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Engagement and Arousal: Optimism's Effects During a Brief Stressor

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Abstract

Optimism is usually associated with better psychological and physiological adjustment to stressors, but some contradictory findings exist. The purpose of this study was to investigate how optimism could result in negative immunological changes following difficult stressors. Because optimists are likely to see positive outcomes as attainable, they may invest greater effort to achieve their goals. It is proposed that such engagement would be more physiologically demanding when pursuing difficult goals. Participants (N = 54) worked on 11 difficult or insoluble anagrams. Optimism when combined with high self-awareness increased time spent working on the anagrams and skin conductance and salivary cortisol during the recovery period. The results support the notion that the increased engagement that arises from optimism may lead to short-term physiological costs.

Keywords

optimism; persistence; cortisol; heart rate; skin conductance

People who hold generalized positive outcome expectancies, that is, optimists, generally adjust better to stressors (Aspinwall & Taylor, 1992; Scheier & Carver, 1992; Segerstrom, Taylor, Kemeny, & Fahey, 1998). Optimism has been associated with better psychological well-being (e.g., Carver et al., 1993; Segerstrom et al., 1998; Stanton & Snider, 1993) as well as physiological well-being as reflected in qualities of the cardiovascular (Räikkönen, Matthews, Flory, Owens, & Gump, 1999) and immune (F. Cohen et al., 1999; Segerstrom et al., 1998) systems. However, some contradictory findings suggest that optimism does not always increase physiological well-being. In laboratory studies, optimists exposed to uncontrollable noise experienced a reduction in natural killer cell cytotoxicity (NKCC) compared with pessimists (Sieber et al., 1992), and optimists engaging in a mental arithmetic task that became more difficult with better performance had smaller delayed-type hypersensitivity (DTH) reactions compared with pessimists, indicating worse cellular immunity (Segerstrom, Castaneda, & Spencer, 2003). Naturalistic studies have also found optimists to have lower immune parameters than pessimists when stressors persisted over time (F. Cohen et al., 1999) or participants experienced goal conflict (Segerstrom, 2001).

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These findings indicate that optimism, instead of buffering against stressful situations, sometimes increases indicators of physiological stress. Some investigators have attributed this effect to expectancy violation (F. Cohen et al., 1999; Sieber et al., 1992). In this model, when people expect positive outcomes but experience uncontrollable or persistent stressors instead, their expectancies are violated and they experience disappointment, among other negative affective states, which causes immune change. However, this interpretation is not supported by other research on violation of outcome expectancy. Following in vitro fertilization failure, breast cancer diagnosis, or cardiac relapse, prior dispositional optimism did not lead to distress and in one case (in vitro fertilization failure) had the opposite effect of improving well-being (Helgeson, 2003; Litt, Tennen, Affleck, & Klock, 1992; Stanton & Snider, 1993).

An alternative model links optimism and indicators of physiological stress not through negative affect but through engagement (Segerstrom, 2001; Segerstrom et al., 2003). According to self-regulation theory (Carver & Scheier, 1998), people confronting difficulties in progressing toward their goals have two options: further engage to overcome those difficulties or disengage to avoid those difficulties. An important determinant of whether people decide to engage or disengage is whether they see desired outcomes with regard to the goal as attainable (i.e., whether they are optimistic). When desired outcomes are seen as attainable, the result is increased effort and goal engagement. When desired outcomes are seen as unattainable, the result is reduced effort and goal disengagement. Conflicts and difficult or stressful situations will therefore lead to goal engagement and persistence among people with positive outcome expectancies and to goal disengagement and giving up among people with negative outcome expectancies.

Optimism has been associated with engaged motivational states as assessed both directly through self-report and indirectly through behavioral indicators such as persistence. Higher dispositional optimism correlated with reports of more engaged coping with stress via strategies such as problem solving and acceptance, as well as less disengaged coping via strategies such as disengagement and denial (e.g., Scheier, Weintraub, & Carver, 1986). The relationship of positive expectancies to task engagement has also been examined using behavioral indicators such as the amount of time participants worked on difficult laboratory tasks, that is, persistence. When prior performance was experimentally manipulated to produce positive rather than negative expectancies for success, participants persisted longer on experimental tasks (Carver, Blaney, & Scheier, 1979; Scheier & Carver, 1982). Likewise, negative expectancies among test-anxious participants led to decreased persistence and performance on anagram tasks (Carver, Peterson, Follansbee, & Scheier, 1983).

In these studies, positive expectancies led to increased persistence only under conditions of high self-awareness. According to control theory, awareness makes salient one's current standing relative to goals, motivating efforts to improve that standing (Carver & Scheier, 1998). Therefore, under circumstances of high awareness, expectancies act as a regulatory guide for effort. Effort is enhanced when expectancies of achieving the goal are high but reduced when expectancies are low. Under circumstances of low awareness, expectancies do not act as a regulatory guide for effort, because the discrepancy between one's standing relative to one's goals is not salient. The interaction between expectancy and awareness occurs both when self-awareness is experimentally manipulated (e.g., by seating people across from a mirror; Carver et al., 1979, 1983) and when self-awareness is naturally high (Carver et al., 1983; Scheier & Carver, 1982).

Goal engagement and persistence are in general assumed to be adaptive strategies. However, because engagement and disengagement have different short-term and long-term effects on health, engagement may not always be the less stressful strategy. Mullen and Suls (1982)

and Suls and Fletcher (1985) examined the literature on immediate and long-term effects of two kinds of coping: avoidance (i.e., stressor disengagement) and approach (i.e., stressor engagement). They concluded that although approach was more adaptive than avoidance in the long term, short-term approach was associated with worse physical adaptation. More recent experimental evidence found an association between task engagement and higher cardiovascular arousal during stressful laboratory tasks (S. Cohen et al., 2000; Maier, Waldstein, & Synowski, 2003; Waldstein, Bachen, & Manuck, 1997). The engagement model therefore specifies that optimism is associated with physiological changes usually associated with stress as a consequence of engagement, explaining findings in which optimism results in downward immune changes (F. Cohen et al., 1999; Segerstrom, 2001; Segerstrom et al., 2003; Sieber et al., 1992).

Optimism, operationalized both as dispositional and task-specific positive outcome expectancies, was expected to lead to more engagement with a difficult task when combined with high self-awareness. Because both dispositional optimism and specific expectancies have been associated with engagement in the literature, we made the same prediction for both. Both public and private self-awareness have interacted with expectancies to predict persistence (Carver et al., 1983; Scheier & Carver, 1982); because an experimenter was present during this task, we focused on public self-consciousness. We consider engagement to be a latent quality that can be observed in a number of ways: self-report, affect, behavior, and physiology. The present study relates optimism to behavioral and physiological indices of engagement and tests the following hypotheses derived from the engagement model:

Hypothesis 1: Optimism, when combined with high self-awareness, will be associated with persistence, as operationalized by time working on the task, a behavioral index of engagement.

Hypothesis 2: Optimism, when combined with high self-awareness, will be associated with higher physiological indicators of stress, as operationalized by heart rate, skin conductance level, and salivary cortisol, physiological indices of engagement. This relationship will hold true even when total time spent on the task is constant. That is, the physiological effects will be due to engagement rather than length of the task.

To test these hypotheses, participants were asked to solve a series of anagrams, the first of which was impossible and the next 10 of which were moderately to very difficult. This design was adopted to maximize the early perception of difficulty and slow progress without completely preventing progress—the circumstances under which optimism should have the most profound effects on engagement and persistence (Carver & Scheier, 1998). Heart rate, skin conductance, and salivary cortisol were assessed at baseline, during the task, and during a 45-minute recovery period. Higher heart rate and skin conductance reflect increased sympathetic nervous system arousal, and higher salivary cortisol reflects increased activity of the hypothalamic-pituitary-adrenal axis. Both systems increase their activity with higher levels of stress, and both are hypothesized to influence immune parameters (Ader, Cohen, & Felten, 1995; Kirschbaum & Hellhammer, 1989, 1994; Krantz & Falconer, 1995; McEwen et al., 1997), and so these indicators suggest mechanisms by which engagement could result in downward immune change.

METHOD

Participants

Participants were 54 undergraduate students enrolled in an introductory psychology course at the University of Kentucky. Recruitment was done via the University of Kentucky's Web-based experiment scheduling system. All participants received partial course credit.

Exclusion criteria were English as second language, regular consumption of more than two alcoholic drinks per day during a 7-day period, regular use of recreational drugs such as marijuana, or use of intravenous drugs such as heroin or cocaine. Additional exclusion criteria were current use of steroid medications such as prednisone or other systemic anti-inflammatory steroids, current use of antidepressants, anticonvulsants, estrogen replacement, or pregnancy. Of the participants recruited for the study, 57 were eligible and participated. Following data collection, 3 participants were excluded because they reported taking prescription medications that were exclusion criteria. The final number of participants was therefore 54, of whom 14 (25.9%) were men and 40 (74.1%) women. Forty-two (77.8%) participants were White, 2 (3.7%) were Asian American, 8 (14.8%) were African American, and 2 (3.7%) were more than one race. Mean age was 19 years (range = 18–29).

Procedure

All participants attended two separate laboratory sessions, held exactly 24 or 48 hours apart and beginning between 3:00 p.m. and 7:00 p.m. Participants were asked not to eat, drink, smoke, or brush their teeth within 30 minutes of arrival at the testing site to avoid contamination of saliva samples. During the first session, informed consent was obtained, and the participant was screened for health. If any of the health behavior exclusion criteria pertained to the participant, they were excused from the study and given a 0.5-hour course credit. If none of the exclusion criteria applied, questionnaires measuring dispositional optimism and public self-consciousness were administered. A 5-minute baseline registering heart rate and skin conductance level was then collected, and the participant was given a final health behavior questionnaire. Approximately 30 minutes after arrival at the test site, a baseline saliva sample for cortisol assessment was collected using a Salivette (Sarstedt, Inc., Newton, NC).

At the second session, baseline heart rate and skin conductance level were recorded for 5 minutes, and a baseline saliva sample was collected. A 20-minute anagram task was then administered to the participant.

Anagram task—Each participant was given instructions explaining that the task was to rearrange groups of letters into meaningful English words and that they would be given 11 anagrams that were to be solved within a period of 20 minutes. Each anagram was to be solved mentally without scrap paper, and the participant was asked to call out each solution to the experimenter, who was in the room. The participant was instructed to work on each anagram for as long as he or she wanted and then move on to the next anagram in the stack. The participants were asked to try to solve the tasks as fast and accurately as possible, but at the same time to spend as much time as they thought they would need on each card. All anagrams were chosen from Feather and Simon (1971) and Tresselt and Mayzner (1966) and were typed in Times New Roman in 36-point font on 4.25 in. × 5.5 in. laminated cards. All anagrams were presented in the same sequence for each participant.

Following description of the task, each participant reported how many of the 11 anagrams he or she expected to solve correctly (i.e., specific expectancy). Two easy practice items (DAMAEG and POLIEC) were then given to make sure the participant understood the task. The 11 anagrams were then placed in a stack in front of the participant, and the task began. The first anagram (GGAWIL) was insoluble; if the participant had not moved on to the second card after 5 minutes, he or she was asked to do so. On the next 10 anagrams, the participant was asked to move on if he or she had not solved or given up on each anagram after 90 seconds. These 10 anagrams were moderate to difficult but soluble. The total amount of time allowed for the task, therefore, was 20 minutes. Because we were interested in the effects of the state of engagement on physiology and not in effects of task duration,

we standardized the total amount of time spent on the task. If a participant was done with all anagrams before 20 minutes had passed, he or she was asked to go back and continue working on the previously unsolved anagrams. Task persistence and performance were based on first-round time and solutions only.

Heart rate and skin conductance level were registered during the 20-minute task and a saliva sample was collected immediately after the task. These measurements were repeated 15 and 45 minutes posttask. During the recovery period, the experimenter left the room, and the participant was asked to relax for the next 45 minutes. Magazines were provided if the participant was interested, but no other activity was allowed, except that at 30 minutes posttask, the participant was given a health behavior questionnaire.

Measures

Background variables—Participants were asked to report their age, sex, and race. They also reported their American College Testing (ACT) score as a control for academic aptitude, which could affect both specific expectancies and the number of anagrams solved.

Dispositional optimism: Life Orientation Test–Revised (LOT-R)—Dispositional optimism was measured with the LOT-R (Scheier, Carver, & Bridges, 1994), a 10-item measure of generalized positive outcome expectancies. Three items are phrased positively (“In uncertain times, I usually expect the best”), three negatively (“If something can go wrong for me, it will”), and 4 are filler items that do not contribute to the total optimism score. The LOT-R has acceptable internal consistency (.78) and construct validity with regard to related constructs (Scheier et al., 1994). There is some evidence that the LOT-R is two-dimensional, with an optimism dimension that correlates with extroversion and a pessimism dimension that correlates with neuroticism (Marshall, Wortman, Kusulas, Hervig, & Vickers, 1992). However, the relevant personality correlate with regard to optimism and engagement is conscientiousness, which is not differentially related to optimism and pessimism items (Segerstrom et al., 2003). Therefore, the full-scale score was used.

Specific expectancy—Prior to the anagram task, participants were asked how many of the 11 anagrams they expected to solve correctly.

Public self-consciousness: The Self-Consciousness Scale—Level of public self-consciousness was measured with the Self-Consciousness Scale (Fenigstein, Scheier, & Buss, 1975), which provided a seven-item measure of public self-consciousness and the self as a social object. Test-retest correlations for the public Self-Consciousness sub-scale are acceptable at .84 (Fenigstein et al., 1975).

Health behavior—A questionnaire related to experiences or activities during the day that could affect cortisol levels was administered on both days. This questionnaire measured physical activity or exercise; feeling of well-being; experience of stress and pain; quality of sleep; diet (intake of protein, fat, complex carbohydrates, and sugar); intake of tobacco, alcohol, and caffeine; and use of prescription medication. This questionnaire was primarily used to exclude participants who were not eligible by virtue of medication or substance use.

Skin conductance level responses—Skin conductance level (SCL) was measured and stored using the Biopac psychophysiology system (GSR100B galvanic skin response transducer) with Acqknowledge software (Biopac, Santa Barbara, CA). Ag-AgCl (silver/silver chloride) electrodes were attached on the palmar surface of the middle phalange of the first and third fingers on the non-dominant hand. SCL was averaged during each minute. Baseline skin conductance was stable across the two experimental days ($r = .65, p < .001$).

Heart rate responses—ECG was measured and stored using the Biopac psychophysiology system (PPG100C photoplethysmograph amplifier) with Acqknowledge software (Biopac, Santa Barbara, CA). A photo-plethysmograph was attached on the palmar surface of the middle phalange of the second finger on the non-dominant hand. Heart rate was calculated on-line and averaged during each minute. Baseline heart rate was stable across the two experimental days ($r = .56, p < .001$).

Cortisol responses—Salivary cortisol provides an accurate assessment that correlates with free (unbound) cortisol levels in blood and poses minimal intrusion to the subject (Kirschbaum & Hellhammer, 1994). Saliva samples were collected using Salivette devices (Sarstedt, Inc., Newton, NC), which consist of a cotton swab resting inside a centrifuge tube. Salivettes were frozen at -20°C or -80°C until assay. Samples were thawed, and cortisol levels were assessed using an enzyme-linked immunosorbent assay (EIA) developed for use with saliva (Salimetrics, Inc., State College, PA). Intra-assay coefficients of variation averaged 11.56% (low control) and 1.48% (high control). The interassay coefficient of variation averaged 6.95% (low control) and 2.97% (high control). Assay sensitivity was 0.007 mg/dL. Raw cortisol values were natural log transformed prior to analysis to reduce skewness. Time from the first baseline was then regressed on transformed cortisol values to yield slope during the experimental period. Kirschbaum, Prussner, and Stone (1995) found intersession reliability of cortisol levels elevated in response to an acute laboratory stressor on each of 5 days to range from $r = .38$ to $r = .60$. Baseline cortisol was stable across the two experimental days ($r = .53, p < .001$).

Statistical Analysis

The effects of optimistic expectancies and public self-consciousness on persistence, performance, and physiology were tested using linear hierarchical regression. In the persistence and performance analyses, ACT score and the complementary measure (i.e., persistence for performance analyses and performance for persistence analyses) were included in the first step. Because persistence and performance were not independent (e.g., solving items faster could mean spending less time on the task), we examined the effect of each after controlling for the other. Main effects of public self-consciousness and dispositional optimism or specific expectancy (number of anagrams expected solved) were entered in the second step, and the interaction between public self-consciousness and dispositional optimism or specific expectancy was entered in the third step. The physiology analyses added a first step that contained relevant biological data, including baseline values on the experimental day; age; sex; race; and, for cortisol analyses, medication use (e.g., oral contraceptives, which were used by 6 participants [12%]). Public self-consciousness, dispositional optimism, and specific expectancy were centered on zero before analysis to reduce collinearity between main effects and interactions. Public self-consciousness correlated moderately with dispositional optimism ($r = -.29$) and specific expectancies ($r = .12$), which themselves were not related ($r = .08$).

Significant interaction effects were plotted for values 1 standard deviation above and below the mean of each predictor (Aiken & West, 1991). Predicted values were calculated including all significant effects in the model (e.g., intercepts, control values).

RESULTS

Effects of the Task

On average, participants spent 549 seconds (range = 184–1,108) attempting to solve the 11 anagrams and solved an average of 5 (range = 0–9 out of 10 possible). Heart rate did not significantly increase from baseline during the task (mean difference = +0.5 bpm) but was

significantly lower than baseline during the follow-up period (mean differences = -4.9 bpm and -5.9 bpm at 15 and 45 minutes, $p < .001$). SCL was significantly increased from baseline during the task (mean difference = $+1.67$ μ mhos, $p .001$) and the recovery period (mean differences = $+1.01$ μ mhos and $+0.83$ μ mhos at 15 and 45 minutes, $p < .001$). Mean salivary cortisol slope was negative ($M = -0.353$, $SD = .485$), which is consistent with the usual diurnal decline in cortisol during the late afternoon. The lack of a comparison group precludes the conclusion that the task increased these parameters over their unstressed levels. However, the main analyses of interest concern individual differences in task and physiological responses.

Effects of Optimism, Expectancy, and Public Self-Consciousness on Task Behavior

The effects of optimism, expectancy, and self-consciousness on persistence and performance are shown in Tables 1 and 2. Optimism was predicted to be associated with higher levels of task engagement as measured by time spent working on the anagram task, particularly among those high in public self-consciousness. Supporting this prediction, there was a significant dispositional-optimism-by-public-self-consciousness interaction predicting more time spent on the task (see Table 1). As shown in Figure 1, at high levels of public self-consciousness, optimism was associated with longer time working on the task; at low levels of public self-consciousness, optimism was associated with shorter time working on the task. Dispositional optimism and public self-consciousness were not associated with number of anagrams solved (see Table 2).

Specific expectancy predicted a different pattern of effects than did dispositional optimism. As shown in Table 1, neither specific expectancy nor the interaction with public self-consciousness predicted time spent on the task. However, higher specific expectancy tended to interfere with performance for those high in public self-consciousness (see Table 2). As shown in Figure 2, at high levels of self-consciousness, high expectancies were associated with fewer problems solved; the reverse was true at low levels of self-consciousness.

Effects of Optimism, Expectancy, and Public Self-Consciousness on Physiology

The engagement model posits that increased task engagement can result in physiological indicators of stress; because optimism increases engagement, it can also increase these indicators. There was evidence that the same constructs that predicted persistence as a behavioral indicator of engagement also predicted physiological responses. In the dispositional optimism model, public self-consciousness and, to a lesser degree, optimism were both associated with higher heart rate during the task; however, their interaction was not significant (see Table 3). In the specific expectancy model, higher public self-consciousness continued to predict higher heart rate, but specific expectancy did not. There were no effects on heart rate in the follow-up period.

The cortisol data also indicated that the constructs that predicted persistence increased levels of indicators of physiological stress. In this case, there was a significant interaction between dispositional optimism and public self-consciousness on cortisol slope (see Table 3). As shown in Figure 3, as self-consciousness increased, optimism was associated with an increasingly flat cortisol slope. Cortisol is expected to decline over time in the late afternoon, and so the anagram task counteracted this normal decline among those high in optimism and public self-consciousness. Specific expectancy did not predict cortisol, either alone or in combination with public self-consciousness.

Finally, the dispositional-optimism-by-public-self-consciousness interaction also predicted skin conductance at 15 minutes posttask and 45 minutes posttask. As for cortisol, these interactions indicated an increasingly positive relationship between optimism and skin

conductance with increasing public self-consciousness. Specific expectancy did not predict skin conductance, either alone or in combination with public self-consciousness.

Persistence and Physiology

Persistence did not significantly predict any of the physiological parameters affected by optimism and self-consciousness (heart rate during the task, cortisol slope, or skin conductance after the task; all $ps > .30$). This finding suggests that the effects of optimism and self-consciousness were the result of the degree of engagement during the entire task, including both the first round, on which persistence was based, and the return to unsolved problems that equated time working on the task across participants. If persistence, which was based on first-round times, predicted physiological responses, that finding would suggest that engagement during the first round was more important than engagement during the second round to physiological responses. In contrast, the relative independence of the two suggests that engagement during the second round is equally, if not more, important to physiological responses to the task.

DISCUSSION

The engagement model specifies that greater goal engagement by optimists is beneficial in the long run, but there may be short-term physiological costs (S. Cohen et al., 2000; Maier et al., 2003; Mullen & Suls, 1982; Segerstrom, 2001; Segerstrom et al., 2003; Suls & Fletcher, 1985; Waldstein et al., 1997). The results of the current study support this model, as optimistic beliefs in combination with high self-awareness increased persistence as well as indicators of sympathetic nervous system and hypothalamic-pituitary-adrenal activity as a consequence of the stressor.

Because optimists are likely to see positive outcomes as attainable, they may be more inclined to engage in continued effort to achieve their goals (Carver & Scheier, 1998), especially when self-consciousness focuses individuals on their goal-directed behavior and increases the effects of self-regulatory guides (Carver et al., 1979). Consistent with this theoretical model, in the present study, self-consciousness combined with dispositional optimism resulted in the longest persistence time.

Goal engagement is generally considered salutary, as progress toward goals can increase positive affect, whereas disengagement can increase negative affect and rumination (Carver & Scheier, 1990; Pyszczynski & Greenberg, 1987). Engagement also increases the likelihood of eventual goal achievement, which should increase well-being. However, this study adds to evidence that engagement can be physiologically taxing in the short term (S. Cohen et al., 2000; Maier et al., 2003; Mullen & Suls, 1982; Suls & Fletcher, 1985; Waldstein et al., 1997). More optimistic and engaged participants who were also self-aware had higher skin conductance and cortisol during the recovery period, reflecting higher sympathetic nervous system and hypothalamic-pituitary-adrenal axis activity. This finding is consistent with previous findings of lower cellular immunity among optimists following stressors that were unresponsive to coping efforts. When optimists persist in their engagement with difficult stressors, there may be consequences in terms of both neuroendocrine and immune parameters with potentially adverse health effects, such as increases in cortisol—as seen in the present study—and decreases in cellular immunity (F. Cohen et al., 1999; Segerstrom, 2001; Segerstrom et al., 2003; Sieber et al., 1992). Furthermore, neuroendocrine changes such as higher cortisol could be the physiological pathway by which decreases in cellular immunity occur under these circumstances (McEwen et al., 1997).

It is important to note that the persistence demonstrated by optimists in these studies is likely to be beneficial in the long term. All of the studies showing downward changes in immunity with higher optimism assessed short-term immune changes, and optimism may have very different implications for long-term immune status. For example, 1st-year law students experiencing academic-social conflict had lower cellular immunity during their first semester, probably because they maintained engagement with both domains (Segerstrom, 2001). However, academic demands of law school wane after the first year, and students who maintained their social networks would be likely to benefit from that investment in the long term (House, Landis, & Umberson, 1988; Seeman, 1996; Uchino, Cacioppo, & Kiecolt-Glaser, 1996).

One exception to the psychologically beneficial effects of engagement is the nonresponsive situation. When situations are nonresponsive, engagement and persistence are inappropriate and potentially harmful responses. However, in the achievement domain, nonresponsive situations are much more likely to occur in the laboratory than in real life, and so persistence on nonresponsive laboratory tasks could be seen as an artifact of a coping style that is beneficial in the real world. Furthermore, real life usually offers alternatives that the laboratory does not; when the laboratory offers responsive alternatives, optimists may be *faster* than pessimists to disengage from nonresponsive tasks (Aspinwall & Richter, 1999). Finally, it is important to remember that the relationship between optimism and lower immunity is specific to difficult or nonresponsive situations; when stressors are controllable or responsive to coping efforts, optimists have higher cellular immune parameters than pessimists (Byrnes et al., 1998; F. Cohen et al., 1999; Segerstrom, 2001; Segerstrom et al., 1998, 2003; Sieber et al., 1992).

This study also reveals differences between the effects of specific expectancy (the number of anagrams the person expected to solve) and dispositional optimism (generalized positive outcome expectancies). Under conditions of high self-awareness, high dispositional optimism increased engagement, but high specific expectancy did not. Furthermore, the combination of high specific expectancy and self-awareness may have actually impaired performance, whereas high dispositional optimism did not. One important difference between generalized and specific beliefs is flexibility: Generalized positive beliefs allow one to make the most of the situation as it exists (“gee, these are harder than I thought they would be, but I’m getting some of them”) as opposed to specific beliefs, which lock in a specific level of performance and may increase anxiety and off-task thoughts that could impair performance (“I thought I could solve 7 of these, and I’ve only been able to get 2 so far”; Armor & Taylor, 1998). The presence of the experimenter may have increased this effect, creating the most anxiety among self-conscious participants (cf. Carver et al., 1983).

It is a well-accepted notion that exposure to stressors may create negative psychological and physiological consequences. However, the relationships among optimism and emotional, behavioral, and physiological responses to stressors are complex. Whereas optimism is emotionally protective, even in the face of disconfirmation (Litt et al., 1992), and increases engagement, which can lead to achievement, it may not always be physiologically protective. Furthermore, the physiological risk may accompany behaviors such as persistence that are psychologically beneficial (Carver & Scheier, 1990). In the present study, optimists persisted more than pessimists at a difficult task but incurred short-term physiological costs associated with engagement. The study demonstrated that engagement is associated with physiological indicators of stress that are plausible mediators between optimism and downward immune change, but future research could test an integrated model of optimism, engagement, stress hormones, and immune change. Furthermore, it will be important to investigate both short- and long-term effects of engagement and disengagement

as they relate to optimism. Future investigations of how optimism interacts with stressors, and under what circumstances, will enlighten this complex area.

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Figure 1.
Predicted persistence as a function of optimism and self-consciousness.

Figure 2.
Predicted performance as a function of specific expectancies and self-consciousness.

Figure 3.
Predicted cortisol slope as a function of optimism and self-consciousness.

TABLE 1

Effects of Optimism and Self-Consciousness on Anagram Task Persistence and Performance

	ΔR^2	F(df)	p <	β
Persistence (time spent on anagrams)				
Step 1	.11	2.73 (2, 47)	.08	
ACT score				-.02
Number solved				-.32***
Step 2	.09	2.54 (2, 45)	.09	
Self-consciousness				.29***
Optimism				-.10
Step 3	.07	3.76 (1, 44)	.04	
Self-Consciousness $\times$ Optimism				.32***
Performance (number solved)				
Step 1	.14	3.68 (2, 47)	.03	
ACT score				.18
Time spent				-.31***
Step 2	.01	0.35 (2, 45)	.71	
Self-consciousness				-.02
Optimism				.11
Step 3	.01	0.64 (1, 44)	.43	
Self-Consciousness $\times$ Optimism				.14

NOTE: ACT = American College Testing.

p < .05.

TABLE 2

Effects of Expectancy and Self-Consciousness on Task Persistence and Performance

	ΔR^2	F(df)	p <	β
Persistence (time spent on anagrams)				
Step 1	.10	2.73 (2, 47)	.08	
ACT score				-.02
Number solved				-.32***
Step 2	.10	2.95 (2,45)	.06	
Self-consciousness				.29***
Expectancy				.13
Step 3	.00	3.76 (1, 44)	.04	
Self-Consciousness $\times$ Expectancy				.05
Performance (number solved)				
Step 1	.14	3.68 (2, 47)	.03	
ACT score				.18
Time spent				-.31***
Step 2	.00	0.06 (2, 45)	.94	
Self-consciousness				-.04
Expectancy				.03
Step 3	.06	3.50 (1, 44)	.07	
Self-Consciousness $\times$ Expectancy				-.29**

NOTE: ACT = American College Testing.

**
p < .10 (two-tailed test).***
p < .05 (two-tailed test).

TABLE 3

Effects of Optimism and Self-Consciousness on Heart Rate, Cortisol, and Skin Conductance

	ΔR^2	F(df)	p <	β
Heart rate (task)				
Step 3	.04	3.44 (2, 40)	.04	
Self-consciousness				.20***
Optimism				.12*
Step 4	.00	0.77 (1, 39)	.39	
Self-Consciousness $\times$ Optimism				.08
Cortisol slope				
Step 3	.01	0.25 (2, 37)	.78	
Self-consciousness				.08
Optimism				.04
Step 4	.06	6.14 (1, 36)	.02	
Self-Consciousness $\times$ Optimism				.28***
Skin conductance level (15 minutes posttask)				
Step 3	.01	0.84 (2, 40)	.44	
Self-consciousness				-.10
Optimism				.05
Step 4	.04	5.42 (1, 39)	.03	
Self-Consciousness $\times$ Optimism				.24***
Skin conductance level (45 minutes posttask)				
Step 3	.02	1.20 (2, 40)	.31	
Self-consciousness				-.09
Optimism				.10
Step 4	.04	4.38 (1, 39)	.04	
Self-Consciousness $\times$ Optimism				.25***

NOTE: Steps 1 and 2 controlled for demographics, baseline values, medications, and ACT scores, as well as steroid medications (e.g., steroid nasal sprays) for cortisol analyses. Baseline values were a strong predictor in all models ($\beta = .66-.85$). In the cortisol model, sex and steroid medications were also significant predictors, such that women and participants taking steroid medications had flatter cortisol slopes. In the interest of space, only Steps 3 and 4 are shown.

* $p < .15$ (two-tailed test).

*** $p < .05$ (two-tailed test).