across stressful situations.

To sum up, a review of the literature on anxiety and coping reveals that three types of variables may predict individual differences in state anxiety: trait anxiety, situation-specific coping strategies, and coping flexibility.

## Overview of the Study

The present study was set in the context of the SARS outbreak in Hong Kong between March 17 and April 13, 2003. This unknown disease aroused considerable uncertainties and instabilities within this period, during which the mood of Hong Kong citizens swayed and their behaviors changed drastically (see Cheng, 2004). Table 1 summarizes the critical incidents that occurred during this period.

At Time 1 of this study, there was little information about the source, causal agents, and available treatment methods for the disease. People had no idea what the disease was and how to cope with it. Such ambiguities may have given rise to considerable individual differences in feelings toward the disease and ways of preventing it. At Time 2, a mass infection had broken out in a housing estate at almost the same time. A person with chronic renal disease, believed to be the "superspreader," spread the disease to hundreds of residents in a building block. The nature of the ambiguous, stressful context quickly turned into an imminent danger. Alarmed by mass

**Table 1**
Summary of Stressful Events During the SARS Outbreak in Hong Kong During the Study Period

| Period | Critical Event in the Period | Number of New Cases (Number of Deaths) |
|---|---|---|
| Pre-study period (March 4–March 16, 2003) | A man dies of SARS in a hospital. Patients and healthcare workers are infected in another hospital in which the man's relative is staying. | 42 (1) |
| Time 1: *Initial community transmission* (March 17–23, 2003) | SARS spreads to family members of infected healthcare workers. The government confirms initial signs of community transmission. | 198 (7) |
| Time 2: *Mass infection* (March 24–30, 2003) | A mass infection occurs in a housing estate. Long queues of people buying face masks, disinfectants, and vitamin pills can be seen almost everywhere. | 290 (4) |
| Time 3: *Bogus news* (March 31–April 6, 2003) | A hoaxer creates a bogus news item that Hong Kong will be declared an infected region in a few hours. Many people rush to buy necessities in stores. | 312 (9) |
| Time 4: *Soaring number of deaths* (April 7–13, 2003) | The number of new death cases doubles that of the past week. In addition to the elderly and those with long-term illnesses, death cases are found among younger healthy adults (age $<40$). | 308 (18) |

infection in the community, people were almost unanimous in actively adopting coping strategies to avoid contracting SARS. At Time 3, a hoaxer further aroused panic by hijacking the design of a major newspaper Web site. The hoaxer posted a bogus news item that Hong Kong would soon be declared an infected region and be sealed off from the rest of the world. Such a rumor quickly spread around the city, causing panic-stricken people to mob stores to buy necessities. While the influence of this anxiety-arousing rumor was attenuated, another anxiety-provoking event emerged shortly after that. At Time 4, the number of death cases had grown rapidly. Within the week, death cases were reported every day, the highest being five for a particular day. Deaths were no longer confined to the elderly and people with serious illnesses, but also involved healthy young adults, thus further adding to the mystery of SARS.

One major aim of this study was to examine possible changes in state anxiety across the four time points. Another aim was to examine trait anxiety, coping flexibility, and situation-specific coping as predictors of changes in state anxiety over time. A prospective design was adopted for this study. Five months before this study, the trait anxiety and coping flexibility of a sample of Hong Kong undergraduates were assessed. Their previously measured trait anxiety and coping flexibility served as predictors in the present study. These participants were invited to take part in this 4-week study, in which their anxiety states and situation-specific coping responses were assessed at each of the four time points. In short, a prospective, multiple time-point study was designed to examine whether trait anxiety, coping flexibility, and situation-specific coping are predictors of fluctuations in state anxiety in a real-life stressful context.

## METHOD

### Participants

Participants were 72 (31 men, 41 women) Chinese undergraduates. The age of the participants ranged from 19 to 24 years, with an average age of 21.14 years ($SD = .99$). The present sample was recruited from a group of participants (94 undergraduates) who completed some relevant measures in October 2002. In mid-March 2003, an invitation to participate in a 4-week study on SARS was sent to this group by e-mail. Seventy-nine indicated interest (acceptance rate: 84%) and were invited to take part. They were paid 100 Hong Kong dollars (about $US12) for their

participation. Participants who participated in this study and those who refused did not differ significantly in trait anxiety and coping flexibility, $F(2, 91) = .32$, $p = .73$.

## Measures

*Trait and state anxiety*. The State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970) was used to assess trait anxiety and state anxiety, respectively. The STAI comprises two separate 20-item scales. The trait scale taps the extent of anxiety that respondents generally feel. The state scale taps the extent of anxiety respondents feel at a particular time point. Both the trait and the state scores range from 20 to 80, with a higher score indicating a higher anxiety level. The Chinese version of the STAI is both reliable and valid (Shek, 1988; Ye, 1990).

*Coping flexibility*. Coping flexibility was measured by the Coping Flexibility Inventory (CFI; Cheng, 2004), which is a situation-based measure assessing respondents' ability to discriminate among stressful events with distinct extents of controllability (i.e., cognitive flexibility) and to deploy different strategies to meet distinct situational demands (i.e., response flexibility; cf. Cheng, 2001). Hypothetical stressful situations are commonly adopted in measures of coping flexibility for between-participants comparisons (e.g., Lester et al., 1994; Schwartz, Peng, Lester, Daltroy, & Goldberger, 1998). The CFI comprises eight hypothetical situations constructed on theoretical and empirical grounds. Four of the stressful situations are controllable events whose outcomes can be changed by one's ability or effort, whereas the other four are uncontrollable events whose outcomes cannot be changed by one's ability or effort.

In each situation, participants were asked to vividly imagine themselves encountering the situation. Their task was to decide whether they would employ primary-approach coping (e.g., problem-solving) or secondary-approach coping (e.g., acceptance) to handle the situation. The coping items of the CFI were selected from a pool of coping items derived from existing coping measures and generated by participants in pilot studies. The selection criteria included: (a) nonsignificant correlations with social desirability scores and (b) power to distinguish high scorers from low scorers of coping flexibility assessed by a well-established questionnaire of

coping flexibility (Cheng, 2001). The primary approach coping and the secondary approach coping subscales of the CFI exhibit adequate internal consistencies (Cronbach's alphas = .69 and .77).

The coping flexibility score, which indicates the appropriate use of coping strategies, is based on the goodness-of-fit hypothesis (Lazarus & Folkman, 1984), which received support from a number of coping studies (e.g., Park, Folkman, & Bostrom, 2002; Roussi, 2002; Sorgen & Manne, 2002; Zakowski, Hall, Cousino Klein, & Baum, 2001). According to this hypothesis, a good strategy-situation fit involves the use of primary-approach coping in controllable situations and the use of secondary-approach coping in uncontrollable situations. The item scores derived from endorsement of a coping strategy that does not match the goodness-of-fit hypothesis were reversely scored. A higher coping flexibility score indicates a greater extent of situation-appropriate coping.

The coping flexibility score was found to be inversely related to preference for consistency and positively related to need for cognition, thus providing evidence for the convergent validity of the CFI. Its discriminant validity was indicated by the nonsignificant relationships between coping flexibility score and conceptually unrelated constructs: social desirability and self-monitoring. The coping flexibility score was inversely associated with anxiety and depression but positively associated with quality of life, thus providing evidence for the criterion-related validity of the measure. Although the CFI comprises hypothetical situations, the coping flexibility score derived from this measure was strongly correlated with the coping flexibility score derived from an open-ended measure that taps participants' actual coping with real-life stressful situations (see Cheng, 2001). Specifically, participants who had a high coping flexibility score were found to vary their use of different coping strategies to meet distinct situational demands in a real-life stressful encounter, thus providing evidence for the ecological validity of the CFI.

*Situation-specific coping strategies.* In this study, a measure assessing strategies for coping with SARS was created, based on an elicitation study (see Cheng & Ng, in press for details) with 98 Hong Kong university students and a number of health department Web sites (i.e., American Centers for Disease Control and Prevention, Department of Health of Hong Kong, Health Canada, and Ministry

of Health of Singapore). In the elicitation study, participants were instructed to report all the strategies they had used to cope with the SARS outbreak. Participants in the elicitation study did not overlap with those in this study. To minimize nil responses, 15 frequently endorsed items (see below) were selected from the item pool and included in the final measure.

To examine the factor structure of this measure, exploratory factor analysis was performed on the 15 items reported by the elicitation sample. Varimax rotation yielded a 4-factor solution. The first factor, *personal hygiene practice*, comprised five items: (a) wear a face mask, (b) wash hands with soap before eating, (c) wash hands after sneezing, coughing, or cleaning the nose, (d) wash clothes immediately after going out, and (e) clean the house with disinfectant or a diluted bleach. The second factor, *lifestyle habits*, consisted of four items: (a) eat a nutritious diet, (b) exercise regularly, (c) get an adequate amount of sleep and rest, and (d) watch, listen to, or read news reports. The third factor, *information seeking,* includes two items: (a) seek information/advice from health professionals, and (b) search for information over the Internet. The fourth factor, *avoidance,* comprises four items: (a) avoid going out to eat, (b) avoid going shopping, (c) avoid shaking hands with people, and (d) avoid meeting people who cough, sneeze, or have just been back from a SARS-infected region. This 4-factor solution was considered to be optimal based on three criteria: variance accounted for (i.e., 64%), interpretability, and simple structure. All these coping subscales are internally consistent (Cronbach's alphas = .73, .64, .63, and .77, respectively). The intercorrelations among the coping strategies over time were low (i.e., all the absolute values of the correlations $<.25$). Thus, these four coping strategies can be considered as orthogonal.

Participants in the main study rated the frequency of adopting each strategy for the past week along a 5-point Likert scale (0 = *never*, 1 = *1 to 2 days*, 2 = *3 to 4 days*, 3 = *5 to 6 days*, 4 = *every day*). The item ratings were summed to create a composite score for each coping factor. Because the number of items for the coping factors was different, the composite scores were adjusted so that they all ranged from 0 to 20 for ease of comparison. Specifically, the composite scores of both lifestyle habits and avoidance were multiplied by 1.25, and that of information seeking was multiplied by 2.50.

### Procedures

Participants were given four sets of questionnaires (assessing state anxiety and situation-specific coping) to be completed at home. At the end of each time point (i.e., March 24, March 31, April 7, and April 14, respectively), they were instructed to fill in each questionnaire set and return it with a stamped, self-addressed envelope. A research assistant called them to remind them to complete the questionnaire set and mail it back each week. A check and a debrief note were mailed to participants on completion of the tasks for the four time points. Eleven participants failed to return the questionnaire on time during the study period. There were no statistically significant differences in any of the trait and state measures between participants who submitted all the questionnaires on time and those who failed to submit some of the questionnaires on time, $F(22, 49) = .96$, $p = .52$. Seven participants dropped out of this study. Their trait anxiety and coping flexibility scores did not differ from the scores of those who completed all the tasks, $F(2, 76) = .17$, $p = .84$. A dummy variable of dropout (with 1 and 0 denoting participants who dropped out and those who completed the study, respectively) was included in the analysis. Results revealed that the dummy variable was nonsignificant in predicting the initial status, linear change, and quadratic change (all $ps > .10$). The patterns of changes over time on the situation-specific measures were similar for these two groups of participants.

## RESULTS

This study aimed to examine participants' (a) anxiety and coping responses at each time point, (b) changes in their anxiety and coping responses over time, and (c) trait anxiety, coping flexibility, and situation-specific coping as predictors of anxiety experienced at each time point.

Before examining these issues, the overall gender effect on all the variables was first examined by multivariate analysis of variance. The effect of gender was nonsignificant, $F(30, 41) = 1.28$, $p = .23$. All the analyses were conducted based on the pooled sample. Table 2 shows the descriptive statistics of all the variables for the four time points.

### Individual Growth Model Analyses

Hierarchical linear modeling (HLM; Raudenbush, Bryk, Cheong, & Congdon, 2001) was performed to test the individual growth model,

**Table 2**
Descriptive Statistics of Major Variables at Various Time Points ($N = 72$)

| Time and variable | Mean | *SD* |
|---|---|---|
| Prior study (October 2002) | | |
| Trait anxiety | 45.24 | 14.62 |
| Coping flexibility | 90.68 | 6.91 |
| Time 1 (March 17–23, 2003) | | |
| State anxiety | 39.26 | 13.69 |
| Personal hygiene practice | 6.42 | 4.66 |
| Lifestyle habits | 9.97 | 4.48 |
| Information seeking | 14.08 | 5.45 |
| Avoidance | 4.15 | 2.42 |
| Time 2 (March 24–30, 2003) | | |
| State anxiety | 52.92 | 10.51 |
| Personal hygiene practice | 12.14 | 3.79 |
| Lifestyle habits | 10.54 | 4.25 |
| Information seeking | 9.19 | 3.20 |
| Avoidance | 13.00 | 4.17 |
| Time 3 (March 31–April 6, 2003) | | |
| State anxiety | 52.11 | 14.06 |
| Personal hygiene practice | 14.35 | 4.18 |
| Lifestyle habits | 10.21 | 4.03 |
| Information seeking | 7.13 | 4.07 |
| Avoidance | 12.78 | 3.77 |
| Time 4 (April 7–13, 2003) | | |
| State anxiety | 49.54 | 11.57 |
| Personal hygiene practice | 10.58 | 4.28 |
| Lifestyle habits | 10.10 | 4.13 |
| Information seeking | 6.13 | 2.37 |
| Avoidance | 13.01 | 4.14 |

which is an integrated approach for studying repeatedly measured data. We used HLM because this statistical procedure can unveil how time-invariant predictors (i.e., trait anxiety and coping flexibility) and time-varying predictors (i.e., personal hygiene practice, lifestyle habit, avoidance, and information seeking) are related to state anxiety over time.

HLM individual growth models are typically conceptualized as two-level models. Within-participant or level-1 model is the model for repeated measures with time-varying predictors within

individuals, whereas a between-participant or level-2 model is the model for the time-invariant predictors across individuals (see e.g., Tate & Hokanson, 1993 for details). We have formulated three HLM individual growth models to test the hypotheses of this study.

*Unconditional model.* The unconditional model is the baseline model that does not contain any predictors. It is also known as the random effects ANOVA model. The model specification is:

Level 1:

$$Sanx_{it} = \pi_{0i} + r_{it} \tag{1}$$

Level 2:

$$\pi_{0i} = \beta_{00} + U_{0i}.$$

The above two equations specify the HLM model for state anxiety (*Sanx*) for the *i*th participant in the *t*th measurement occasion. Because this study comprised four measurement occasions, we took $t = 0$, 1, 2, and 3 for ease of interpretation (Raudenbush & Bryk, 2002). $\beta_{00}$ refers to the fixed effects intercept representing the average score of state anxiety across all occasions, whereas $r_{it}$ and $U_{0i}$ refer to the level-1 random error and the level-2 random effects, respectively.

*Linear and quadratic growth models.* Linear and quadratic models are frequently used in longitudinal studies. By comparing these two models against the baseline model, we can examine whether the linear model or the quadratic model is required to fit the present data. The model specification for the quadratic growth model is:

Level 1:

$$Sanx_{it} = \pi_{0i} + \pi_{1i}(Time_{it}) + \pi_{2i}(Time_{it})^2 + r_{it} \tag{2}$$

Level 2:

$$\pi_{0i} = \beta_{00} + U_{0i}$$

$$\pi_{1i} = \beta_{10} + U_{1i}$$

$$\pi_{2i} = \beta_{20} + U_{2i}.$$

The terms $Time_{it}$ (where $Time_{it} = 0$, 1, 2 and 3) and $(Time_{it})^2$ specify the linear and the quadratic changes for state anxiety. The terms $\pi_{0i}$,

$\pi_{1i}$ and $\pi_{2i}$ refer to the initial status of state anxiety (i.e., the level of state anxiety at the initial time point) as well as rates of linear changes and rates of quadratic changes over time at the following time points. By including the random terms (i.e., $U_{0i}$, $U_{1i}$ and $U_{2i}$), we allow individuals to have different initial status as well as different rates of linear and quadratic changes.

*Individual growth model with time-invariant and time-varying predictors.* Another advantage of the HLM rests on its inclusion of both time-invariant and time-varying predictors within a single model. The model specification for the individual growth model is:

Level 1:

$$Sanx_{it} = \pi_{0i} + \pi_{1i}(Time_{it}) + \pi_{2i}(Time_{it})^2 + \pi_{3i}PHP_{it} + \pi_{4i}LH_{it} + \pi_{5i}IS_{it} + \pi_{6i}AV_{it} + r_{it} \quad (3)$$

Level 2:

$$\pi_{0i} = \beta_{00} + \beta_{01}Tanx + \beta_{02}Copeflex + U_{0i}$$

$$\pi_{1i} = \beta_{01} + \beta_{11}Tanx + \beta_{12}Copeflex + U_{1i}$$

$$\pi_{2i} = \beta_{20} + \beta_{21}Tanx + \beta_{22}Copeflex + U_{2i}$$

$$\pi_{3i} = \beta_{30}$$

$$\pi_{4i} = \beta_{40}$$

$$\pi_{5i} = \beta_{50}$$

$$\pi_{6i} = \beta_{60}.$$

In this model, three features are noteworthy. First, personal hygiene practice (*PHP*), lifestyle habit (*LH*), information seeking (*IS*), and avoidance (*AV*) are the time-varying predictors for state anxiety in the model. These time-varying variables are hypothesized as the

predictors for state anxiety at the same time frame. Second, trait anxiety (*Tanx*) and coping flexibility (*Copeflex*) are proposed as the predictors for the initial status of state anxiety ($\pi_{0i}$), the linear change ($\pi_{1i}$) and the quadratic change ($\pi_{2i}$) of state anxiety. In other words, we are testing whether trait anxiety and coping flexibility are moderators for the initial status, linear change, and quadratic change of state anxiety. Third, random terms for the time-varying predictors are not included because it is not possible to estimate all the random components in this model.

## Results of the HLM

By fitting the unconditional model in Equation 1, the intraclass correlation was .20. This result indicates that 20% of the variance in state anxiety over time was attributable to *interindividual* differences, whereas 80% of the variance was attributable to *intra-individual* differences across time points. Such a result indicates that the state anxiety reported by participants varied across the 4-week period.

In order to investigate the change of state anxiety over time, the linear and the quadratic growth models in Equation 2 were fitted. The test statistic for the linear model against the baseline model was $\chi^2(3) = 24.07$, $p < .001$, whereas the test statistic for the quadratic model against the linear model was $\chi^2(4) = 40.78$, $p < .001$. The results showed that both linear and quadratic changes are required to capture the changes in state anxiety over time. We thus conducted further analyses based on the quadratic model.

We fit the individual growth model with time-invariant and time-varying predictors in Equation 3. Results revealed that the individual growth model had a better fit of data than the model in Equation 2 with $\chi^2(8) = 38.27$, $p < .0001$. Such a result suggests that adding the time-invariant and time-varying predictors could improve the prediction of state anxiety. We conducted analyses on alternative covariance structures to identify the model that provided the best fit of the present data (see Raudenbush, 2002). We fitted three widely used models in longitudinal research: (a) the homogeneous level-1 variance model, which assumes that the covariance structure of state anxiety over time is based on the variance components and homogeneous level-1 variance; (b) the first-order autoregressive or AR(1) model, which assumes that the error structure correlates with the prior wave of error structure only; and (c) the unrestricted model, which specifies

the error structure as any positive definite matrix. Results revealed that the unrestricted model provided a better fit of data than did the homogeneous level-1 variance model [$\chi^2(3) = 12.79$, $p = .005$] and the AR(1) model [$\chi^2(2) = 10.56$, $p = .005$]. Thus, we reported results drawn from the unrestricted model only.

Table 3 shows the parameter estimates of the individual growth model with an unrestricted error structure. To examine the effects of individual variables, we refer to the parameter estimates in Table 3.

Several interesting findings regarding the individual growth model were obtained. As shown in Table 3, both linear and quadratic changes ($\hat{\beta}_{10}$ and $\hat{\beta}_{20}$) were significant, indicating that the quadratic change of state anxiety was present after the effects of all the other variables had been controlled. The parameter estimate for the linear change was positive, but that for the quadratic change was negative. These findings indicate that despite the general trend of increase in state anxiety over time, state anxiety tended to first increase sharply and then drop gradually at subsequent time points.

Trait anxiety was significant in predicting the initial status ($\hat{\beta}_{01}$), linear change ($\hat{\beta}_{11}$), and quadratic change ($\hat{\beta}_{21}$) of state anxiety. Participants with higher levels of trait anxiety tended to report higher initial state anxiety. However, trait anxiety was also inversely correlated with the linear change.

Coping flexibility was nonsignificant in predicting the initial status of state anxiety ($\hat{\beta}_{02}$). Moreover, coping flexibility did not predict the linear and the quadratic changes of state anxiety.

For the time-varying predictors, the coping strategy of personal hygiene practice ($\hat{\beta}_{30}$) and avoidance ($\hat{\beta}_{60}$) were statistically significant. These results suggest that participants reporting greater use of avoidance and less personal hygiene practice tended to report lower state anxiety over time.

## DISCUSSION

This study adopted a prospective, multiple time-point design to examine changes in anxiety responses to the SARS outbreak in Hong Kong. During the 4-week study period, participants' anxiety responses fluctuated. Trait anxiety was found to predict such fluctuations across time points. Consistent with the prediction of the state-trait theories of anxiety, trait anxiety assessed 5 months previously could predict initial levels of state anxiety. However, the

**Table 3**
Parameter Estimates of Fixed and Random Effects of the Individual Growth Model

| | Estimate | Standard error | $t$ | $p$ |
|---|---|---|---|---|
| | | Fixed effects | | |
| Initial status ($\pi_{0i}$) | | | | |
| Constant ($\hat{\beta}_{00}$) | 39.16 | 1.95 | 20.10 | $<.001$ |
| Trait anxiety ($\hat{\beta}_{01}$) | 0.28 | 0.10 | 2.74 | .007 |
| Coping flexibility ($\hat{\beta}_{02}$) | − 0.36 | 0.22 | − 1.68 | .093 |
| Linear change ($\pi_{1i}$) | | | | |
| Constant ($\hat{\beta}_{10}$) | 18.74 | 2.90 | 6.47 | $<.001$ |
| Trait anxiety ($\hat{\beta}_{11}$) | − 0.37 | 0.14 | − 2.63 | .009 |
| Coping flexibility ($\hat{\beta}_{12}$) | − 0.04 | 0.30 | − 0.14 | .89 |
| Quadratic change ($\pi_{2i}$) | | | | |
| Constant ($\hat{\beta}_{20}$) | − 5.12 | 0.81 | − 6.31 | $<.001$ |
| Trait anxiety ($\hat{\beta}_{21}$) | 0.10 | 0.04 | 2.35 | .019 |
| Coping flexibility ($\hat{\beta}_{22}$) | − 0.01 | 0.09 | − 0.10 | .925 |
| Personal Hygiene Practice ($\pi_{3i}$) | | | | |
| Constant ($\hat{\beta}_{30}$) | 0.33 | 0.15 | 2.23 | .026 |
| Lifestyle Habits ($\pi_{4i}$) | | | | |
| Constant ($\hat{\beta}_{40}$) | − 0.16 | 0.14 | − 1.15 | .253 |
| Information Seeking ($\pi_{5i}$) | | | | |
| Constant ($\hat{\beta}_{50}$) | − 0.14 | 0.16 | − 0.88 | .38 |
| Avoidance ($\pi_{6i}$) | | | | |
| Constant ($\hat{\beta}_{60}$) | − 0.57 | 0.16 | − 3.62 | .001 |

| | Correlation structure | | | |
|---|---|---|---|---|
| | Time 1 | Time 2 | Time 3 | Time 4 |
| Time 1 | (154.65) | | | |
| Time 2 | .30 | (84.54) | | |
| Time 3 | .27 | .31 | (181.71) | |
| Time 4 | .20 | .13 | − .03 | (106.31) |

*Note*. Values in parentheses denote variances.

positive association between trait and state anxiety was only present at the initial time points. Individual differences in state anxiety became minimal at subsequent time points.

Such changes in the predictive role of trait anxiety over time may be attributable to the changing nature of the threatening event. At

the outset of the outbreak, panic and fear among the public arose from the many obscurities surrounding the disease, such as its source, causal agent, means of transmission, and ways of treatment. At this stage of ambiguity, individuals higher in trait anxiety may have been more likely to interpret the event as highly threatening and to have experienced higher levels of anxiety than those lower in trait anxiety. Such a notion stems from Beck's (1976) cognitive theory of anxiety. This theory posits that individuals with heightened anxiety are characterized by an interpretative bias, which facilitates threat-laden construal of ambiguous events. A number of studies (e.g., Calvo, Eysenck, & Castillo, 1997; Hadwin, Frost, French, & Richards, 1997; MacLeod & Cohen, 1993; Mathews & Mackintosh, 2000) have provided support to this postulation by showing that individuals with heightened trait anxiety tend to endorse a threatening interpretation of an ambiguous situation than do their counterparts lower in trait anxiety. In light of this theory, the fear and worries generated by SARS were probably due to its ambiguity and novelty. As shown in a population survey (Lam et al., 2003), about 10% of the Hong Kong respondents believed that the probability of themselves having a SARS infection was greater that that of their contracting influenza or the common cold. Such a finding suggests the presence of interpretation bias among some of the public. After the probable causal agent (i.e., coronavirus) and potential treatment methods (e.g., corticosteroids and ribavirin) of SARS were identified at the end of March (see Nie, Luo, & Hui, 2003; Peiris et al., 2003; So et al., 2003), the ambiguity of the disease may have diminished and the predictive role of trait anxiety may have been weakened.

Apart from trait anxiety, situation-specific coping strategies of personal hygiene practice and avoidance were also found to predict fluctuations in state anxiety over the 4-week period. Compared to lifestyle habits and information seeking, the results showed that personal hygiene practice and avoidance played a stronger role in explaining state anxiety. The avoidance strategies used by participants to handle the SARS outbreak can be categorized as avoidant coping, which is a major type of coping strategy (see Roth & Cohen, 1986). In the coping literature, avoidant coping refers to attempts to escape from the stressful event (see Roth & Cohen, 1986). The present results showed that individuals who used more avoidance tended to experience less state anxiety during the study period. Such results may be explained by the issue of control in the study of contextual coping (see e.g.,

Lefcourt, 1992 for an overview). To elaborate, if the outcome of a stressful event is controllable or changeable, it will be more adaptive in altering the specific aspect of the person-environment relationship causing the anxiety. For a stressful event whose outcome is beyond one's control, however, it seems maladaptive to engage in futile attempts to do something to solve the uncontrollable problem. Hence, the adaptiveness of avoidant strategies, as revealed in this study, suggests that the SARS outbreak was largely an uncontrollable stressful event. The novel, unknown characteristics of the SARS virus posed challenges to healthcare professionals and perplexed the government and health authorities around the world. Not knowing how to cope with this unknown, but life-threatening, disease, individuals may have adopted avoidant strategies to prevent themselves from contracting SARS from other people or in public areas. Adopting such strategies may have functioned to ease their anxiety during the outbreak.

Although an inverse relationship has been found between avoidance and state anxiety, personal hygiene practice was found to be positively associated with state anxiety. The greater use of this strategy elicited greater state anxiety among Hong Kong people. Personal hygiene practice was endorsed as a preventive measure in the publicity campaigns organized by the Department of Health of Hong Kong. After these measures had been extensively publicized, the frequency of practice of personal hygiene increased (see Lam et al., 2003; Tang & Wong, 2003). The present findings suggest that adoption of such preventive measures may elicit greater anxiety while the use of more avoidant coping may mitigate anxiety. However, it is also likely that those who are more anxious may adopt more preventive measures and less avoidance. Additional analyses using coping strategies as the dependent variables were conducted with trait anxiety and coping styles as level-2 predictors. Results revealed that coping flexibility was also significant in predicting the initial status, linear change, and quadratic change of personal hygiene practice. Specifically, people with higher levels of coping flexibility tended to increase their practice of personal hygiene at the beginning of the outbreak and then reduced their practice over time. However, coping flexibility was not significant in predicting the other three situation-specific coping strategies. Further studies are required to investigative the possible directions of influence among these variables.

## Theoretical and Research Implications

The present study may have implications for personality theories. In personality psychology, the trait approach and the person-situation interactionist approach are two major theoretical paradigms explicating individual differences in behaviors. Trait theories (e.g., Allport, 1961; Cattell, 1967) propose that individuals are predisposed to a particular personality trait or style, which remains largely stable across situations. Person-situation interactionist theories (e.g., Magnusson, 1974; Mischel, 1977) maintain that personality characteristics are manifested in some situations but not in others. These two approaches to personality may each have made unique contributions to the literature. Stable personality traits may be useful in predicting behavioral tendency. Situation-specific behaviors may provide a detailed account of how individuals react to the specific demands of situations. Consistent with this notion, the present results suggest that both personality traits and situation-specific behaviors can predict anxiety responses in a real-life stressful context. An integrative approach may be beneficial in addressing the confluence of these perspectives by including both stable personality style and situation-driven responses in the study of behaviors. The understanding of behaviors may be enhanced by an analysis of these two types of factors.

This study may also have research implications for the study of both personality traits and situation-specific behaviors. The present results have demonstrated that HLM is an appropriate method for examining the respective effects of these two types of variables because it allows simultaneous examination of time-invariant (i.e., personality traits) and time/situation-varying (i.e., state or situation-specific behaviors) variables in an integrated model. Although it is possible to analyze longitudinal data using repeated measures analytical methods, HLM offers several unique advantages over these traditional methods. First, HLM allows an analysis of variables with distinct initial statuses for different individuals as well as linear and quadratic changes with random effects. However, the initial status, linear change, and quadratic change are set at the same point for all individuals in repeated measures analytical methods.

Second, repeated measures analytical methods do not include time-varying covariates in the model. The omission of these covariates limits the potential to test personality traits and situation-specific behaviors within the same model. The present results have

demonstrated the effects of both time-invariant (trait anxiety) and time-varying (avoidance and personal hygiene practice) variables on changes in state anxiety over time. Thus, HLM seems to be more appropriate for testing both types of variables. In addition, with the inclusion of time-invariant variables (e.g., trait anxiety) as moderators in the HLM, researchers can examine how these personality traits contribute to linear and quadratic changes of a dependent variable. Thus, stable traits are hypothesized as moderators of the different relationships for the dynamic time-dependent variables. In short, HLM provides a conceptual orientation and a flexible set of statistical techniques for analyzing both stable personality traits and dynamic situation-specific behaviors. This method is recommended for researchers who are interested in examining both trait and situation-specific behaviors.

## Cautionary Notes and Concluding Remarks

Before concluding, several caveats are noteworthy. First, the present study examined two types of psychological responses, namely emotional and coping responses. Emotional response is indicated by anxiety, whereas coping response is assessed by a limited set of coping behaviors. It should be noted that anxiety and coping behaviors may not be the only variables that account for individual differences in state anxiety. In coping research, coping includes not only behavioral coping but also cognitive coping. It is possible that some participants may have adopted cognitive and behavioral strategies other than those listed in the questionnaire developed for this study. Further studies examining the integrative approach should expand the scope of psychological responses by including cognitive and behavioral coping strategies.

Second, a notable caveat of this study is its relatively small sample size. The predictive role of trait anxiety and personal hygiene practice was found to be marginally significant. Such results may be attributable to the lack of power due to the relatively small sample size and the relatively few time points. The sample size issue is complicated in HLM because there are two levels of sample size: (a) number of measurement occasions at level 1, and (b) number of participants at level 2. Raudenbush and Liu (2000) suggested a trade-off between sample sizes at different levels. Increasing the number of measurement occasions at level 1 can reduce the number of participants at

level 2 provided that the same power is required to detect the changes across time. Maxwell (2000) also demonstrated how statistical power increases dramatically when more time-points are added to the design. Thus, researchers using HLM should consider the sample size issue at both levels.

Third, this study adopted a retrospective approach in the assessment of situation-specific coping. Participants were asked to report coping strategies they had used in the past week. The study by Stone and colleagues (1998) showed that retrospective report could not reflect momentary coping. The longer the time period of recall, the greater the differences between retrospective and momentary coping (see also Coyne & Gottlieb, 1996). Although participants in this study reported their coping in a relatively short period (i.e., 7 days), it is still possible that their retrospective account does not represent their coping responses at certain moments.

To conclude, the first few weeks of the SARS outbreak in Hong Kong provided an ideal context to study how stable personality style and situation-specific coping are related to anxiety experienced in an unknown health threat. At the time of writing, the World Health Organization (WHO) has cleared the list of SARS-affected regions and has lifted all travel warnings. However, there is no evidence that SARS will be vanquished. The WHO has warned of a possible return of the epidemic in coming influenza seasons. Also, the pathogenesis and the mode of transmission of the disease are still largely unknown. Once the mysteries behind this disease have been understood, the nature of the SARS epidemic may no longer be a health threat and the general public's anxiety and coping responses to the disease may be different from those obtained in this study.

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