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**Day-to-Day Physical Symptoms:  
Individual Differences in the Occurrence,  
Duration, and Emotional Concomitants  
of Minor Daily Illnesses**

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**ABSTRACT** Even minor illnesses represent significant events in the ongoing lives of most people. As such, daily event methodologies could be applied to the study of ongoing health and illness. When daily health is considered as a temporal process, it is possible to expand our formulation of the relation between personality and day-to-day health. We use a daily event approach to model three temporal parameters of day-to-day health: the occurrence rate of symptoms, the duration of symptoms, and the covariation of symptoms and moods over time. We then examine whether these three models of day-to-day health are related to personality variables commonly used in health psychology research. The occurrence of illness related most strongly to neuroticism, the duration of illness related most strongly to the trait of aggressive responding, and Type A behavior related to less unpleasant affect reported during episodes of respiratory infection, aches, and depressive symptoms. Results are discussed in terms of how alternative models of health/illness are made possible by the daily event perspective.

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One category of important daily events includes changes in ongoing health status. The onset of a sore throat, a stomachache, or a strained back can represent a transient but attention-getting event in one's daily life. Various symptoms arise and dissipate over time in day-to-day life. Health is essentially a process embedded in time. As such, it would appear that a time-series or daily event methodology could be profitably applied to the study of ongoing daily health and illness.

One research question within health psychology concerns the relation between personality and illness. Usually the illness variables studied concern major life-threatening or life-limiting diseases, such as cancer, heart disease, or arthritis (e.g., H. J. Eysenck, 1985). However, if one looked at health as an ongoing temporal process, in terms of daily health status, then less severe but more common illnesses and symptoms would emerge as important. Certainly more people are affected by colds than by heart attacks. More people get strained muscles than cancer. Most people's health fluctuates within a rather narrow band of relatively minor but personally significant day-to-day symptoms.

But daily health *does* fluctuate, and these fluctuations may represent significant events in the ongoing lives of most people. Consequently, researchers could take a process approach (Larsen, 1989a) to the study of daily health. A process approach would focus on temporal patterns in daily health, such as the occurrence or duration of symptoms over time, or the temporal covariation between daily symptoms and other daily variables such as mood or life events.

When daily health is considered as a temporal process then it is possible to expand our conception of the relation between personality and health. The purpose of this article is to develop and illustrate various temporal formulations of the personality-illness relation that are made possible when a daily event perspective is applied to the study of ongoing health status. We propose three temporal formulations whereby personality variables may relate to aspects of daily health.

### **Formulations of the Personality-Illness Relation**

The 1989 *Annual Review of Psychology* includes an article on personality (Carson, 1989), as well as an article on health psychology (Rodin & Salovey, 1989). It is interesting that the personality article contains a section on "personality and health" and the health article contains a section on "health and personality." Both of these articles note that

personality may relate to health in various ways. The dominant formulation in the research reviewed in both articles is that certain personality factors may foster proneness to the occurrence of illness. Other reviews of the personality-health literature (e.g., Holroyd & Coyne, 1987; Taylor, 1990) also note that the primary formulation in this area is on the relationship between disease occurrence and personality.

*Personality and the occurrence of illness.* A good example of the formulation of personality and illness occurrence is the work by Depue and Monroe (1986), who identify four personality variables related to the occurrence frequency of somatic symptoms. Under the rubric of the "disease-prone" personality, Friedman and Booth-Kewley (1987a) reviewed the literature employing this formulation and summarized those personality variables consistently found to be associated with the occurrence of various severe illnesses. This research formulation of the relation between personality and disease occurrence actually takes many forms, depending on how personality is thought to inhibit or promote the occurrence of illness. For example, personality may relate primarily to vulnerability to stress or poor coping, which in turn leads to the occurrence of illness. Or personality may relate primarily to deleterious health behaviors (e.g., smoking) that in turn lead to the occurrence of illness. Or personality may relate primarily to immune competence, which in turn is responsible for the occurrence of illness. The general formulation of personality and disease occurrence thus does not necessarily posit a direct causal effect.

Nevertheless, research based on this formulation often takes the form of relating personality variables directly to the occurrence frequency of symptoms. This is usually accomplished by having subjects complete a retrospective symptom report and relating those reports to measures of personality (e.g., Aldwin, Levenson, Spiro, & Bosse, 1989). Such a method implies that illness occurrence is a between-person construct. In the current study we conceive of illness occurrence as a within-person construct that occurs over time. We thus prospectively assessed the self-reported occurrence frequency of daily symptoms and then examined symptom occurrence in relation to specific personality variables. The first formulation of personality and health examined in this study is that personality variables may relate to long-term health by being associated with occurrence frequency of illness over time.

Like many researchers in the personality-health literature, we will

be working with self-reported symptoms. These self-reports reflect the perception of somatic disturbances that may or may not be completely reliable indicators of actual physical symptoms (Watson & Pennebaker, 1989). Nevertheless, symptom scales such as ours are often found to correlate significantly with external indicators of illness, such as medical records, documented visits to physicians,<sup>1</sup> and physicians' ratings (Pennebaker, 1982; Watson & Pennebaker, 1989). Prospective studies in particular often find that self-reported health indicators are related to mortality from various diseases (Kaplan & Kotler, 1985). It is interesting to note that, although self-reports of illness often correlate with objective indices of illness, and self-reports of illness often correlate with neuroticism-type variables, the objective indicators of illness often do not relate significantly with neuroticism variables. This led Watson and Pennebaker (1989) to speculate that self-reports of illness most likely contain two components: one that is veridical with true health problems, and the other that is more psychological, having to do with increased perception of and/or willingness to complain about minor discomforts.

Several researchers have studied daily illness and symptom reports over time, often with a focus on stress (Bolger, DeLongis, Kessler, & Schilling, 1989; Caspi, Bolger, & Eckenrode, 1987; Clark & Watson, 1988; Eckenrode, 1984; Watson, 1988). Rarely, however, do researchers examine whether within-person effects are different for different people (i.e., show between-person variation). For example, Clark and Watson (1988) and Watson (1988) show that, within persons, reports of negative affect and physical symptoms tend to co-occur and, between persons, those subjects who report more negative affect over time also report more symptoms over time. What is not revealed by such analyses is whether the within-person effect (the linkage between state affect and physical symptoms) is moderated by a between-person variable (i.e., differs for different persons, perhaps as a function of personality). Although Caspi et al. (1987) did simultaneously examine within-person variance as a function of between-person variables, these variables focused more on sociological conditions (e.g., neighborhood quality) than personality. In the current study we will examine illness

1. It is unclear just how accurate such "objective" measures of health really are. For example, regarding physician visits, it is widely known that some people make frequent visits to their physician even though there is no underlying medical pathology.

symptoms as within-person phenomena, and then test whether specific patterns of illness so identified are a function of between-person variables (i.e., personality). Such an approach allows us to get beyond a conceptualization of illness as individual differences in who becomes ill, and to focus additionally on individual differences in the temporal course of illness.

Although the research formulation of relating personality to self-reported illness occurrence is widely used, especially in retrospective form, Holroyd and Coyne (1987) suggest that "this model . . . oversimplifies the role of personality variables in illness" (p. 367). Other investigators (Krantz & Hedges, 1987) have suggested that researchers should expand their conception of health psychology by examining different mechanisms that may potentially link personality to illness, rather than continue to simply correlate traits with the occurrence of illness.

If one focuses on illness as a *process* that occurs over time, then alternative formulations of the relation between personality and illness become available. For example, personality may relate not so much to the occurrence of illness as to the *course* that an illness takes once it does occur. Attempting to understand the course of illness suggests that we need to study persons over time in order to examine temporal aspects of the illness.

*Personality and the duration of illness.* The occurrence formulation of personality and health described above implies that personality factors play a role in determining who is likely to become ill. A somewhat more process-oriented model would suggest that personality may play a role in determining who is likely to recover from illness most efficiently. This formulation suggests a category of hypotheses concerned with whether and how certain personality variables may be relevant to the recovery rate or duration of illness.

An example of this duration formulation of the personality and illness course is suggested by Akiskal, Hirschfeld, and Yerevanian (1983) in the context of depression. They suggest that personality may play a negligible role in determining who is likely to suffer endogenous depression, but may play a large role in who is likely to recover from depression once it does occur. Another example of the formulation that personality might relate to the recovery rates, and hence duration, is provided by Scheier et al. (1989). These authors found a relation be-

tween the personality trait of dispositional optimism and recovery rate from coronary artery bypass surgery. Although these authors were not examining the duration of symptom episodes per se, they nevertheless did examine the duration of recovery following a trauma.

In the present study we will examine the duration of the symptom course over time, in addition to the occurrence frequency of daily symptoms. Using time-series methods we quantify the probabilistic degree to which symptoms persist over contiguous observation periods for each subject. We examine, for each person, the degree to which current symptoms are predictable from past symptoms, and whether the probabilistic sequencing of symptoms is longer for some persons than others. It seems likely that illness occurrence and illness duration are at least somewhat distinct processes. For example, what causes a person to catch a cold (a virus) is most likely quite different from what causes him or her to get better (rest, plenty of fluids). The behavior patterns that contribute to the occurrence of illnesses are most likely distinct from the behavior patterns that lead to an efficient and speedy recovery. This suggests that certain personality factors may relate to the occurrence of illnesses, while others may relate to their duration. Thus the second formulation of personality and health examined in this study is that certain personality variables related to long-term health may be associated with the duration of symptom episodes.

*Personality and the emotional concomitants of illness.* The third formulation of personality and health examined in this study proposes that certain personality variables may exaggerate the effects of symptoms on the person's ongoing emotional life. Many researchers view moods and emotions as a signal system. For example, Thayer (1989) suggests that moods function, in part, as indicators of the body's readiness for action and its need for rest and recuperation. Epstein (1983) also suggests that moods reveal to the person their "state of affairs" and thus function as information about what is going wrong (unpleasant affect) or right (pleasant affect) with the self-system. Affect may thus serve as a form of information or feedback to the person about his or her overall functioning, including health functioning.

Schwartz (1984) suggests a systems view of health that emphasizes self-regulation through information feedback. Feedback is any form of information about the functioning of the self that is available to allow the person to engage in self-regulation. Disregulation, according

to Schwartz, leads to illness and can occur through inattention to feedback necessary for self-regulation. That is, being disconnected from feedback leads to dysregulation and disorder. Like pain, emotions are viewed by Schwartz as "reflecting a negative feedback process with the purpose of helping the organism to make appropriate adjustments so as to restore homeostasis" (p. 164).

For emotions to be useful in the self-regulation of health, however, they must occur and be attended to by the person. For example, if an individual does not feel "down," or depressed, during a cold, then he or she may not engage in the self-regulatory behaviors necessary to recover efficiently from the cold. If one is stoically inattentive to the subjective emotional impact of a cold, then one is disconnected from a source of information useful in guiding self-regulatory and health-restoring behaviors. This may have a negative impact on long-term health status.

Personality factors may influence health by determining the degree to which a person attends to or acknowledges the emotional impact of his or her physical symptoms. That is, if some persons do not feel depressed during physical symptoms, they may be less likely to take regulatory action to counteract and recover from the illness. The immediate example that springs to mind is the time-pressured overachiever who refuses to let a cold get him or her down, perhaps suffering more severely from the illness than if he or she had paid attention to the emotional concomitants of the symptoms and taken self-regulatory action. The third formulation of personality and health examined in this study is that certain personality dimensions relate to long-term health by influencing the degree to which a person's emotions are linked to changes in daily health status.

To obtain an index of the linkage between daily emotions and daily symptoms, we quantified the degree of covariation between daily moods and daily symptoms over time for each subject. It seems likely that when an individual is symptomatic he or she would experience unpleasant affect, and that unpleasant affect would abate once symptoms are no longer present. This would lead to a negative correlation (computed within-person over time) between symptoms and moods; when symptoms are "up," moods are "down," and vice versa. Nevertheless, we expected to find individual differences in this relationship and therefore examined whether people differed in the within-person linkage between daily moods and symptoms, as well as whether these differences re-

lated to certain personality variables associated with long-term health consequences.

*Personality variables.* The present study will focus on three personality traits in relation to the parameters of daily health discussed above. The first personality trait of interest is neuroticism, a widely used variable in health psychology research. Neuroticism refers to a tendency toward chronic dysphoria, anxiety, and worry (Watson & Clark, 1984), as well as a general susceptibility to react with strong negative emotions to unpleasant events (Larsen & Ketelaar, 1989, in press). Several researchers (Costa & McCrae, 1985, 1987; Watson & Pennebaker, 1989) have demonstrated a relationship between neuroticism and self-reports of health complaints, even though those complaints may not actually reflect physical illness. In the present study we therefore hypothesized that neuroticism will predict the occurrence frequency of symptom reporting. There are no a priori reasons to believe that neuroticism will relate to the duration of symptoms nor to the emotional concomitants of symptoms. In fact, if we assume that the neurotic's frequent symptom reports may be due, in part, to a generalized complaining tendency, then any given health complaint is as likely as any other health complaint on any single occasion. That is, on any given occasion the neurotic is just as likely to report a backache as an upset stomach, or is as likely to report a runny nose as a headache. The point is that there is no reason to expect that the neurotic is more likely to report longer duration symptoms than the nonneurotic. Also, even though neurotics tend to show a stronger linkage between life events and mood (i.e., are more reactive; Bolger & Schilling, 1991), there is no reason to predict that the linkage between mood and illness will be stronger for neurotic than nonneurotic subjects.

A second personality trait of interest concerns anger/hostility. A tendency toward aggressive responding to anger-provoking or frustrating situations has been implicated as a component of the disease-prone personality (Friedman & Booth-Kewley, 1987a, 1987b), as well as related to a variety of psychological (Kernis, Grannemann, & Barclay, 1989) and physiological reactivity measures (Diamond, 1982; Siegel, 1984). For example, Shekelle, Gale, Ostfeld, and Paul (1983) found that individual differences in global hostility, assessed with the Cook-Medley scale (Cook & Medley, 1954), predicted 20-year mortality even after controlling for five risk factors (i.e., smoking, blood pressure, chole-



terol, ethanol intake, and age). Barefoot, Dodge, Peterson, Dahlstrom, and Williams (1989) also found that the Cook-Medley Global Hostility scale predicted 19-year mortality rates among a sample of lawyers. These authors found, however, that specific subsets of the Cook-Medley item pool were more predictive of mortality than others. In particular, items having to do with aggressive responding were among the best predictors of mortality.

Roger and Neshoever (1987) suggested that a high potential for aggressive responding may "be associated with delayed recovery [from illness] through the . . . reactivation of emotional responses" (p. 533). Melamed (1987) also suggests that the tendency to exhibit angry and emotional responses keeps the person emotionally aroused and extends the psychological impact of stressful stimuli long after the actual presence of such stimuli. Individuals prone to aggressive responses are more likely to have reactivated arousal responses to stressful or frustrating events. This implies a slower recovery from stress-induced symptoms. In the present study we thus expected that a personality dimension representing a propensity toward aggressive responding will relate most strongly to the duration of daily physical symptoms.

The third personality trait of interest is the Type A behavior pattern, widely assumed to relate to health outcomes. Questionnaire measures of this syndrome mainly tap into a behavior pattern of impatience, excessive drive, competitiveness, and exaggerated achievement motives (Friedman & Booth-Kewley, 1987a). We believe that this constellation of traits might foster an inattention to the emotional concomitants of physical symptoms. That is, the Type A person might be the kind of person who, for example, refuses to let a cold get him or her down. Perhaps Type A individuals take the bumps, bruises, and viruses of daily life without emotional complaint because they are too busy doing as much as possible in the least amount of time. Suls and Sanders (1988) suggest that the Type A's burdensome schedule does little to promote health-maintaining behaviors (e.g., regularly scheduled meals, exercise, balanced diet, sufficient sleep, close social support networks). Personal knowledge of Type A individuals suggests that they simply do not have the time or the inclination to feel bad when symptoms occur. We thus hypothesized that the Type A personality variable may relate to a decreased linkage between daily moods and daily physical symptoms. That is, we hypothesized that Type A individuals will not report feeling as emotionally down when they are sick, whereas people without Type

A behavior will show a stronger linkage between daily moods and daily symptoms.<sup>2</sup>

In summary, the purpose of this study is to use a daily event or time-series approach to model three different formulations of daily health: the occurrence frequency of symptoms over time, the duration of symptoms over time, and the covariation of symptoms and moods over time. These formulations will be applied to each subjects' data to generate process variables that describe individual differences in these temporal aspects of daily health. We will then examine whether these process variables relate to the above personality traits in the predicted manner. That is, we expect neuroticism will relate to the occurrence frequency of symptom reporting, that anger/hostility will relate to the duration of symptom episodes, and that Type A behavior will relate to a lowered covariation between daily symptoms and daily moods.

A final topic we will address in this article concerns the possibility of lead/lag effects in the relation between symptoms and moods. Although this topic is somewhat tangential to our concern with personality and health, we will nevertheless explore these relations to further illustrate the potential of data gathered over time to address unique questions about health. We will use time-series models to explore whether moods precede or succeed the occurrence of physical symptoms. These models will be applied to each subject's mood and symptom data. The parameters derived from these within-subject time-series analyses will then be aggregated to indicate the average degree of lead and lag effects between physical symptoms and moods.

The present study is unique in several respects. First, we investigated relatively common and somewhat minor changes in health status (e.g., colds, muscle soreness, stomach upset) rather than the major diseases studied by most investigators in this area (e.g., cancer, heart disease). This emphasis on common but minor changes in health status can be likened to the shift of emphasis recently seen in the life-event literature, where researchers are beginning to study microstressors or

2. We do not want to understate the case that self-report measures of Type A behavior do not predict coronary diseases as well as structured interview measures (Matthews, 1988; Suls & Sanders, 1988; Taylor, 1990). Even though the components of self-reported Type A behavior may not be consistently pathogenic for heart disease, they may nevertheless play a role in the types of rather minor health problems investigated in the current study.

common "daily hassles" instead of the relatively uncommon but major life events studied in the past (DeLongis, Folkman, & Lazarus, 1988; Kanner, Coyne, Schaeffer, & Lazarus, 1981). A second unique aspect of the present study is the application of the daily sampling methodology to questions about day-to-day health, personality, and emotion. We gathered data on moods and health status three times a day for 2 consecutive months. This method allowed us to track the course of illness and recovery from illness over time, and to observe the emotional concomitants of illness in the ongoing daily lives of our subjects. Finally, another unique aspect of this study is that we applied a process or time-series (Larsen, 1987) approach to our daily data. This approach allowed us to model the temporal patterning of illness and emotion at the level of the individual subject over time, and then examine whether such temporal patterns exhibit meaningful individual differences across subjects (i.e., are related to personality variables; see Larsen, 1989a, Larsen & Cowan, 1988, or Larsen & Kasimatis, 1990, for other examples). This approach allowed us to integrate our temporal models of health and illness into a research design that included measures of personality.

## **METHOD**

### **Subjects**

Subjects were 43 undergraduates enrolled in a semester-long independent study course. So as not to preclude a representative sample of college undergraduates, the only requirement for participation was completion of an introductory psychology course. Subjects received a letter grade based on attendance and participation in weekly meetings, completion of assignments, and a written report.

### **Procedure**

Subjects completed a mood and symptom report three times a day for 2 consecutive months (8 weeks). At noon each day, subjects rated their mood and physical symptoms for that morning. They completed the same form at dinner-time to report on their moods and symptoms that afternoon, and again at bedtime to report on their evening moods and symptoms. The daily report phase of this study occurred between October and December at a large Mid-western university. The mood and symptom reports, completed three times a

day, were returned to the experimenter on a daily basis, except on weekends, when the subjects turned in their Friday, Saturday, and Sunday forms on Monday. This requirement ensured fairly good compliance with daily reporting (Larsen & Diener, 1987). This prospective method of sampling moods and physical symptoms three times a day was used in order to reduce distortions due to memory, as it allows for assessment within 6 hours following the moods and symptoms.

## Measures

### *Daily mood measure*

The mood measure, administered three times per day, consisted of nine emotion adjectives. Subjects responded to the question: "How much of the following emotions did you experience during the reporting period?" The response scale ranged from 0 (not at all) to 6 (extremely much). The nine emotion adjectives were happy, joyful, enjoyment/fun, pleased, depressed/blue, unhappy, frustrated, worried/anxious, and angry/hostile. Based on previous factor analyses of daily emotion adjective ratings (Diener, Larsen, Levine, & Emmons, 1985), the above adjective set represents a single, bipolar factor, with the pleasant adjectives loading on one pole and the unpleasant adjectives loading on the opposite pole. This set of adjectives represents the pleasantness-unpleasantness dimension of mood (Larsen & Diener, *in press*).<sup>3</sup> Mood scores were calculated by subtracting the average responses to the pleasant adjectives from the average responses to the unpleasant adjectives. High scores thus indicate unpleasant affect, such that correlations with risk factors should be positive.

3. Regarding our bipolar mood measure, the adjectives we used do not assess positive affect and negative affect, as currently defined (e.g., Watson, 1988). Rather, the adjectives we used assess mainly the pleasantness-unpleasantness dimension of mood, which is bipolar. We preferred this dimension to the positive and negative affect labels for a number of reasons. Larsen (1989b) reported that, in terms of personality traits, positive affect loads extraversion and negative affect loads neuroticism, whereas pleasantness loads measures of life satisfaction and psychological well-being, and unpleasantness loads measures of depression. So, with the pleasantness-unpleasantness dimension, we are working with mood adjectives that discriminate depressives from people satisfied with their lives, not with mood adjectives that discriminate extraverts from neurotics. Larsen (1989b) also reported the results of a mood induction study, where the pleasantness-unpleasantness adjectives were more sensitive to a laboratory mood manipulation than either the positive or negative affect adjective sets. These findings suggest that the pleasantness-unpleasantness dimension is a purer reflection of hedonic tone than either positive or negative affect.

*Daily symptom measures*

The measure of physical symptoms, administered three times per day along with the mood measure, consisted of a checklist containing 24 symptoms. The subject checked the symptoms he or she experienced during the time period for which they were reporting, i.e., morning, afternoon, or evening. The symptoms were extracted from existing symptom checklists to obtain a representative account of daily health status. Subjects responded to the instructions: "During this time period, did you experience any of the following (check all that apply)?" A list of symptoms then followed: headache, backache, dizziness, nausea/upset stomach, heart pounding, constipation/diarrhea, nervousness, muscle soreness, hot or cold flashes, shortness of breath, intensely energetic, tightness in chest, low energy/tired, trouble concentrating, shyness, poor appetite, loss of interest/bored, critical of others, crying or urge to cry, congestion, sore throat, temper outbursts, trembling/shaking, and runny nose.

We wanted to determine if the daily symptoms exhibited enough temporal covariation such that we could reduce the symptom set to meaningful underlying dimensions. To address this question we factor-analyzed the daily symptoms over all the occasions of observation, using Chain P-technique factor analysis (Cattell, 1975). Because the symptom checklist was completed three times a day for 2 months, we had a total of 7,225 observations over which to factor-analyze the symptom data.<sup>4</sup> This factor analysis yielded four meaningful factors with eigenvalues greater than one.

The individual symptoms with loadings greater than .40 on each factor are as follows. The first factor loaded "loss of interest/bored," "trouble concentrating," "urge to cry," and "low energy/tired." This factor will be called a *depression dimension* since it loaded those symptoms that are classic indicators of depression. The second factor loaded "headache," "backache," and "muscle soreness." This factor will be called an *ache dimension* since it loaded those symptoms that are associated mainly with muscle problems. The third factor loaded "poor appetite," "nausea/upset stomach," "constipation/diarrhea," "trembling," and "dizziness." This factor will be called a *gastrointesti-*

4. The reader may wonder about the possibility of individual differences in the factor structure of the symptom reports. This is a possibility given that our factor analysis was performed over both occasions and individuals. It would be desirable to know that the identified factors were present not only across the array of subjects by occasions, but also within individual subjects as well. Our array consisted of 168 reporting occasions for each of 43 individual subjects. Consequently, this array contains roughly four times as much within-subject variance as between-subject variance. Our factor-analytic results are thus likely to represent patterns of symptom covariation reflecting more of the consistent within-subject variance than between-subject variance (i.e., the within-subject covariance patterns that are consistent across subjects).

*nal dimension* since it loaded those symptoms often associated with digestive system disturbances. The fourth factor loaded "sore throat," "runny nose," and "congestion." This factor will be called an *upper respiratory infection dimension* since it loaded those symptoms having to do with irritation of the respiratory tract. Our analyses of the daily symptom data will focus on four factor scores computed by unit weighting and averaging the above symptoms that loaded on each of the factors. Each subject will thus have four symptom factor scores for each occasion of observation: depression, ache, gastrointestinal, and upper respiratory infection symptoms.<sup>5</sup>

### *Temporal parameters of daily symptoms*

*Occurrence of daily symptoms.* Frequency measures of the four symptom clusters were computed by counting, for each subject, how often symptoms from each factor were reported over the 2 months of thrice-daily observation. Symptom frequency in this study is thus computed in a prospective manner. Retrospective studies, on the other hand, have subjects recall how often various symptoms occurred over some *past* time period (Scheier & Carver, 1985; Smith, Pope, Rhodewalt, & Poulton, 1989). The retrospective method confounds memory biases with actual symptom frequency and may introduce substantial nonsymptom variance into the correlation between certain personality dimensions and symptom frequency (Costa & McCrae, 1985, 1987; Larsen, in press). Because our occurrence measures of the four symptoms are gathered prospectively, we avoid some of the reporting biases obtained in retrospective reports.

*Duration of daily symptoms.* Duration scores were computed by treating each subject's daily symptom reports as time-series data and autocorrelating each symptom cluster with itself over various time lags (see Gottman, 1981, for discussion of autocorrelation). That is, each symptom score was correlated with the same symptom score one time lag removed, two time lags removed, three time lags removed, etc. As an example, respiratory infection at Time  $T$  was correlated with respiratory infection at Times  $T + 1$ ,  $T + 2$ ,  $T + 3$ . . . . If symptom occurrence tends to be followed in time by further symptom occurrence, then significant lagged autocorrelations will be found. If symptoms per-

5. Compliance was excellent. The majority of our subjects had no missing reports. The single subject with the most missing data had 6% of the reporting occasions missing (9 out of 168 occasions). Missing data were estimated in order to maintain equal intervals in the data sets for each subject. In each subject's daily data set missing values for mood scores and symptom factor scores were estimated by substituting the subject's own total series mean.

sist over contiguous observation periods, then the autocorrelation will estimate this degree of symptom duration.

The autocorrelation is a probabilistic indicator of duration. It does not tap uninterrupted symptom episodes as much as it reflects the stochastic nature of symptoms over time. That is, the autocorrelation in general provides a probabilistic index for predicting event sequences. In our application, it reflects the degree to which the probability of a symptom occurring at Time  $T$  depends on whether symptoms occurred previously in the series (e.g.,  $T - 1$ ,  $T - 2$ ,  $T - 3$ , etc.). In our study we were interested in whether these probabilities differ for different people. Also, the autocorrelation is not simply an indicator of predictability. The autocorrelation indicates the degree of predictability of symptoms over multiple contiguous reporting occasions. It is thus a probabilistic indicator of contiguity, not mere predictability. The autocorrelation contains information about duration, if duration is conceived as the probabilistic sequencing of symptoms across contiguous reporting occasions.

Autocorrelations were computed separately for each subject for each of the four symptom clusters to model individual differences in the duration of symptoms over time. For each subject we then determined the maximum lag at which the autocorrelation remained significantly different from zero. The "symptom duration" variable thus represents the largest number of lags at which the autocorrelation remains significant for each subject for each symptom.<sup>6</sup> A larger number means a longer duration of symptom factor scores.

*Emotional concomitants of daily symptoms.* To assess the relationship between daily mood and physical symptoms, we regressed daily mood on each symptom score over the occasions of observations for each subject. We did this after controlling for autocorrelation in each subject's daily mood scores. That is, the following model was fit to each subject's four daily symptom scores:

$$\begin{aligned} \text{Mood}_t = & a + \beta_1 \text{Mood}_{t-3} + \beta_2 \text{Mood}_{t-2} \\ & + \beta_3 \text{Mood}_{t-1} + \beta_4 \text{Symptom}_t \end{aligned} \quad (1)$$

6. One potentially problematic issue concerns whether the autocorrelations exhibit complex patterns in the correlogram (a correlogram is a graphical X/Y display of the autocorrelation magnitude along an axis of increasing lag values). For example, the correlogram would indicate the presence of a cyclical component in the time series if it drops and then rises at a later lag. (For example, if the value of the autocorrelation becomes insignificant at Lags 2, 3, and 4, then rises to significance at Lag 5, this would indicate a cyclical component with a period of 5.) For our symptom variables, the correlograms were all monotonic decreasing out to 20 lags, which is where we stopped autocorrelating. We found no evidence of cyclicity in any of our symptom variables. These symptom variables simply do not produce complicated patterns of autocorrelation.

The individual difference variable we use to assess the covariation between mood and symptoms for each subject is the regression coefficient  $\beta_4$  in the above equation. We controlled for autocorrelation in mood by partialling out three lagged mood terms. We did this because most researchers never find a 1-day carryover in mood and, since three lags cover a 24-hour period in our data set, we need to go back three lags to control for up to a 1-day carryover. We did this for each subject, regardless of individual differences in lagged effect, so that all subjects would be equivalently "corrected" prior to examining the synchronous relation between mood and symptoms. This is a conservative approach because it removes *all* autocorrelation in mood back to three lags, not just that autocorrelation estimated to be error. The synchronous relation between mood and symptoms for each subject (the regression coefficient  $\beta_4$  in the above equation) is thus more likely to be due to shared concurrent variance than any residual shared (error or nonerror) lagged variance.

In analyzing residuals after fitting the full model to each subject's data we found essentially no autocorrelation among the residuals. The values of the Durbin-Watson statistic computed for individual subjects all fell in the range of 1.87 to 2.07 (see the SPSS-X Trends manual for a discussion of the Durbin-Watson statistic; SPSS, 1988). The Durbin-Watson statistic can range from 0 to 4, with values of 2 indicating a complete lack of autocorrelation after fitting the model. The values of the Durbin-Watson statistics obtained in our sample indicated that no statistically significant autocorrelation was left in the residuals after fitting the above model to each subject's data.

This within-subject regression coefficient tells us the degree of linkage between the subject's symptoms and daily moods. If a subject shows a large beta weight between mood and symptoms then we may assume that such a subject's emotional life is linked in some manner to his/her physical health status. A subject who shows a relationship between daily mood and symptoms has reportable affective changes that co-occur with changes in health status. High positive values of this regression coefficient indicate that unpleasant affect co-occurs with symptoms, even after controlling for autocorrelation in the affective states.

Other researchers have similarly compared individual time series to each other in terms of the parameters derived (Gottman, 1981) or treated the parameters from individual time series as individual difference variables (Larsen, 1987). Laird and Ware (1982) present a general model for identifying both within- and between-subject parameters in time-series data. Michela (1990) also provides an extensive discussion of using within-subject correlational measures as between-subject individual differences scores. Our approach with the "emotional concomitant" variables is very similar to his, except that we controlled for autocorrelation *within* each subject's individual time series and used a regression coefficient as the individual difference variable.



*Personality measures*

All personality measures used were administered prior to the onset of the daily report phase of this study. The experimenters met with the subjects in a large group setting once a week for 4 weeks prior to the onset of daily reporting. Each meeting lasted approximately 3 hours. During these meetings subjects completed a variety of personality questionnaires.

*Neuroticism.* The Eysenck Personality Inventory-Revised (EPI-R; S. B. G. Eysenck, H. J. Eysenck, & Barrett, 1985) was administered, from which neuroticism scores were obtained. The Eysenck neuroticism scales are widely used in research on personality and health. The current scale consists of 24 items drawn from previous neuroticism scales (e.g., H. J. Eysenck & S. B. G. Eysenck, 1975) to increase internal consistency (which ranges from .80 to .88 across samples; S. B. G. Eysenck et al., 1985). Some researchers have referred to neuroticism scales as measures of emotionality (Aldwin et al., 1989), negative affectivity (Allred & Smith, 1989; Smith et al., 1989), or anxiety (Rodin & Salovey, 1989). Items on this neuroticism scale tap into chronic dysphoric experiences such as sadness, guilt, low self-esteem, worry, and insecurity.

*Anger/hostility.* The anger control subscale of the Emotion Control Questionnaire (ECQ; Roger & Neshoever, 1987) was used in this study. This scale was developed specifically for use in research on the role of personality as a moderator of the effects of stress on illness. The anger control scale is a 10-item true-false scale consisting of such items as "If someone were to hit me, I would hit back" (reverse keyed), "If a friend borrows something and returns it dirty or damaged, I usually just keep quiet about it," and "I'd rather concede an issue than get into an argument." High scores indicate more control over aggressive responding to anger-provoking or frustrating situations. That is, all items refer to control over behavioral aggression, as opposed to aggressive or hostile affect. This scale has a KR-20 internal consistency estimate of .81, a 6-month test-retest correlation of .75, and has been shown to be independent of neuroticism (Roger & Neshoever, 1987). The developers of this measure (Roger & Neshoever, 1987) have demonstrated that anger control correlates significantly and negatively with a projective measure of aggressive tendencies, the Picture-Frustration Study (P-F; Rosensweig, Flemming, & Clark, 1947). The P-F technique presents subjects with pictures of stick figures in frustrating situations and asks subjects to provide a behavioral response for the frustrated person. When the content of subjects' responses was coded for anger expression, this score correlated  $-.48$  ( $p < .01$ ) with scores on the anger control scale. Other convergent and discriminant validity evidence is

reported by Roger and Nesshoever (1987), suggesting that this scale does tap decreased behavioral aggression.

The Cook-Medley scale (1954) was also used to measure global hostility. The Cook-Medley measure of global hostility is a collection of 50 theoretically selected Minnesota Multiphasic Personality Inventory (MMPI) items initially derived to identify teachers who did not get along with their students. The item content of the Cook-Medley scale is thus quite heterogeneous, containing items that reflect social avoidance, cynicism, blaming, and negative affect, as well as hostile and aggressive behavior items (Barefoot et al., 1989). This scale has been found to correlate with adverse health outcomes, particularly cardiovascular diseases (Chesney & Rosenman, 1985; Dembrowski & Costa, 1987; Williams et al., 1980). There is, however, some uncertainty as to exactly what this scale measures (Costa, Zonderman, McCrae, & Williams, 1986; Smith & Frohm, 1985), as well as a few failures of the scale to significantly predict health outcomes (Leon, Finn, & Bailey, 1987; McCranie, Watkins, Brandsma, & Sisson, 1986). The Cook-Medley Global Hostility scale is included in our study due to its long history of use in the health psychology literature.

*Type A behavior.* The Jenkins Activity Survey (JAS; Jenkins, Zyzansk, & Rosenman, 1979) was used as a measure of the Type A behavior pattern in this study. The college-student version of this scale was employed, where items on the scale are reworded to pertain to college students rather than to adults (e.g., items referring to work pertain to schoolwork). Rather than dichotomize subjects into Type A and Type B categories, scores on the JAS were kept at the interval level for analysis so as to maximize information contained in item responses.

Although some authors have been critical of self-report measures of Type A behavior (e.g., Contrada, Wright, & Glass, 1985), scales such as the JAS are predictive of a variety of health outcomes, physiological reactivity to challenging psychological manipulations (Harbin, 1989; MacDougall, Dembrowski, & Krantz, 1981), as well as emotional distress (Suls & Wan, 1989). The JAS measures mainly the impatience, pressured drive, competitiveness, and excessive achievement motivation of people labeled Type A, with minimal emphasis on hostility (Carson, 1989; Friedman & Booth-Kewley, 1987b). Suls and Wan (1989) conducted a meta-analysis on Type A studies and conclude that, although the structured interview measure of Type A behavior is more predictive of coronary heart disease than the JAS, the JAS is nevertheless more predictive of dysphoric emotional states than the structured interview. Additionally, Suls and Sanders (1988) find that self-reported Type A behavior relates to a higher incidence of accidents and violence. Even though the behavioral constellation assessed by the JAS may not represent the "toxic" ingredients for coronary heart disease, it may nevertheless contain elements

predictive of more minor health problems, such as those under investigation in our study. Others have also suggested that the components of Type A behavior represented in the JAS may predict common everyday symptoms and minor health-relevant behaviors more than the long-term consequence of coronary heart disease (Strube, Boland, Manfredo, & Abdulrahman, 1987; Suls & Sanders, 1988; Ward & Eisler, 1987). Our study does not concern coronary heart disease. The self-report of excessive achievement strivings, competition, and time urgency provided by the JAS is satisfactory as a first attempt to investigate these relations with minor daily symptoms.

## RESULTS

### Temporal Parameters of Daily Symptoms

Descriptive statistics for all parameters of daily symptoms are presented in Table 1. In terms of occurrence, the most frequently reported symptoms related to upper respiratory problems, followed by symptoms of depression, aches, and gastrointestinal problems. In terms of duration, it can be seen that the upper respiratory infection symptom factor had the longest series of significant lagged autocorrelations, averaging almost five and a half lags forward in time. Since three lags covers a 24-hour time interval in our data set (i.e., the sampling rate was three samples per day) this implies that, on average, if we know a person has respiratory symptoms on one occasion, we are able to significantly predict the existence of such symptoms almost 48 hours later. This does not imply that respiratory symptoms last only 2 days. Rather, the meaning of this lag variable in this study is that respiratory symptoms persist in a probabilistic manner that allows significant predictability over five and a half contiguous observational periods.

The shortest duration symptom was the gastrointestinal cluster, with average significant lagged autocorrelations over one and a half time lags. This suggests that having gastrointestinal symptoms at one time period (for example, in the morning) significantly predicts such symptoms one and a half time periods later (in the afternoon or evening), on average.

It is interesting to note that the so-called depression symptom cluster had a very short duration, with significant autocorrelations slightly less than two lags. The symptoms in this cluster refer to low energy, loss of interest, trouble concentrating, and the urge to cry. Among normal college students, these symptoms may be rather transient, rarely

**Table 1**  
**Descriptive Statistics for Parameters of Daily Symptoms<sup>a</sup>**

	Mean	SD	Range
<b>Occurrence</b>			
Depression	15.66	12.93	2 to 59
Aches	12.04	11.63	1 to 72
Gastrointestinal	6.06	6.42	1 to 36
Upper respiratory	24.64	24.28	0 to 106
<b>Duration</b>			
Depression	1.81	1.85	0 to 7
Aches	2.77	2.39	0 to 9
Gastrointestinal	1.58	1.81	0 to 7
Upper respiratory	5.40	3.67	0 to 12
<b>Emotional concomitants<sup>b</sup></b>			
Depression	2.40	1.46	.02 to 4.06
Aches	1.30	2.50	.03 to 4.10
Gastrointestinal	1.78	4.41	.05 to 8.72
Upper respiratory	.14	1.21	.04 to 3.21

a. The unit of analysis is the observation occasion (three per day for 8 weeks).

b. Represented as regression coefficients for predicting unpleasant mood from concurrent levels of each symptom factor.

carrying over for more than a day. It is interesting that depression symptoms actually had a shorter duration than the ache symptom cluster. The relatively temporary nature of the depression symptom cluster thus suggests not so much true clinical depression, but rather the behavioral symptoms of stress or strong negative affect, common enough among college students to form a unitary factor.

We were interested in whether occurrence and duration represent independent parameters of daily illnesses. That is, do people who get sick frequently also suffer from their illnesses for a longer duration? To address this question we correlated the occurrence and duration scores for each symptom across subjects. These correlations are the coefficients in the diagonal of Table 2. We see a large correlation between occurrence and duration only for the upper respiratory infection symptom. Since respiratory infections had the longest duration of any symptom, if a subject reported the occurrence of respiratory symptoms, those

**Table 2**  
**Pearson Correlations between the Frequency and Duration of Symptoms**

Duration	Occurrence			
	Depression	Aches	Gastrointestinal	Upper respiratory
Depression	<b>.16</b>	.15	.45**	.15
Aches	.14	<b>.40**</b>	.39**	.50**
Gastrointestinal	-.06	.28*	<b>.31*</b>	.41**
Upper respiratory	.06	.14	.01	<b>.71**</b>

Note. Bold numbers in diagonal represent correlations between occurrence frequency and duration for each symptom. Numbers above the diagonal are the intercorrelations of the occurrence frequency measures of different symptoms, whereas numbers below the diagonal are the intercorrelations of the duration measures of different symptoms.

\* $p < .05$   
 \*\* $p < .01$ .

symptoms tended to persist.<sup>7</sup> The other symptom factors showed fairly modest correlations between symptom duration and occurrence, suggesting that these two aspects of these illnesses could have differential correlates with personality.

The triangular off-diagonal component of the matrix in Table 2 represents the intercorrelations of the occurrence and duration parameters across the different symptom clusters. The occurrence frequency of gastrointestinal problems, aches, and upper respiratory symptoms correlated significantly though moderately with each other. The occurrence frequency of depression symptoms covaried only with the occurrence frequency of gastrointestinal symptoms. The moderate intercorrelations between measures of symptom occurrence may suggest a form of reporting bias. This pattern of intercorrelations might be explained, in

7. The duration score may be influenced by the absolute occurrence frequency for specific symptoms. In our sample, the highest correlation between duration and occurrence was for the respiratory symptoms. Also, respiratory symptoms had the highest lagged autocorrelation, over twice as long as any other symptom cluster. This suggests that, on average, if a respiratory infection occurs, it tends to last awhile. This will lead to a large correlation between occurrence and duration for this symptom cluster. If a cold occurs, it tends to run a predetermined course. It is interesting to note that dura-

part, by a tendency of some subjects to be more perceptive of and/or willing to complain about minor discomforts (Watson & Pennebaker, 1989). In terms of duration, there was much less intercorrelation among the symptom factors. Only the duration of gastrointestinal symptoms tended to correlate modestly with the duration of ache symptoms. This suggests the possibility that our measures of symptom duration may not be as influenced by a general reporting bias as our measures of symptom occurrence.

### Intercorrelations of the Personality Measures

The correlations between all the personality measures used in this study, as well as their distributional characteristics, are presented in Table 3. As can be seen, these intercorrelations are quite modest. The neuroticism scale showed some overlap with two other personality scales. The relation between neuroticism and the JAS is not surprising in light of Suls and Wan's (1989) meta-analysis showing that the JAS is moderately but consistently related to emotional distress and Suls and Sanders's (1988) suggestion that self-reported Type A behavior may contain a component of neuroticism. It could be that relations found between self-report measures of Type A behavior and symptoms are due,

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tion for respiratory symptoms did not correlate with any of the personality variables. This may be due to the fact that the respiratory symptom factor is perhaps the most exogenous of our symptom factors. That is, certain behaviors may bring on a stomach-ache (eating or drinking too much), certain behaviors may bring on muscle soreness (vigorous recreation), and certain behaviors may bring on depressed affect (failing an exam because of a lack of studying). However, one does not necessarily behave in certain ways to bring on a cold. Most likely a large proportion of the respiratory symptom episodes were due to viral infections. This study was run between October and December, the time of year when one is most likely to catch a cold in the Midwest. So it seems that, for truly exogenous-cause symptoms, there may be a stronger relation between occurrence and duration than for the other symptoms that might have more behavioral causes.

One interesting application of these ideas might be to identify subjects who do not show the expected match between occurrence and duration for some exogenous-caused symptom. In particular, one would look for those subjects whose duration scores have a lower value than might be predicted from their occurrence score (*i.e.*, have negative residuals from the sample regression line). Such people are recovering faster than would be expected or predicted. Investigators then might inquire as to what such subjects are doing to accelerate their recovery.

**Table 3**  
**Intercorrelations and Descriptive Statistics**  
**for Personality Measures**

	Type A behavior	Anger control	Cook- Medley hostility	Mean	SD	Range
Type A behavior				16.07	5.41	6 to 29
Anger control	-.08			6.16	2.51	1 to 11
Cook-Medley hostility	.06	-.27*		26.11	4.50	16 to 37
Neuroticism	.30**	-.03	.27*	12.78	4.92	3 to 21

\* $p < .05$

\*\* $p < .01$ .

in part, to the overlap between self-reported Type A behavior and neuroticism. Because of this overlap, all subsequent correlational analyses of Type A behavior and health reported in this article were performed both with and without controlling for neuroticism. None of the correlations between Type A behavior and the health parameters changed significantly as a function of partialling out neuroticism. We therefore only report the first-order Pearson correlations for the Type A variable.

The relation between neuroticism and the Cook-Medley measure of global hostility is also to be expected, given that the MMPI-derived Cook-Medley scale contains some items tapping cynicism, blaming, and negative affect. A surprisingly low correlation was found between the measure of anger control and the Cook-Medley measure of hostility. However, the anger control measure contains only items referring to the control of aggressive behavior in response to anger-provoking or frustrating situations. The Cook-Medley scale, on the other hand, contains only 3 out of 50 items that refer explicitly to aggressive responding (Barefoot et al., 1989). In fact, Barefoot et al. show that the Cook-Medley scale is extremely heterogeneous and that the sum of the 3 aggressive responding items correlates only an average of .26 with the other distinct item clusters derived from the Cook-Medley item set. Apparently, the many facets of global hostility identified by Barefoot et al. (i.e., cynicism, blaming, hostile affect, aggressive responding, and social avoidance) are not highly coherent. Our finding supports the notion that acting aggressively is somewhat distinct from feeling angry, having a negativistic outlook, and the other components of

global hostility. Because Barefoot et al. found that aggressive responding was among the best prospective predictors of long-term mortality, we expect that the anger control measure, since it measures lowered aggressive response behavior, should correlate more highly with our symptom duration variables than global hostility as assessed by the Cook-Medley scale.

### Personality Correlates of the Temporal Parameters of Daily Symptoms

In Table 4 we present Pearson correlations between the three personality variables and the three temporal models of daily symptoms. In terms of the occurrence of symptoms, we see that the strongest correlations are with neuroticism, especially for the frequency of depression and gastrointestinal symptoms. However, Type A behavior did correlate with symptom occurrence for depression. It is interesting that the occurrence frequency of respiratory symptoms did not correlate with any of the personality variables examined in this study.

In terms of duration,<sup>8</sup> a highly discriminative pattern of correlations emerged. With the exception of respiratory symptoms, the duration of all other symptom clusters correlated significantly and negatively with anger control. Individuals with less potential for angry behavior and who do not exhibit aggressive responses report illness symptoms that tend to run a shorter average course than individuals who experience anger and exhibit aggressive behavior, as would be predicted from Roger and Neshoever's (1987) and Melamed's (1987) speculation about this personality variable. The one significant correlation between Type A behavior and duration parameters was with depression duration, suggesting that when high Type A individuals become depressed, their depressive symptoms tend to last longer than the depressive symptoms of low Type A individuals. Neuroticism showed no significant correlations with the duration parameters of any of the symptom clusters, even though neuroticism was significantly related to three out of

8. There were two subjects with no symptoms from the respiratory factor and three subjects with no symptoms from the depression factor reported during the 2 months of observation. These subjects were dropped from the duration and emotional concomitants analyses for these symptoms. It makes no sense to analyze within-subject covariance patterns for subjects who had no variance on one of the variables of interest.



**Table 4**  
**Pearson Correlations between Personality Variables**  
**and Parameters of Daily Symptoms**

	Depression	Aches	Gastro-intestinal	Upper respiratory
Occurrence of symptoms				
Type A behavior	.31*	.05	.16	.06
Anger control	.05	.12	-.25	.07
Cook-Medley hostility	.07	.24	.14	.04
Neuroticism	.47**	.15	.44**	.08
Duration of symptoms				
Type A behavior	.37**	.13	-.12	.06
Anger control	-.40**	-.41**	-.26*	.05
Cook-Medley hostility	.19	.21	.31**	.08
Neuroticism	.15	.21	-.07	.24
Symptom covariation with mood				
Type A behavior	-.34**	-.26*	.38**	-.52**
Anger control	-.02	.13	.18	.10
Cook-Medley hostility	.01	-.07	-.11	-.12
Neuroticism	.01	.06	-.09	.21

\* $p < .05$

\*\* $p < .01$ .

four of the symptom occurrence scores. Interestingly, the duration of respiratory symptoms did not correlate significantly with any of the personality variables, even though the duration scores on this symptom cluster had the largest between-subject range of any of the symptom duration scores (ranging from 0 to 12 significant lagged autocorrelations across subjects). The recovery rate from upper respiratory symptoms is thus unrelated to any of the personality variables assessed in this study.<sup>9</sup>

In terms of the concurrent relation between mood and daily symptoms, a very interesting pattern of significant correlations emerged with

9. Reviewers raised the concern of the computation of the symptom "duration" variable. The autocorrelation may not be immediately obvious as an index of duration. In addition, a more straightforward method of operationalizing the duration parameter might be desirable. Toward this end we tried operationalizing the concept of an illness episode as the length of time from the onset of an illness until the next symptom-

the Type A behavior measure. The negative correlations in this part of Table 4 mean that subjects high on the Type A personality dimension reported less linkage between negative mood and symptoms than subjects low on this personality dimension. Recall that the variable being correlated with the personality measures is the within-subject regression coefficient between daily mood and daily symptoms. These regression coefficients ranged from zero to strongly positive in this sample. The larger the within-subject regression coefficient, the stronger the co-occurrence between unpleasant affect and symptoms for that subject. These within-subject regression coefficients were then correlated with the personality measures to generate the results in this part of Table 4. A positive correlation in this part of Table 4 indicates that subjects high on Type A behavior showed less concurrent covariation between unpleasant affect and daily symptoms.

Table 4 indicates that subjects high on the JAS measure of Type A behavior have decreased covariation between unpleasant mood and the daily symptom clusters of respiratory infection, aches, and depression. That is, high Type A individuals report feeling less emotionally down during episodes of these particular symptoms than low Type A

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free period. That is, once any single symptom from a particular factor was reported, we computed the number of subsequent observation periods until no symptoms from that factor were reported. We called this a symptom episode. For each subject we then counted the number of symptom episodes that occurred and computed the average *length* of symptom episodes for each subject on the four symptom factors. The average episode length was then correlated with the personality variables. Average episode length produced correlations with personality variables that were very similar to those correlations found for the symptom *occurrence* variable. In fact, average episode length turned out to be highly correlated with occurrence frequency. The correlations between average episode length and symptom occurrence frequency were .86 for depression, .89 for aches, .75 for gastrointestinal problems, and .55 for upper respiratory symptoms. We also computed the correlations between our duration index (the number of significant lagged autocorrelations) and average episode length. The correlations between episode length and our autocorrelation measure were much lower than the correlation between episode length and symptom occurrence frequency. The average episode length, computed in this manner, thus appears to represent *occurrence frequency* much more than duration. This blurs the distinction we are trying to establish between occurrence and duration. Another nontrivial reason to keep the autocorrelation index of duration is that the autocorrelation is computationally easier to obtain than average episode length, computed as above. Readers may thus be more likely to implement the autocorrelation measure of duration in their own research.

individuals. Interestingly, the exact opposite was found for gastrointestinal symptoms. Here Type A behavior was related to an increased co-occurrence of unpleasant affect and this particular symptom. This suggests that an episode of gastrointestinal distress is likely to be accompanied by more unpleasant affect for high Type A individuals than for low Type A individuals.

### Assessing Lead and Lag Relations between Symptoms and Moods

Early feedback from editors and reviewers of our work challenged us to explore the possibility of lagged relations between moods and symptoms, taking each subject separately. Even though this was tangential to our concern with personality effects, the identification of lead/lag relations poses an interesting time-series question about symptoms and moods. Addressing such questions can illustrate the unique potential of data gathered over time.

To assess lead/lag relations between symptoms and moods, we fit two types of models to each subject's data, one predicting mood from past symptoms, controlling for autocorrelation in mood:

$$\begin{aligned} \text{Mood}_t = & \beta_1 \text{Mood}_{t-3} + \beta_2 \text{Mood}_{t-2} + \beta_3 \text{Mood}_{t-1} \\ & + \beta_4 \text{Symptom}_t + \beta_5 \text{Symptom}_{t-1} + \beta_6 \text{Symptom}_{t-2} \\ & + \beta_7 \text{Symptom}_{t-3} \end{aligned} \tag{2}$$

Another model predicted symptoms from past moods, controlling for autocorrelation in the symptoms:

$$\begin{aligned} \text{Symptom}_t = & \beta_1 \text{Symptom}_{t-3} + \beta_2 \text{Symptom}_{t-2} \\ & + \beta_3 \text{Symptom}_{t-1} + \beta_4 \text{Mood}_t + \beta_5 \text{Mood}_{t-1} \\ & + \beta_6 \text{Mood}_{t-2} + \beta_7 \text{Mood}_{t-3} \end{aligned} \tag{3}$$

These models were fit to each of the four symptoms for each subject separately. We then averaged the parameters of these models across subjects to obtain the mean relationships between moods and symptoms at various time lags. The averaged parameters for these models are presented in Table 5.

Regarding lead/lag relations, in general, moods lead symptoms more

**Table 5**  
**Averaged Standardized Beta Weights from Autoregressive Analyses of**  
**Lead-Lag Relations between Symptoms and Moods<sup>a</sup>**

Equations that predict mood from past symptoms															
Mood <sub>t</sub>	=	.32	Mood <sub>t-1</sub>	.05	Mood <sub>t-2</sub>	.08	Mood <sub>t-3</sub>	.25	Depress <sub>t</sub>	-.01	Depress <sub>t-1</sub>	-.01	Depress <sub>t-2</sub>	-.01	Depress <sub>t-3</sub>
Mood <sub>t</sub>	=	.32	Mood <sub>t-1</sub>	.05	Mood <sub>t-2</sub>	.08	Mood <sub>t-3</sub>	.16	Aches <sub>t</sub>	-.02	Aches <sub>t-1</sub>	-.02	Aches <sub>t-2</sub>	.01	Aches <sub>t-3</sub>
Mood <sub>t</sub>	=	.32	Mood <sub>t-1</sub>	.05	Mood <sub>t-2</sub>	.08	Mood <sub>t-3</sub>	.14	Gastro <sub>t</sub>	.00	Gastro <sub>t-1</sub>	-.01	Gastro <sub>t-2</sub>	.00	Gastro <sub>t-3</sub>
Mood <sub>t</sub>	=	.32	Mood <sub>t-1</sub>	.05	Mood <sub>t-2</sub>	.08	Mood <sub>t-3</sub>	.06	Respir <sub>t</sub>	.02	Respir <sub>t-1</sub>	-.01	Respir <sub>t-2</sub>	.01	Respir <sub>t-3</sub>
Equations that predict symptoms from past moods															
Depress <sub>t</sub>	=	.21	Depress <sub>t-1</sub>	.05	Depress <sub>t-2</sub>	.05	Depress <sub>t-3</sub>	.25	Mood <sub>t</sub>	-.04	Mood <sub>t-1</sub>	-.02	Mood <sub>t-2</sub>	-.02	Mood <sub>t-3</sub>
Aches <sub>t</sub>	=	.28	Aches <sub>t-1</sub>	.05	Aches <sub>t-2</sub>	.09	Aches <sub>t-3</sub>	.16	Mood <sub>t</sub>	-.04	Mood <sub>t-1</sub>	-.05	Mood <sub>t-2</sub>	-.01	Mood <sub>t-3</sub>
Gastro <sub>t</sub>	=	.17	Gastro <sub>t-1</sub>	.03	Gastro <sub>t-2</sub>	.05	Gastro <sub>t-3</sub>	.14	Mood <sub>t</sub>	-.03	Mood <sub>t-1</sub>	-.01	Mood <sub>t-2</sub>	-.01	Mood <sub>t-3</sub>
Respir <sub>t</sub>	=	.34	Respir <sub>t-1</sub>	.12	Respir <sub>t-2</sub>	.12	Respir <sub>t-3</sub>	.06	Mood <sub>t</sub>	.02	Mood <sub>t-1</sub>	-.03	Mood <sub>t-2</sub>	.02	Mood <sub>t-3</sub>

a. Addition signs (+) have been omitted between adjacent terms to improve readability; mood is scaled so that high scores indicate that more unpleasant affect was reported. Depress = depression; Gastro = gastrointestinal problems; Respir = upper respiratory problems.

than symptoms lead moods. That is, the absolute values of the standardized beta weights for predicting future symptoms from current mood ( $\beta_5$  in Equation 3) were larger, on average, than the standardized beta weights for predicting future mood from current symptoms ( $\beta_5$  in Equation 2). However, the intriguing aspect of these findings is that the beta weight for predicting future symptoms from current mood is negative for all symptoms except the respiratory factor. This means that most of the symptom factors tended to be reported following a more positive mood than would be expected by chance. Granted, this effect is very small. However, the beta weights for predicting symptoms from previous mood are two to four times larger than the beta weights for predicting mood from previous symptoms. Since these are standardized beta weights they can be directly compared to each other in this manner.

One post hoc interpretation of these findings invokes a context explanation. A symptom occurring in the context of an existing good mood is more likely to be noticed and complained about (reported) than the same symptom occurring in the context of a bad mood. Imagine that you have a slight backache. It is likely that this backache will be more salient if it impinges on an existing good mood than if it occurs during an existing bad mood. Because the averaged effects are small and the interpretation admittedly post hoc, we will keep our comments about lead/lag relations between symptoms and moods to a minimum. However, we do want to point out that even though the mean lagged beta weights were small, there was a wide range of individual differences in the sizes of the effects, with some subjects showing lagged effects that achieved significance in terms of predicting the occurrence of future symptoms from more positive previous moods. For example, negative mood scores predicted later symptoms of depression with beta weights ranging from  $-.35$  to  $.21$ . The weights for predicting future aches from previous negative mood scores ranged from  $-.36$  to  $.25$ , and the weights for predicting future gastrointestinal problems from previous negative mood scores ranged from  $-.29$  to  $.22$ . These distributions of lagged beta weights across subjects were all skewed in the direction of more positive moods predicting the occurrence and severity of later symptoms (skew values are  $.42$  for depression,  $.95$  for aches, and  $.11$  for gastrointestinal problems). This implies that more subjects than not conform to our explanation that symptoms following in the wake of more positive moods tend to be reported as more severe, at least for the

three reported above. Because these analyses are tangential to our main topic of personality and health, we will not develop these ideas any further here. Rather, we simply raise the issue of individual differences in lagged effects as a way of guiding the reader to consider this as one of the many analytic possibilities inherent in time-series data of this sort.

Another interesting aspect of Table 5 is the large first-order autoregressive component in mood. This suggests that moods do carry over across adjacent time periods sampled in this study. Researchers who have examined autoregressive models of mood typically do not find significant carryover across days in daily studies (e.g., Bolger & Schilling, 1991; DeLongis et al., 1988). It might be that we found lagged autoregression effects for moods because our sampling rate was much faster than most time-series studies in this area (i.e., three samples per day instead of the typical single daily report).

## DISCUSSION

In the area of health and personality, most researchers focus on personality variables in relation to the frequency of illness occurrence. We have referred to this traditional conceptualization as the "occurrence" formulation of personality and health. However, if we take a daily event approach to health we can focus on health/illness as a process that fluctuates over time. The daily research design allows us to focus on these fluctuations and prospectively study health as a temporal process. This permits us to ask questions about health/illness, emotion, and personality that are unassailable with traditional cross-sectional, retrospective, or pre-/post-research designs. New routes of inquiry are opened by the daily method of research. In the current study we used this method to develop temporal models of the course of various daily symptom clusters. We focused on three temporal parameters of day-to-day symptoms as individual difference variables: occurrence frequency, duration, and emotional concomitants of daily symptoms.

We found that neuroticism and, to a lesser extent, Type A behavior, related to the occurrence frequency of symptom reporting. This held for all symptoms except respiratory symptoms, the occurrence frequency of which correlated with none of the personality variables incorporated in this study. In terms of the duration of symptoms, the strongest correlations were with anger control, in the negative direction. People who do not manifest aggressive responses to anger-provoking or frustrat-

ing situations tend to report having symptoms of shorter duration than those reported by subjects who do respond with anger and aggressive behavior. This effect held for all symptoms except upper respiratory infections. The duration parameter for the respiratory symptom cluster, although having the widest variance of any duration variable across subjects, did not correlate with any of the personality variables assessed in this study. In terms of the emotional concomitants of daily symptoms, the only significant correlates were with the Type A behavior self-report measure. Respiratory distress, aches, and depression were less tightly linked to unpleasant emotions for high Type A individuals compared to low Type A individuals. That is, high Type A subjects reported less unpleasant affect *during* symptom episodes than low Type A individuals. We speculate that the high Type A individual is too busy trying to accomplish more in less time and thus is disinclined to let these symptoms interfere. This effect held for all but gastrointestinal symptoms, where the opposite pattern was found.

The notion of a disease-prone personality carries an implicit assumption about the formulation of the relation between personality and illness. Most work on personality and disease follows an occurrence formulation, where personality is assumed to play a role in determining who is likely to become ill. The present study demonstrates that alternative formulations become available when illness is considered as a temporal process. Specifically, we can model different aspects of the illness course and examine patterning in the day-to-day fluctuations between illness and health. We can use such temporal models to examine the duration of various symptoms or their impact on other aspects of day-to-day life. Health/illness is an inherently temporal process: Our understanding of personality and health will be enhanced to the extent that we bring temporal formulations of this process to our research designs and temporal analyses (e.g., time-series) to the data generated from such designs.

The editors of this special issue on daily events have asked the authors to address issues faced in the conceptualization and methodology of their specific studies. One difficulty in this type of research is to appreciate the possibilities inherent in data gathered over time. Time becomes a facet of the data in this approach, and data so gathered contain variance along three dimensions: persons, variables, and time. An important logistic issue is how to keep from being overwhelmed by the temporal aspect of the data (i.e., the size of the data set grows geometrically

as a function of the number of occasions sampled) and still use this information in a meaningful way (i.e., more than as just a dimension over which one averages to get more stable/reliable estimates). Traditional statistical approaches commonly used in psychology are limited to two-dimensional data sets—Persons  $\times$  Variables. The introduction of the third dimension—time—adds a degree of complexity to the data set, but also opens up possibilities for addressing questions that cannot be addressed with two-dimensional data. Nevertheless, one needs a framework for thinking about and analyzing data derived from intensive time-sampling research strategies. Larsen (1989a) has proposed one framework based on Cattell's (1975) concept of the data box. A very similar framework, based on within-subject correlational designs, has been presented by Michela (1990). Other authors in this special issue suggest different ways to think about the role of time in data analysis. There are also similar approaches to such data found in the biometric literature (e.g., Zeger & Liang, 1986; Zeger, Liang, & Albert, 1988). In particular, the seminal article by Laird and Ware (1982) proposes a unified class of longitudinal models that generate within-subject parameters as well as parameters to account for the differences between subjects. The approach followed in the current study is a special case of the more general models proposed by Laird and Ware (1982).

The types of time-series analyses available, and the number of parameters that may be generated from each, can result in a large number of models potentially open to investigation. This raises another important issue for researchers contemplating the use of these methods. One must start with a substantive research question, which should guide the methodological approach to time in the data analysis. If one proceeded purely inductively, one could try a lot of different models before stumbling on something interesting (and something that may not replicate). Instead, one's research question should guide the selection of time-series models to use in the analyses. In our case, we had research questions about individual differences in the *course* of minor illnesses. Being interested in the course of illness demanded that we consider specific time-series parameters to model specific aspects of symptoms over time. The specific aspects of symptom course in which we were interested—occurrence, duration, and emotional concomitants of illness episodes—then led us to consider how such aspects could be modeled by various time-series analyses applied to the daily data sets for each subject. We then used a time-series approach to model these



process-descriptive variables at the level of the individual: frequency counts to model the occurrence of symptoms, lagged autocorrelations to model the duration of symptoms, and bivariate autoregressive beta weights to model the emotional concomitants of symptoms.

Data analysis in our study proceeded according to a process approach to temporal research (Larsen, 1989a). That is, we looked for patterning within each subject's symptom data over time, and quantified these patterns with various summary statistics computed for each subject. These within-subject (idiographic) statistics then became nomothetic "scores" for analyses computed between subjects (i.e., individual difference analyses). We were then able to ask such between-subject questions as: Do people differ in the occurrence of symptom reporting over time, and does this relate to health-relevant personality variables? Do people reliably differ from each other in their recovery rate from illnesses, and does this individual difference relate to any health-relevant personality dimensions? Do people differ in terms of the linkage between daily mood and daily symptoms, and does this individual difference relate to any health-relevant personality dimensions? Such an approach moves the study of illness into the realm of daily-event methodologies and opens up an expanded arena of inquiry about the relationship between personality and health.

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