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Minireview

Optimism and immunity: Do positive thoughts always lead to positive effects?

Suzanne C. Segerstrom*

Department of Psychology, University of Kentucky, 115 Kastle Hall, Lexington, KY 40506-0044, USA

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Abstract

The effects of dispositional optimism, as defined by generalized positive expectations for the future, on physical health are mixed, especially in diseases that can be immunologically mediated such as HIV and cancer. Both experimental and naturalistic studies show that optimism is negatively related to measures of cellular immunity when stressors are difficult (e.g., complex, persistent, and uncontrollable) but positively related when stressors are easy (e.g., straightforward, brief, and controllable). Although the negative relationship between optimism and immunity has been attributed to the violation of optimists' positive expectancies and subsequent disappointment, empirical evidence suggests that it is more likely to be a consequence of optimists' greater engagement during difficult stressors. For example, negative mood does not account for the effect, but conscientiousness, a personality facet related to engagement, does. The mixed immunological correlates of optimism may explain why it does not consistently predict better disease outcomes.

Dispositional optimism, as defined by generalized positive expectations for the future, virtually always predicts better psychological adjustment. In numerous studies, the more positive people expected their futures to be, the better their mood, the fewer their psychiatric symptoms, and the better their adjustment to diverse situations including college transition, pregnancy, cardiac surgery, and caregiving (see Carver and Scheier, 1999; for a review). People with optimistic expectations also report better physical health, but some have suggested that optimists report better physical health because their better psychological adjustment confers a reporting bias (Smith et al., 1989).

Studies explicitly studying biological outcomes offer a qualified endorsement of the positive effects of optimism on physical health and health indicators. With regard to the cardiovascular system, a number of studies have demonstrated positive effects of optimism; for example, optimism predicted lower ambulatory blood pressure (Räikkönen et al., 1999) and substantially lower risk of rehospitalization following coronary artery bypass graft surgery (Scheier et al., 1999). However, one study found no relationship between optimism and recovery and length of stay after cardiac surgery (Contrada et al., 2004)

Studies of HIV and cancer patients yield more mixed results. Optimism predicted lower mortality risk in head and neck cancer patients (Allison et al., 2003), but not in lung cancer patients (Schofield et al., 2004), and only among younger patients in a mixed cancer sample (Schulz et al., 1996). In HIV+ Black women with human papilloma virus, optimism was associated with higher natural killer cell cytotoxicity (NKCC) and $CD3^+CD8^+$ cell percentage, which may portend better clinical outcomes from these viruses (Byrnes et al., 1998). Among HIV+ gay men, optimism was associated with lower HIV viral load but had a curvilinear relationship with $CD4^+$ cell counts such that optimism was only beneficial though moderate levels; high levels of optimism did not

* Fax: +1 859 323 1979.
E-mail address: scsege0@uky.edu.

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confer any additional benefit (Milam et al., 2004). Another study found no relationship between optimism and CD4 count among HIV+ gay men (Tomakowsky et al., 2001).

1. Optimism and immunity: the disappointment hypothesis

The failure of optimism to consistently predict better physical health indicators and outcomes is consistent with this pessimistic view of optimism: "The best doesn't always occur. When things go wrong in a big way, the optimist may be particularly vulnerable." (Tennen and Affleck, 1987, p. 382). According to this view, by virtue of having generally positive thoughts and feelings, optimists set themselves up for disappointment if the positive future they envision does not materialize. Their psychological vulnerability also extends to the physical realm when optimists' disappointment and distress result in negative effects on physiological systems, including the immune system.

Naturalistic and experimental studies of optimism and immunity support the idea that optimism can have both positive and negative immune correlates. In a naturalistic study of community-dwelling women, optimism had different relationships to T cell percentages in peripheral blood and NKCC depending on whether stressors were brief or prolonged (Cohen et al., 1999). When stressors were brief (i.e., they lasted less than one week), optimism appeared to be protective against the effects of stressors. Pessimistic women had a decline in $CD8^+CD11b^+$ T cell percentages with increasing stress, but optimistic women were unaffected. This effect reversed when stressors were prolonged, that is, they lasted more than one week. Under those circumstances, more optimistic women were more immunologically vulnerable: For them, more stress was associated with lower $CD8^+CD11b^-$ T cell percentages and NKCC. Conversely, more pessimistic women seemed to be protected: For them, more stress was associated with *higher* $CD8^+CD11b^-$ percentages and did not affect NKCC.

These results are consistent with an earlier, experimental study that also found differing effects of optimism, this time on the basis of stressor uncontrollability (Sieber et al., 1992). In this study, young male participants were exposed to an intermittent loud noise stressor. The exposure occurred under experimental conditions that varied actual and perceived control, such that some participants could actually control the noise offset, others perceived such control but could not actually control the noise offset, and some were explicitly aware that they could not control the noise offset. The effects of optimism on NKCC after the stressor depended on whether control was available. When control (either actual or perceived) was available, optimistic participants had higher NKCC than pessimistic participants. However, when control was not available in either form, optimistic participants had lower NKCC than pessimistic participants.

The authors of these two studies interpreted their results as supporting the disappointment hypothesis: persistent or uncontrollable stressors violated optimists' positive expectations that they could terminate or control the stressors, leading to distress and decrements in immune parameters. However, these interpretations contradict direct evidence that optimists are ordinarily *not* disappointed by negative or difficult outcomes. Three studies have examined optimism prior to negative outcomes (in vitro fertilization failure, cardiac relapse, breast cancer diagnosis) and found no evidence for increased psychological vulnerability after the experience for those with higher a priori optimism (Litt et al., 1992; Helgeson, 2003; Stanton and Snider, 1993). In the case of in vitro fertilization failure, pre-procedure optimism actually protected against psychological distress (Litt et al., 1992).

2. Optimism and immunity: the engagement hypothesis

I have suggested an alternative hypothesis to explain negative effects of optimism on the immune system (see Fig. 1; Segerstrom, 2001; Segerstrom et al., 2003; Solberg Nes et al., in press). This hypothesis specifies that under difficult circumstances, more optimistic people remain engaged with those circumstances whereas more pessimistic people disengage, avoid, or give up. Giving up can be a physiologically protective response because stressor exposure is minimized in the short term by giving up rather than remaining engaged (although the reverse is true in the long term; Mullen and Suls, 1982; Suls and Fletcher, 1985). Therefore, the engagement hypothesis states that when circumstances are easy or straightforward, optimism will be positively related to immunity because engagement can lead to termination of the stressor (e.g., via problem-solving). However, when circumstances are difficult or complex, optimism will be negatively related to immunity because it leads to ongoing engagement with persistent stressors.

I have tested this hypothesis in first-year law students, who face two kinds of stress: the difficulty of law school itself, and the difficulties that the time demands of law school create in other domains (Segerstrom, 2001, 2004). First-year students commonly cite the conflict that arises between the time demands of law school and other pursuits, such as social relationships and extramural interests, as one of the most stressful aspects of law school. I take advantage of a natural quasi-experiment that varies the level of this conflict: Moving away to go to law school decreases conflict, whereas staying home makes it worse. For example, an occasional e-mail may maintain one's relationship with an old college

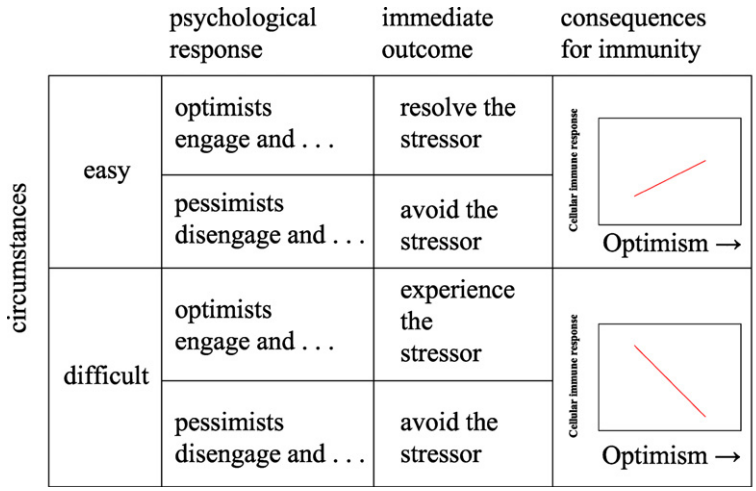

Fig. 1. Effects of optimistic engagement and pessimistic disengagement when circumstances are easy or difficult. Effects on immunity shown are drawn from effects on DTH induration in studies of first-year law students (Segerstrom, 2001, 2004).

roommate from across the country or the state (low conflict with law school), but both parties are likely to be dissatisfied with this level of investment in the relationship from across town (high conflict with law school). Relocation therefore varies the difficulty of circumstances surrounding law school. When students move away from their extramural relationships and commitments to go to law school, their circumstances are relatively easy and straightforward. For them, optimism should have positive effects on immune parameters. When students stay home and have to balance their extramural commitments with law school, their circumstances are relatively difficult and complex. For these students, optimism should have negative effects on immune parameters.

This hypothesis was supported in three independent law school samples. In the first sample, optimism was positively associated with number of $CD4^+$ T cells in peripheral blood when students had moved away to go to law school ($b = 55$[1]), but negatively associated when they stayed home ($b = -201$). A second sample showed the same effect for delayed-type hypersensitivity (DTH) skin testing with mumps and candida antigens. More optimism was associated with larger mean DTH responses (indicating stronger cellular immunity) when students moved away ($b = 2.4$), but smaller DTH responses when they stayed home ($b = -10.1$) (Segerstrom, 2001). A third sample showed the same interaction effect between optimism and relocation on DTH to mumps alone. Again, more optimism was associated with larger DTH responses when students moved away ($b = 3.1$) and smaller DTH responses when they stayed home ($b = -4.0$) (Segerstrom, 2004).

A laboratory study showed a similar interaction between optimism and stressor difficulty: when a difficult, non-responsive laboratory stressor was added to moderate, responsive academic stress, the effect of optimism on DTH also changed (Segerstrom et al., 2003). Professional students were randomly assigned to either perform a 7 min mental arithmetic task or not. The mental arithmetic task became more difficult with better performance, meaning that individuals engaging the task more fully (e.g., by expending more mental effort) would be "rewarded" with a more difficult task. The DTH antigen was injected after a resting period among those who did not do the task and immediately after the task among those who did. Among participants who did not do the task, more optimism was associated with larger DTH responses 48 h later ($b = 3.4$), but among participants who did do the task, more optimism was associated with smaller DTH responses ($b = -5.2$). Again, under circumstances when engagement led to greater exposure to a difficult stressor, more optimism was associated a greater decrement in cellular immunity.

Finally, a laboratory study demonstrated that optimists are in fact more likely than pessimists to engage difficult tasks such as those used by Sieber et al. (1992) and Segerstrom et al. (2003), providing a plausible psychological mediator of the immune effects (Solberg Nes et al., in press). Participants were given a set of difficult anagrams to solve during a 20 min period. Optimistic participants worked longer on the anagrams on their first attempts to solve them, indicating greater task engagement. More importantly, optimists also had higher skin conductance and cortisol after the task, providing plausible physiological mediators of immune effects (e.g., activation of the hypothalamic–pituitary–adrenal axis).

[1] All beta weights show the predicted change in number of $CD4^+$ T cells or mm induration in DTH for a 1-point change in the optimism scale. The optimism scale reflects mean item endorsement where 1 = strongly disagree [with optimistic statements] and 5 = strongly agree [with optimistic statements].

2.1. The role of affect and depression

A series of laboratory and naturalistic studies, then, have demonstrated that optimism has positive effects on cellular immunity when stressors are easy or responsive but negative effects when stressors are difficult or less responsive (see Table 1). Although some evidence suggests that engagement is a more likely mechanism for these effects than disappointment and distress (Helgeson, 2003; Litt et al., 1992; Stanton and Snider, 1993; Solberg Nes et al., in press), examining the role of affect in these studies further differentiates support for the two hypotheses. In particular, the disappointment hypothesis relies heavily on negative affect as a mediator. For the disappointment hypothesis to be true, optimists have to be "let down" affectively by their failure to realize a positive future. Engagement, by contrast, is a state that can have affective correlates (e.g., excited, involved, interested) but is primarily cognitive and motivational.

All of these studies, with the exception of Sieber et al. (1992), have examined either state or trait negative affect as an explanation for the effects of optimism. In the law student studies, effect sizes stayed the same before and after controlling for positive and negative daily mood (Segerstrom, 2001, 2004). Positive daily mood associated with larger DTH responses and negative daily mood associated with smaller DTH responses (Segerstrom, 2004), but mood could not account for the optimism effect. These assessments covered the 24 h preceding skin test administration and the 48 h between administration and evaluation, so mood during the skin test was apparently not the mechanism by which optimism affected immune responses. This poses a problem for the disappointment model, which posits that difficult circumstances are more distressing for optimists because their positive expectations have been violated.

The results for trait negative mood were mixed. In one law student sample (Segerstrom, 2001), controlling for trait negative mood completely accounted for the optimism effect on immunity (and vice versa), but in the Cohen et al. (1999) sample of community-dwelling women, trait negative mood did not account for any of the effects of optimism on T cells. Similarly, in the mental arithmetic laboratory study, trait negative mood did not account for any of the effects of optimism (Segerstrom et al., 2003). These different results may arise from the use of different scales to measure trait negative mood. For example, measures vary in the degree to which they contain items that substantively overlap with optimism (e.g., "I'm seldom apprehensive about the future"; Costa and McCrae, 1992), and therefore the degree to which they would necessarily decrease optimism effects. Importantly, in these studies, trait negative mood cannot account for variance above and beyond the effects of optimism, suggesting that it is the part of trait negative mood that overlaps with optimism that predicted effects on the immune system. One study examined the effects of an alternative trait mediator, conscientiousness. Conscientiousness is closely linked to the engagement model through its emphasis on goal pursuit and achievement striving (e.g., "I work hard to accomplish my goals"; Costa and McCrae, 1992). In the mental arithmetic study, conscientiousness accounted for most of the optimism effect, supporting the engagement model (Segerstrom et al., 2003) and suggesting that the effect of optimism was due to greater tenacity and striving in approaching the task on the part of optimistic and conscientious participants.

Another construct that overlaps with optimism is depression, a psychiatric condition that includes problems with affect (e.g., sadness), cognition (e.g., hopelessness), and behavior (e.g., inactivity). Affective mediation having been ruled out, it is still possible that other aspects of depression are active in these studies. For example, inactivity has accounted for reduced lymphocyte proliferation in depressed women (Miller et al., 1999). However, the naturalistic studies controlled for potential behavioral mediators such as activity, sleep, and substance use, and excluded individuals taking medications (e.g., antidepressants) that could confound results (Cohen et al., 1999; Segerstrom, 2001), and

Table 1
Summary of studies: interactions between optimism and stressor type predicted immune parameters

Study	*N*	Population	Stressor types	Outcome	Interaction effect size (*r*)
Cohen et al. (1999)	42	Caucasian women aged 18–45	Naturalistic: acute (<1 week) or chronic (>1 week)	%$CD8^+CD11b^+$	.27
				%$CD8^+CD11b^-$	.48
				NKCC	.31
Sieber et al. (1992)	55	Men aged 18–26	Experimental: control, perceived control, or no control	NKCC	.33
Segerstrom (2001); Study 1	48	Law students	Naturalistic: high or low goal conflict	# $CD4^+$	.43
Segerstrom (2001); Study 2	22	Law students	Naturalistic: high or low goal conflict	DTH	.60
Segerstrom (2004)	46	Law students	Naturalistic: high or low goal conflict	DTH	.33
Segerstrom et al. (2003)	38	Medical and law students	Experimental: presence or absence of mental arithmetic task	DTH	.38

Note. For *r*, effect sizes of .10 are considered small; .30, medium; and .50, large.

quasi-experimental designs further reduce the possibility of confounds (Segerstrom et al., 2003; Sieber et al., 1992). Potential overlap with cognitive factors in depression naturally remains, since hopelessness and pessimism—the inverse of optimism—are characteristic of depression. It is possible that these characteristics of depression interact with stressor qualities to predict immune parameters in a manner parallel to optimism, a possibility that should be explored in future research.

3. Specific expectancies and immunity

The aforementioned studies focused on positive expectations for the future in general. However, people also have specific expectations about domains in their lives, events within those domains, and even behaviors within those events. In general, research has supported a more straightforward relationship between specific expectancies and immunity: positive specific expectancies reduce the immunological impact of stressors within that domain. For example, specific expectancies about law school predicted higher NKCC and $CD4^+$ T cells during the first semester (Segerstrom et al., 1998), and an intervention that increased self-efficacy, a positive expectancy that one can perform a specific behavior, also increased T cell numbers ($CD3^+$, $CD4^+$, and $CD8^+$; Wiedenfeld et al., 1990). The results for immunologically mediated disease are also more consistent. More positive HIV-specific expectancies were associated with later symptom onset and longer survival after AIDS diagnosis (Reed et al., 1994, 1999). It is important to recognize that specific and generalized optimism can simultaneously exert different effects: for example, law school optimism exerted a positive main effect on $CD4^+$ T cells at the same time that dispositional optimism interacted with relocation to predict $CD4^+$ cell numbers (Segerstrom, 2001; Segerstrom et al., 1998).

4. Conclusion

How optimism affects the immune system critically depends on the circumstances being examined. Under many circumstances, both dispositional optimism and specific expectancies appear to buffer the immune system from the effects of psychological stressors. However, there is sometimes a physiological cost to be paid for the optimistic strategy of engaging difficult stressors rather than disengaging and withdrawing. This physical cost is reflected in higher cortisol (Solberg Nes et al., in press) as well as lower cellular immunity (see Table 1). In turn, these costs may affect the course of diseases such as viral infection (e.g., HIV) and some types and stages of cancer for which disruptions in cortisol and cellular immunity are prognostic (Sephton and Spiegel, 2003). The varied physiological correlates of optimism remain to be demonstrated in clinical populations but may explain why the effects of optimistic beliefs on physical health indicators and outcomes are not as consistently positive as are their effects on mental health.

An important question for future research relates to this question of long-term outcomes. Although engagement results in higher stress in the short term, its consequences can reverse in the long term and lead to better outcomes (Mullen and Suls, 1982; Suls and Fletcher, 1985). A column could be added to the Figure in which long-term results show that pessimists have only temporarily avoided persistent problems, whereas optimists have solved problems to the extent that they could. Although optimism predicted lower immunity in short-term studies, it has not predicted worse physical health in the long run (null effects are the worst outcome), and this difference may reflect a balance between short-term costs and long-term benefits. As in many topic areas within psychoneuroimmunology, links among optimism, immunity, and health remain to be clearly drawn. However, it is clear that to the question of whether optimism is good or bad for immunity: The answer is 'yes.'

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