Effects of Environmental Predictability and Personal Mastery on Self-Regulatory and Physiological Processes

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College student participants high and low in personal mastery were exposed to an experimental priming manipulation that made salient the unpredictable aspects of college, the predictable aspects of college, or neutral features of the college environment. They then completed a thought-listing task regarding thoughts about college and measures of self-regulatory processes. Blood pressure and pulse data were collected every 2 minutes. Participants exposed to the predictable manipulation made more references to the future and more references to personal goals and had lower systolic blood pressure and pulse pressure reactivity compared with those in the neutral condition and to those in the unpredictable condition. Participants high (vs. low) in mastery showed more evidence of active self-regulation. Implications for the study of stress are discussed.

Environments that are chronically stressful are toxic for human physical and mental health (see Taylor, Repetti, & Seeman, 1997, for a review). A large body of empirical literature has demonstrated that people under chronic stress experience psychological distress (e.g., Brown & Harris, 1978; Pearlin & Schooler, 1978), depression (McGonagle & Kessler, 1990; Pearlin, Meaghan, Lieberman, & Mullan, 1981), and physical symptoms (e.g., Gannon & Pardie, 1989). Exposure to specific long-term stressors, such as occupational stress or caregiving, also has been tied to psychological distress and to adverse health outcomes, including higher rates of cardiovascular disease and infectious disease (Kiecolt-Glaser, Dura, Speicher, Trask, & Glaser, 1991; Repetti, 1993). The well-established socioeconomic status (SES) gradient for all-cause mortality is believed to be at least partly mediated by the greater chronic stress experienced the lower one's position on the SES ladder (Adler, Boyce, Chesney, Folkman, & Syme, 1993). Recent analyses of the role of chronic stress in the cumulative wear and tear on the body and the health conditions that may result (McEwen, 1998; McEwen & Stellar, 1993) add fuel to the need to study the ways in which chronic stress compromises physiological and self-regulatory functioning.

An important feature of environments that is believed to contribute to chronic stress and its concomitant adverse health effects is exposure to unpredictable or uncontrollable circumstances (Haidt & Rodin, 1999). For example, low control, especially when it is coupled with high demands, has been tied to both psychological distress and poor health in the workplace (e.g., Frankenhaeuser, 1991; Karasek & Theorell, 1990), especially risk for cardiovascular disease (e.g., Karasek, Baker, Marxer, Ahlbom, & Theorell, 1981). Low control or the loss of control also has been tied to health problems among the elderly (e.g., Langer & Rodin, 1976; Schulz,

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1976). In addition, a large laboratory literature (see Thompson, Cheek, & Grahma, 1988) suggests that situations of unpredictability or low control may promote greater physiologic reactivity to acutely stressful events than is the case when a sense of personal control has been induced.

Among the mechanisms posited for the adverse effects of unpredictability on health and mental health are threats to self-regulation. It is known that self-regulatory activities vary greatly with the predictability of the environment (Aspinwall & Taylor, 1997). For example, chronic vigilance to potential threats, lack of planning, an inability to set long-range goals, a present temporal orientation, and the need to respond to problems online all have been postulated to be self-regulatory consequences of managing an unpredictable environment (e.g., Aspinwall & Taylor, 1997). In contrast, environments that are predictable or that afford opportunities to exert personal control may lead to self-regulatory activities characterized by such features as a future temporal orientation, long-term planning, and goal setting (Aspinwall & Taylor, 1997). In addition to the mediational role that self-regulatory activities may play in the relation between unpredictability and poor mental and physical health, dysfunctions in self-regulatory activities appear to have other adverse life effects, such as the inability to develop active coping strategies, which are believed to be superior methods for dealing with stress (e.g., Holahan & Moos, 1987); the inability to use proactive coping strategies that may eliminate or offset stressful events altogether (Aspinwall & Taylor, 1997); and the failure to practice preventive health behaviors (e.g., Botvin, Eng, & Williams, 1980).

An issue that remains unresolved is whether exposure to a predictable or controllable environment confers physiological and self-regulatory benefits in its own right. Most studies that have evaluated the effects of predictability versus unpredictability have employed a stressor that participants believe they can control or not, and so there is no neutral condition against which potential positive effects of predictability may be evaluated independent of the adverse effects of unpredictability. This issue has taken on increasing significance in the context of recent theoretical and empirical demonstrations of the importance of positive health. That is, environmental circumstances and personal resources may foster resilience and thriving in the face of adversity, as opposed to merely offsetting adverse responses to threatening events (Bower, Kemeny, Taylor, & Fahey, 1998; Eppel, McEwen, & Ickovics, 1998; Updegraff & Taylor, 2000). Although some have concluded that positive states of mind may indeed be health protective and mental health protective (see Ryff & Singer, 1998), others have pointed out that the research evidence primarily favors adverse effects on health through negative experiences and states of mind more than it does protective features of positive experiences and states of mind (e.g., Robinson-Whelan, Kim, MacCallum, & Kiecolt-Glaser, 1997). Thus, this issue remains controversial.

Personal mastery is an individual difference factor that may moderate how a predictable versus unpredictable environment is perceived and negotiated (Aspinwall & Taylor, 1997; Pearlin & Schooler, 1978). Generally speaking, beliefs that one is able to control, influence, or predict outcomes have been associated with positive psychological functioning (e.g., Rodin, 1986; Rodin, Timko, & Harris, 1985). A sense of personal control or mastery also has been linked to better physical health outcomes, including lower incidence of coronary heart disease (CHD) (Karasek et al., 1981), better self-rated health and functional status (M. Seeman & Seeman, 1983), and lower mortality risk (M. Seeman & Lewis, 1995). However, under some circumstances, higher beliefs in personal mastery can be associated with poorer health outcomes (Rodin, 1986; T. E. Seeman, 1991; Thompson et al., 1988). Especially when there are incongruities between personal beliefs in mastery and situational conditions of high unpredictability or low control, strong beliefs in mastery can lead to higher levels of physiological and neuroendocrine activity indicative of stress (e.g., Houston, 1972; Manuck, Harvey, Lechleiter, & Neal, 1978; Sieber et al., 1992). People identified as having a strong need for control through Type A measures (Miller, Lack, & Asroff, 1985; Strickland, 1978) respond to lack of control in laboratory situations with greater physiologic reactivity (Krantz, Glass, & Snyder, 1974). Recurring high reactivity to such uncontrollable situations may contribute to CHD risk (e.g., T. E. Seeman, 1991). Thus, whereas personal mastery may represent an effective individual difference resource in predictable or controllable circumstances, whether it is adaptive in unpredictable or uncontrollable circumstances is controversial.

The present study examined these issues by comparing the effects of unpredictable, predictable, and neutral circumstances on self-regulation and physiological reactivity and examining the moderation of those responses by individual differences in mastery. Whereas previous research has manipulated acute stress in the laboratory through challenge paradigms, the present research made use of a priming methodology in which the chronically unpredictable, chronically predictable, or neutral features of an enduring environment of participants, namely, the college environment, were manipulated. We hypothesized that when individuals are primed with the unpredictable features of an environment that they must negotiate daily, they will experience adverse physiological changes in the form of elevated blood pressure and enhanced pulse rate and a decline in self-regulatory skills, such as future orientation, planning, and goal setting. We hypothesized that individuals exposed to a manipulation that makes salient the predictable features of the environment to which they are chronically exposed would not experience adverse physiological changes and would demonstrate evidence of adaptive self-regulatory activities, including future temporal orientation, planning, and goal setting. Compared with those low in mastery, we predicted that those high in mastery would be more benefited by the predictability manipulation in terms of biological and self-regulatory functioning; as noted, the literature generates contradictory predictions regarding the effects of personal mastery in unpredictable circumstances.

METHOD

Participants

Ninety-six undergraduates from the University of California, Los Angeles, participated in the study to fulfill a course requirement. The sample included 71 women and 25 men (M = 19.91 years). The sample was 32% Anglo, 33% Asian, 4% African American, 15% Latino, and 16% other.

Procedure

Participants were recruited to the lab and run individually. They were told that the purpose of the research was to examine students' thoughts about their college experiences and how the college experience affects students' health. All participants then completed the Pearlin Mastery Scale (Pearlin & Schooler, 1978). The Pearlin Mastery Scale was developed as a measure of the extent to which a person views his or her life chances as being under personal control or as fatalistically ruled (Pearlin & Schooler, 1978). The scale demonstrates reasonable internal consistency (α = .76) and has good construct validity, both in terms of its internal factor analytic consistency and its externally validated association with other psychological characteristics (Pearlin & Schooler, 1978). This measure has since been used in numerous studies of the relationship between perceptions of personal control and health (e.g., Lachman & Weaver, 1998; see Haidt & Rodin, 1999, for a review).

Participants sat quietly for the next 8 minutes as the baseline blood pressure assessments were made. Blood pressure assessments were made every 2 minutes, which resulted in four readings during the baseline period. The average of the last two ratings of this preliminary 8-minute period constituted the baseline measures. Systolic blood pressure, diastolic blood pressure, and pulse rate readings were taken every 2 minutes thereafter using an automated blood pressure and pulse rate monitor.

Participants were then randomly assigned to one of three groups. The perceived predictability of the environment was primed through written communication. One group of participants was exposed to a communication that made salient the predictable aspects of the college environment, including the reliability with which classes are held, knowing in advance which classes are offered and when, being able to choose what classes to take and what field to major in, and knowing in advance information about major requirements and grading standards. A second group of participants was exposed to a written communication that made the unpredictable aspects of the college environment salient, such as not getting into one's classes of choice, conflicting class schedules, cancellation or rescheduling of classes, lack of choice over how to satisfy major requirements, professors' varying styles of teaching and different enrollment or grading systems, and the occurrence of random events that interfere with academic work (e.g., becoming sick and having to miss classes or exams). Participants in these two groups were then asked to write about three additional features of the college environment based on their own experiences that corresponded to the communication they had been given. That is, in the predictable condition, participants were asked to take a moment to think about their own college experience and the predictable aspects of college life that are most useful to them in terms of helping them adjust successfully in college. In the unpredictable condition, participants were asked to take a moment to think about their own college experience and the unpredictable aspects of college life that are most difficult for them to adjust to in college. Participants in the control group were given a communication about the physical features of the college campus (e.g., describing the buildings, the landscape, and the physical environment) and a neutral task of describing three additional physical characteristics of the college campus. The three communications were each approximately 500 words in length, and the entire task (reading and extra examples) took approximately 6 minutes to complete.

Following this task, participants were instructed to write down all college-related thoughts that came to mind for the next 10 minutes. Following the thought-listing task, participants completed a questionnaire that assessed aspects of self-regulation and temporal orientation. Many of the questionnaire items were adapted from the Stanford Time Perspective Inventory (Gonzalez & Zimbardo, 1985), the Temporal Orientation Scale

(Jones, Pomare, & Lasane, 1992), and the Consideration of Future Consequences Scale (Strathman, Gleicher, Boninger, & Edwards, 1994). The individual items were developed and assigned to a particular composite variable on a conceptual basis. The questions assessed optimism (e.g., "How optimistic are you about the future?"), emotional impact of future temporal focus (e.g., "How good do you feel when you think about or look toward the future?"), expectancies regarding the future (e.g., "How likely is it that you will succeed academically in college?"), planning (e.g., "To what extent do you have a clear plan for the future at this moment?"), evaluations of past experiences (e.g., "How positive were the past experiences of your life before college?"), emotional impact of past temporal focus (e.g., "How good do you feel when you think about life before college?"), attitude toward thinking about the past (e.g., "How much do you like thinking about the past experiences of your life before college?"), evaluations of current experiences (e.g., "How happy are you with your current experiences at UCLA?"), emotional impact of present temporal focus (e.g., "How good do you feel when you think about your current experiences at UCLA?"), attitude toward living in the present (e.g., "How much do you enjoy just living in the present?"), and motivation (e.g., "How motivated are you to do well in college?"). Each item was assessed using a 7-point interval scale (1 = *not at all*, 7 = *extremely*), and items within each construct were summed to create a composite variable. Cronbach's alphas are as follows: optimism ($\alpha = .71$), emotional impact of future temporal focus ($\alpha = .79$), attitude toward thinking about the future ($\alpha = .78$), planning ($\alpha = .77$), evaluations of past experiences ($\alpha = .92$), emotional impact of past temporal focus ($\alpha = .71$), attitude toward thinking about the past ($\alpha = .82$), evaluations of current experiences ($\alpha = .91$), emotional impact of present temporal focus ($\alpha = .82$), attitude toward living in the present ($\alpha = .73$), expectancies for future goal achievements ($\alpha = .71$), and motivation ($\alpha = .64$).

RESULTS

Data were analyzed using 3 × 2 two-way ANOVA with environment salience (predictable, unpredictable, and neutral) and mastery (low, high) as the two independent variables. Planned contrasts explicitly compared the predictable and unpredictable conditions. The Pearlin Mastery Scale (Cronbach's $\alpha = 0.76$) was assessed on an interval scale from 1 (*high in mastery*) to 4 (*low in mastery*). The values ranged from 1.33 to 3.00, with a median of 2.08 and standard deviations of 0.35. A median split was used to categorize participants. Participants scoring 1 to 2.07 were categorized as high in mastery, and participants scoring 2.08 to 4 were categorized as low in mastery.

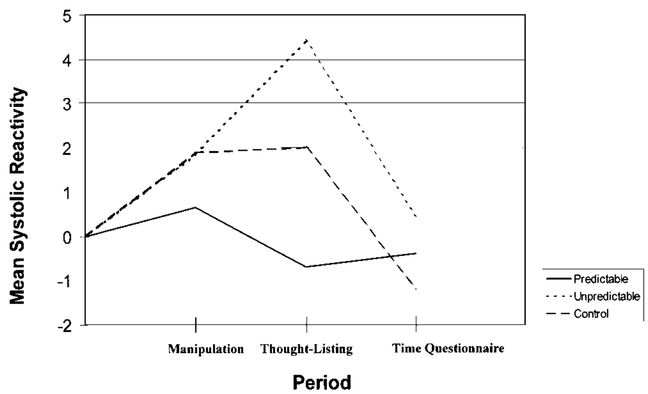

Figure 1 Mean systolic reactivity as a function of environment salience.

Physiological Measures

Blood pressure readings obtained during each period (e.g., during the manipulation, the thought-listing task, and the completion of the questionnaires) were averaged for each period. To produce reactivity scores, the baseline reading (which was the average of the last two readings from the 8-minute rest period) was subtracted from the average blood pressure reading for each period. This was done separately for systolic blood pressure, diastolic blood pressure, and pulse pressure reactivity. To see if the baseline measures needed to be controlled for in the analyses, the correlations between the reactivity scores and the baseline measures were examined for each period. Whereas there were no significant correlations between the systolic baseline reading and the systolic reactivity scores for each period, there were significant negative correlations between the diastolic baseline reading and the diastolic reactivity scores for each period (rs = –0.26 to –0.36, ps < .01). Thus, the analyses for the diastolic reactivity scores used baseline diastolic blood pressure as a covariate.

The ANOVA revealed a predicted significant main effect of the manipulation on systolic blood pressure reactivity during the thought-listing task, $F(2, 89) = 3.26$, $p = .04$. Immediately after exposure to the predictable manipulation during the thought-listing task, participants in this group showed lower systolic reactivity (M = –0.80) than did participants in the control group (M = 1.99) and those in the unpredictable condition (M = 4.38), $t(93) = 1.35$, $p = .18$ and $t(93) = 2.50$, $p = .01$, respectively (see Figure 1).[1] There were no significant differences in diastolic reactivity due to the manipulation, $F(2, 88) = 1.50$, $p = .23$.[2]

We also examined the effect of the manipulation on pulse pressure reactivity (i.e., systolic blood pressure – diastolic blood pressure – systolic baseline + diastolic

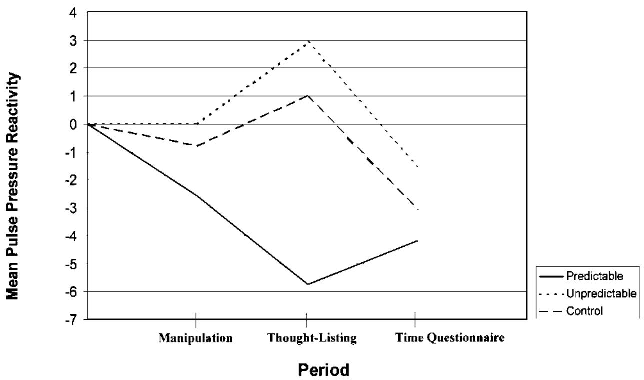

Figure 2 **Mean pulse pressure reactivity as a function of environment salience.**

baseline). Pulse pressure reactivity is a summary measure of blood pressure changes in response to stress that takes account of baseline differences. It has been found to be a strong and independent predictor of intima-media thickness (IMT) of the carotid artery and, as such, indicates status on a significant risk factor for cardiovascular disease (Matthews, Owens, Kuller, Sutton-Tyrrell, & Jansen-McWilliams, 1997). Its clinical significance makes it a useful indicator of cardiovascular reactivity to stress in the present investigation. A significant main effect on pulse pressure reactivity during the thought-listing task was found, $F(2, 89) = 7.73$, $p < .001$. Participants in the predictable condition showed lower pulse pressure reactivity during the thought-listing task ($M = -5.70$) compared with participants in the control group ($M = .99$), $t(93) = 2.95$, $p < .01$, and the unpredictable environment ($M = 2.91$), $t(93) = 3.82$, $p < .001$ (see Figure 2). There were no significant condition differences in pulse rate.

Thought-Listing Analyses

The thought-listing data were coded by two coders for the number of statements that referred to past events, present events, and future events. Each reference to the past, present, or future also was coded for whether the reference was positive, negative, or neutral in tone. In addition, the number of statements about future goals (e.g., education goals, graduation goals, career goals, etc.) was assessed. Interrater agreement across all categories was .81. Overall, there were no significant differences in the number of thoughts that were listed by condition, and none had been predicted.

The analyses revealed a significant main effect of predictability on number of thoughts about the future in the predicted direction, $F(2, 88) = 3.09$, $p < .05$. Making salient the predictable aspects of the college environment fostered a future orientation (as indicated by the

TABLE 1: Mean Number of Thoughts About the Future as a Function of Environment Prime

	Predictable		*Control*		*Unpredictable*	
	M	SD	M	SD	M	SD
Thoughts about the future	8.72_a	8.05	5.19_b	5.82	5.94	5.24
Thoughts about future goals	1.63_a	4.67	0.50	1.16	0.23_b	0.50

NOTE: Means across each row not sharing a common subscript are significantly different from each other at $p \geq .05$.

higher number of references to future events) ($M = 8.72$) compared with the neutral condition ($M = 5.19$) and the unpredictable condition ($M = 5.94$), $t(92) = -2.18$, $p < .05$ and $t(92) = -1.70$, $p = .09$, respectively. Participants exposed to the predictable manipulation also listed more thoughts about future goals ($M = 1.63$) than did those exposed to the unpredictable manipulation ($M = .23$), $t(92) = -1.98$, $p < .05$; however, $F(2, 88) = 2.19$, $p = .12$ (see Table 1).[3] These effects were not moderated by mastery.

To see if the physiological changes were mediated by changes in self-regulation or vice versa, the two physiological measures that showed significant effects for experimental condition were correlated with future temporal orientation and goal focus, which were the two self-regulatory activities that showed changes during the same time period. Systolic blood pressure was correlated –.01 with future temporal orientation and –.05 with thoughts about future goals, and pulse pressure reactivity was correlated –.03 with future temporal orientation and –.08 with thoughts about future goals, indicating that the psychological and physiological responses were independent of each other.

Questionnaire Analyses

The questionnaire items composing each variable were averaged to form an index of each variable. All alphas reached acceptable levels. There were no main effect differences on the questionnaire items due to the predictability manipulation.

We had expected that mastery would moderate psychological responses to the predictability manipulation, but for the most part, analyses of mastery revealed only main effects (see Table 2). High mastery participants were significantly more optimistic about the future, $F(1, 87) = 27.10$, $p < .001$ ($M = 5.16$ vs. 4.19); reported more positive emotions when thinking about the future, $F(1, 88) = 31.24$, $p < .001$ ($M = 5.50$ vs. 4.20); had a more positive attitude when thinking about the future, $F(1, 87) = 22.14$, $p < .001$ ($M = 5.85$ vs. 4.98); were more likely to report having a plan for the future, $F(1, 88) = 5.41$, $p < .02$

TABLE 2: Mastery Effects on Self-Regulation Questionnaire

	Mastery				
	Low		*High*		
	M	SD	M	SD	p <
Optimism	4.19	0.90	5.16	0.91	.001
Positive emotional impact of future temporal focus	4.20	1.26	5.50	0.80	.001
Positive attitude toward thinking about the future	4.98	1.00	5.85	0.78	.001
Having a plan for the future	4.19	0.95	4.89	0.79	.02
Having a plan for the distant future	4.16	1.38	4.70	1.08	.05
Positive evaluation of past experiences	4.89	1.37	5.66	1.18	.01
Positive emotional impact of past temporal focus	5.06	1.30	5.88	1.02	.001
Positive attitude toward thinking about the past	4.78	1.21	5.38	1.21	.02
Positive evaluation of current experiences	4.64	1.45	5.53	1.21	.01
Positive emotional impact of present temporal focus	4.77	1.35	5.72	1.20	.001
Positive attitude toward living in the present	4.66	1.13	5.60	0.86	.001
Motivation/effort	5.72	1.12	6.27	0.97	.01
Expectancies for future goal achievement	4.50	0.99	5.13	0.71	.01

(M = 4.89 vs. 4.19); evaluated the past more positively, $F(1, 87) = 9.07$, $p < .01$ (M = 5.66 vs. 4.89); reported more positive emotions when thinking about the past, $F(1, 88) = 11.41$, $p < .001$ (M = 5.88 vs. 5.06); had a more positive attitude when thinking about the past, $F(1, 87) = 6.02$, $p < .02$ (M = 5.38 vs. 4.78); evaluated their current experiences more positively, $F(1, 88) = 9.42$, $p < .01$ (M = 5.53 vs. 4.64); reported more positive emotions when thinking about their current situation, $F(1, 89) = 12.97$, $p < .001$ (M = 5.72 vs. 4.77); had a more positive attitude toward living in the present, $F(1, 88) = 21.02$, $p < .001$ (M = 5.60 vs. 4.66); were more motivated to achieve their goals, $F(1, 89) = 7.04$, $p < .01$ (M = 6.27 vs. 5.72); and had higher expectancies for future goal achievements, $F(1, 87) = 12.27$, $p < .01$ (M = 5.13 vs. 4.50) than did low mastery participants. There also was a Condition × Mastery interaction for attitude toward thinking about the past, $F(2, 87) = 3.24$, $p < .05$, which indicated that, in the unpredictable and neutral environments, low mastery participants possessed a more negative attitude toward thinking about the past (*M*s = 4.41 and 4.50) compared with high mastery participants (*M*s = 5.69 and 5.38); there was no difference between those high and low in mastery in the predictable condition (M = 5.35 vs. 5.13).

Gender Effects

Recent research (e.g., Matthews, Woodall, Kenon, & Jacob, 1996; Woodall & Matthews, 1993) suggests that men may show vulnerability to risk factors related to cardiovascular disease (CVD) earlier than women; therefore, we compared the genders on their sympathetic reactivity to stress. Three-way ANOVAs with environmental predictability, mastery, and gender as the three independent variables revealed main effects of gender for pulse rate reactivity during the manipulation period, systolic reactivity during the thought-listing period, and pulse rate reactivity during the completion of the time questionnaire, $F(1, 83) = 4.32$, $p < .05$, $F(1, 83) = 5.12$, $p < .05$; and $F(1, 83) = 4.16$, $p < .05$, with men showing significantly higher reactivity (*M*s = 7.78, 4.15, and 6.70) than women (*M*s = 3.68, 1.06, and 2.17) at all three time points. There were also significant Condition × Gender interactions for systolic and diastolic reactivity during the manipulation, $F(1, 83) = 4.59$, $p < .05$ and $F(1, 83) = 5.80$, $p < .05$. Specifically, there were no significant gender differences in the predictable condition, but in the unpredictable condition, men showed higher systolic and diastolic reactivity (*M*s = 5.45 and 7.18) than did females (*M*s = –0.37 and –1.53), $t(86) = 2.60$, $p < .05$ and $t(86) = 3.26$, $p < .05$, respectively.

On the self-regulation questionnaires, women showed a more positive attitude toward thinking about the past, $F(1, 81) = 3.97$, $p < .05$ (M = 5.19 vs. 4.81) and had higher expectancies for future goal achievements, $F(1, 81) = 4.44$, $p < .05$ (M = 4.89 vs. 4.61) than did men.

DISCUSSION

The present investigation was guided by the assumption that chronically stressful features of the environments in which people regularly participate have deleterious effects on self-regulatory behavior and on physiological functioning. This study, an effort to examine this process experimentally, yielded results consistent with such a perspective. In so doing, it makes several contributions to the literature. First, it demonstrates that predictability in the environment may benefit physiological and self-regulatory functioning. Second, it establishes a paradigm for studying effects of chronic stress experimentally in the laboratory. Third, it shows that self-regulatory effects such as a future temporal orientation can be affected by experimentally primed chronic stress. We discuss each of these results in turn.

Following exposure to the predictable manipulation, participants showed lower systolic reactivity and pulse pressure reactivity than did individuals exposed to the unpredictable features of their environment or to the control condition. As Figures 1 and 2 illustrate, participants in the unpredictable condition were somewhat higher in systolic reactivity and pulse pressure reactivity than were those in the neutral condition, but these difference were not significant. At first, this lack of significant differences may appear inconsistent with a large literature suggesting the physiological and psychological adverse consequences of unpredictable circumstances (e.g., see Thompson & Spacapan, 1991). However, much of the prior literature has compared reactions to predictable versus unpredictable circumstances without a neutral control. In the present study, the predictable and unpredictable conditions were significantly different from each other, as in prior research, but only the predictable condition means were significantly different from the control condition. The reason for this fact may stem from differential exposure to the manipulated conditions. That is, all participants experience both the predictable (e.g., having regular course times, knowing the requirements for the major) and neutral aspects (e.g., the grounds and buildings of the campus) of the environment but students vary in their exposure to the unpredictable features of the environment (e.g., cancelled classes, difficulty getting into classes). Consequently, there may have been greater variability in how the unpredictability priming manipulation was experienced. The condition standard deviations bear out this interpretation. The standard deviation for systolic reactivity was twice as large in the unpredictability condition (SD = 11.54) as in the predictable (SD = 5.98) and control (SD = 6.35) conditions. The same pattern was true for pulse pressure reactivity (SD unpredictable = 13.12, SD predictable = 5.85, SD control = 6.56).

The study suggests the viability of studying at least some aspects of chronic stress in the laboratory. In the past, only acute stress experiences have been deemed tractable to experimental investigation. Our results show that priming chronically unpredictable and predictable aspects of an environment can mimic the disruptions in self-regulation and physiologic functioning that are thought to occur in chronically stressful environments. The results also point to some important limitations of this approach. First, as is true of all priming manipulations, the effects appear to be very short term. Second, future research should strive for relatively uniform exposure to the primed chronically stressful conditions.

An issue that has remained unresolved in the previous literature is whether a state loosely described as “positive health” may be achieved, in part, through exposure to beneficial environmental conditions (e.g., Robinson-Whelan et al., 1997; Ryff & Singer, 1998). Although the data from the present study are experimental and short term, they tend to support researchers who have argued for the potential role of positive factors to be health promoting as well as negative factors to be health compromising. The results suggest that prior research may have underestimated the benefits of prediction in focusing on the liabilities of unpredictability.

Priming the predictable aspects of the college environment affected self-regulation in the predicted manner, albeit modestly. Specifically, the predictable manipulation fostered a future orientation in college students, as indicated by the higher number of references to future events and to goals made by participants in this condition. The importance of a future temporal orientation for tasks ranging from academic achievement to a reduced likelihood of engaging in risky health behaviors is well established (De Volder & Lens, 1982; Jones et al., 1992; Keough, Zimbardo, & Boyd, 1996; Nuttin, 1985; Raynor, 1969; Raynor & Rubin, 1971; Rothspan & Read, 1996; Strathman et al., 1994; Teahan, 1958). To the extent that temporal orientation is altered by chronically stressful events, such an alteration may have a potentially wide range of effects on self-regulatory activities. We are not aware of any prior research that has demonstrated experimentally the adverse effects of exposure to unpredictability on self-regulatory activities such as temporal orientation. Temporal orientation has usually been studied as a relatively stable individual difference characteristic, a predictor of reactions to adverse circumstances (e.g., Gonzalez & Zimbardo, 1985). The present research suggests, in contrast, that temporal orientation may ebb and flow, depending on environmental conditions that influence it, and foster or disrupt ongoing self-regulatory activity accordingly. However, the closed-ended questions designed to further explicate the effects of stress on self-regulation failed to show any condition differences. It is likely that the short-term effect of the priming manipulation had dissipated by this time. The fact that the physiological differences also largely abated following the thought-listing task is consistent with this interpretation. Alternatively, it is possible that the summary nature of those questions (e.g., judgments about past activities) diverted attention from the manipulation, thus largely eliminating its effects.

The fact that individual differences in mastery did not moderate reactions to manipulations was unexpected. However, as control researchers (e.g., Aspinwall & Taylor, 1997; Thompson, Armstrong, & Thomas, 1998) have suggested, perceptions of mastery or control may operate primarily at the appraisal stage of responding to stressors. Thus, individual differences in mastery may moderate responses to new stressors but not moderate responses to chronic, familiar stressors that have already been appraised and, to a degree, incorporated into one's life experience. Merely because a chronic stressor becomes salient again by virtue of an experimental prime need not result in additional appraisal, although the adverse physiological and self-regulatory consequences of that chronic stressor would still be experienced.

Despite the fact that the condition effects were not moderated by mastery, the present investigation is enlightening with respect to the cognitive and perceptual concomitants of personal mastery. In particular, individuals high in mastery appear to think about the future more, think about the future more positively, and have more plans for the future compared with those low in mastery. Whether expectations for the future enhance mastery, a sense of mastery leads to positive expectations for the future, or both is unknown.

Although the manipulations affected self-regulatory activities and physiological reactivity largely as predicted, these effects were independent of each other. This pattern suggests that physiological reactivity in response to changes in predictability of the environment is not mediated by the self-regulatory changes that occur (or the reverse). The low relation between psychological and physiological stress responses has been noted by other researchers as well and may be related to the different brain regions that are thought to be implicated in sympathetic reactivity (e.g., the hypothalamus and the limbic system) versus self-regulatory disruption (e.g., the prefrontal cortex).

An alternative explanation for the physiological results can be derived from Obrist (1981), who argued that blood pressure is influenced by effort expended under stress. Thus, it could be argued that participants in the unpredictable condition had somewhat more difficulty completing the thought-listing task and predictable condition participants had less difficulty, with control participants in the middle. Although effortfulness of the thought-listing task was not directly assessed, participants in the thought-listing task did not differ significantly by condition in the number of thoughts they listed during this timed task, suggesting that there were no condition differences in the effort that needed to be expended.

Recent formulations of the effects of chronic stress on bodily functioning (McEwen, 1998; McEwen & Stellar, 1993) have suggested that adverse environmental characteristics may interact with individual risk factors to produce cumulative adverse effects on stress regulatory systems. There is evidence for such a relationship in the present data. Research evidence suggests that men may be more vulnerable at earlier ages than women to risk factors for cardiovascular disease, such as heightened reactivity to stress (Matthews et al., 1996; Woodall & Matthews, 1993). In the present study, men had higher pulse rate reactivity and systolic reactivity for certain experimental periods and, more important, had higher systolic and diastolic reactivity in the unpredictable condition during the manipulation, suggesting their potential greater physiologic vulnerability to fluctuating experiences of predictability.

Some limitations of the research bear mention. First, the study involved young, healthy college student participants, and it is unknown whether samples varying in age or SES would respond in similar fashion. Second, overall, the effects were relatively weak and short-lasting. Although a priming methodology would be expected to show only short-term effects, extrapolating to chronic stress is risky. The study provides only limited information about the relation of stress to self-regulatory skills. Although temporal orientation and references to goals were enhanced by the predictability manipulation, there was little evidence of general disruption of self-regulatory activities, such as planning and organization, in response to heightened unpredictability.

Even in the context of these limitations, however, the present study provides encouraging evidence for the study of dimensions of chronic stress in the laboratory and concomitant effects on self-regulatory activities and physiological reactivity. In addition, the present study provides evidence that environmental conditions emphasizing predictability and regularity may contribute to lower physiological reactivity and to improved self-regulatory skills in the form of a future orientation and emphasis on personal goals. These findings underscore what has come to be an important message in the health psychology literature: Positive experiences may merit as much attention as negative ones in understanding the relation of psychosocial experiences to physiological and self-regulatory outcomes.

NOTES

1. Analyses of systolic reactivity, $F(2, 88) = 3.16$, $p < .05$, and of pulse pressure rate reactivity, $F(2, 88) = 5.67$, $p < .005$, also were repeated with baseline measures covaried out, and the findings remained significant.

2. It should be noted that when sympathetic reactivity in response to stress occurs, systolic (the force exerted on the blood vessels walls during the contraction of the heart) but not necessarily diastolic (the force exerted on the vessel walls in between contractions) changes in blood pressure would be expected, as is found in the present study.

3. A marginally significant Condition × Mastery interaction also was found for number of negative thoughts about the present, $F(2, 88) = 2.61$, $p = .08$. Tukey's post hoc analyses suggested that whereas there was no significant difference in the number of negative thoughts about the present for participants low and high in mastery in the predictable/controllable environment (*M*s = 3.29 vs. 3.53), participants low in mastery were more likely to dwell on the negative aspects of their current situation than were participants high in mastery in the unpredictable

environment (*M*s = 6.05 vs. 2.27) and the neutral environment (*M*s = 5.17 vs. 2.35).

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