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ORIGINAL ARTICLE

Forgiveness, Stress, and Health: a 5-Week Dynamic Parallel Process Study

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Abstract

Background Psychological stress is a well-known risk factor for poor health, and recent research has suggested that the emotion-focused coping process of forgiveness may help mitigate these effects. To date, however, no studies have examined how levels of forgiveness, stress, and health fluctuate and interrelate over time.

Purpose We addressed this issue by examining how forgiveness, stress, and mental and physical health symptoms change and relate to one another over 5 weeks. We hypothesized that increases in state levels of forgiveness would be associated with decreases in perceptions of stress, which would in turn be related to decreases in mental and physical health symptoms. A reverse effects model was also tested.

Methods We recruited a large, community-based sample of 332 young, middle-aged, and older adults (16–79 years old; $M_{age} = 27.9$). Each week for 5 weeks, participants reported on their levels of state forgiveness, perceived stress, and mental and physical health symptoms.

Results Levels of forgiveness, stress, and mental and physical health symptoms each showed significant change and individual variability in change over time. As hypothesized, increases in forgiveness were associated with decreases in stress, which were in turn related to decreases in mental (but not physical) health symptoms (i.e., forgiveness → stress → health). The reverse effects model (i.e., health → stress → forgiveness) provided a relatively poorer fit.

Conclusions This study is the first to provide prospective, longitudinal evidence showing that greater forgiveness is associated with less stress and, in turn, better mental health. Strategies for cultivating forgiveness may thus have beneficial effects on stress and health.

Keywords Forgiveness · Stress · Coping · Individual differences · Trajectories · Symptoms · Risk · Mechanism · Development · Health · Disease

The question of how experiences of stress and the emotion-focused coping process of forgiveness each relate to health has been examined in several studies. However, many of these investigations have utilized cross-sectional study designs and none have examined the important issue of *temporal sequencing* or, more specifically, how changes in state levels of forgiveness, stress, and health are associated with each other over time. To address this issue, we conducted a 5-week longitudinal study that tested a dynamic, parallel process, indirect-effects model wherein changes in levels of forgiveness were hypothesized to be related to experiences of stress that are in turn associated with health.

Forgiveness as a Dynamic, State-Like Process

Forgiveness has been conceptualized as the cognitive-motivational-emotional experience of decreasing negativity and increasing positivity toward an offender in the face of adversity [1, 2]. Forgiveness of others can be considered both a trait and state phenomenon. Work on this topic has most

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commonly studied links between trait forgiveness and health [3, 4], but some researchers have argued for the importance of investigating forgiveness of others as a dynamic, state-like process [1]. From this perspective, it is possible that levels of forgiveness—even of past events—can change over the course of a week, with these changes in turn having important implications for people's levels of stress and disease.

The few studies that have conceptualized forgiveness as a dynamic, state-like process have been insightful. Exline et al. [5] conducted two studies examining the temporal characteristics of forgiveness. In the first study, they examined empathy, responsibility, revenge, and avoidance each week for 5 weeks, and in the second study, they measured these same constructs biweekly over 9 weeks. Across both studies, increases in empathy and decreases in attributing responsibility for a situation to another person were associated with increases in forgiveness. In three other studies, McCullough et al. [6] examined the temporal characteristics of forgiveness and rumination. In the first two studies, they collected data biweekly over 9 weeks, and in the third study, they employed a 21-day daily-diary design to study associations between forgiveness and rumination. Across these studies, increases in forgiveness were associated with decreases in rumination. In addition, decreases in rumination were related to increases in forgiveness, and these effects were mediated by decreases in anger. Finally, in a third pair of studies, McCullough et al. [7] examined the mathematical function of forgiveness over time by reanalyzing data collected by McCullough et al. [6]. They also examined new 21-day daily-diary data with a 3-month follow-up. The authors found that forgiving motivations (i.e., low revenge and avoidance, and high benevolence) followed a logarithmic function, and that increases in unforgiving motives were associated with lower levels of offender responsibility and intentionality attributions, less painfulness of the transgression, and higher perceived relationship value.

These studies provide converging support for the formulation that forgiveness is a dynamic, state-like process that (a) changes over time, (b) is associated with psychosocial and relational processes, and (c) is related to psychosocial well-being outcomes, such as rumination. What this research does not reveal, though, is how changes in forgiveness relate to changes in psychological stress levels or health. Indeed, to our knowledge, no study to date has examined the temporal unfolding of forgiveness over time, and how changes in forgiveness relate to changes in individuals' stress levels and mental and physical health symptoms.

Stress and Coping Theory of Forgiveness

Researchers have drawn on Lazarus and Folkman's [8] transactional theory of stress and coping to conceptualize the putative effects of forgiveness on health [9–11]. According to this theory, stress is the result of cognitive appraisal processes that culminate in an individual's perception that environmental demands exceed one's ability to cope. These appraisals are in constant flux, and as environmental stimuli and individual coping responses change, the appraisals are updated to reflect current circumstances. Like forgiveness, therefore, stress appraisals and individuals' health status as a result of these appraisals can change and influence each other in a reciprocal manner over time.

Consistent with this transactional theory, the reciprocal nature of stress influencing health *and* health influencing stress has been well documented. Indeed, psychological stress is well known to predict the development of many health problems, including cardiovascular disease and depression [12, 13], and chronic health conditions have in turn been shown to generate stress [14, 15]. A complete review of these reciprocal links is beyond the scope of this article, but the existence of these effects underscores the importance of examining reciprocal associations, which can only be done using prospective, longitudinal methods. In this context, it has been proposed that changes in levels of state forgiveness may improve health by altering stress appraisals that in turn mitigate the negative effects of stress on health. As noted above, however, these dynamics have not yet been examined in the context of a longitudinal study.

Because forgiveness researchers have drawn heavily on the transactional theory of stress to develop an explanatory model of forgiveness and health, the stress and coping model of forgiveness includes several postulates that are similar to the transactional theory of stress [9–11]. In particular, this model holds that (a) unforgiveness, as indexed by anger, hate, and resentment, creates stressful intrapersonal and interpersonal situations; (b) unforgiveness contributes, in some part, to the detrimental effects of stress on health; and (c) forgiveness is a coping mechanism that is capable of reducing experiences of stress that are associated with unforgiveness. Although forgiveness is not the only strategy available for coping with adversity, according to this model of forgiveness, it is one of the more effective responses for reducing stress perceptions and enhancing health.

Consistent with these postulates, several studies have shown that forgiveness is associated with more happiness, better mental and physical health, healthier physiologic profiles, and less depression [16–21]. Additionally, a small literature exists on prospective models of forgiveness and health, which have permitted an exploration of how forgiveness is related to changes in distress, depression, and health over at least two time points [22–24]. Unfortunately, what these studies do not provide is a window into how simultaneous changes in forgiveness and health are related. Studies with three or more time points are ideal for examining *trajectories of change* in multiple constructs. However, only one study to date has examined changes in forgiveness and mental health

(i.e., rumination and depression) over 8 weeks [25]. This study found that forgiveness and mental health both change over time, and that changes in these factors are positively correlated. Although the statistical modeling used in this study showed that improvements in mental health predicted subsequent increases in forgiveness, the analyses did not show that increases in forgiveness predicted changes in mental health. More broadly, what this and other studies have not investigated is how changes in forgiveness relate to perceptions of stress that in turn influence health. Moreover, no studies to date have examined longitudinal associations between forgiveness, stress, and mental and physical health symptoms. As a result, only piecemeal evidence presently exists for the stress and coping model of forgiveness.

Present Study

To address these issues, we assessed how levels of forgiveness, perceptions of stress, and mental and physical health symptoms change and relate to each other on a weekly basis, over 5 weeks, in young, middle-aged, and older adults. More specifically, we performed a theoretically driven test of two models derived from the stress and coping model of forgiveness. In the first model, we tested the primary hypothesis that increases in forgiveness are associated with decreases in perceptions of stress, which in turn relate to decreases in mental and physical health symptoms. In the second model, we tested the alternative, reverse effects hypothesis that decreases in mental and physical health symptoms are associated with decreases in perceptions of stress, which in turn relate to increases in forgiveness.

Method

Participants and Procedures

Participants were 332 young, middle-aged, and older adults (120 males, 207 females, and 5 unknown) recruited using flyers and email announcements on college campuses and the surrounding community. At study entry, participants ranged in age from 16 to 79 years old ($M = 27.9$, Median = 21), with a skew toward younger participants. Institutional review board approval was obtained prior to the start of the study and all individuals provided informed consent before participating. Participants completed study measures each week for 5 weeks and were asked to reflect on the past week when completing each measure. Weekly assessments were selected based on the study design used by Orth et al. [25], who found that this time span allows ample opportunity for changes to occur in levels of both forgiveness and forgiveness-related health symptoms.

Measures

State Forgiveness State forgiveness was measured using the Rye Forgiveness Scale [2]. The measure consists of 15 items that assess the absence of negative emotions and presence of positive emotions in relation to experiences of adversity. Participants were instructed to "think of how you have responded to a person who has wronged or mistreated you." In responding to the items, therefore, participants could have referenced any past situation to report their current feelings of forgiveness. Using a state measure of forgiveness allows for an assessment of fluctuations in each participant's weekly levels of forgiveness. An example item is, "I wish for good things to happen to the person who wronged me." Responses to each item were provided on a 1 (*strongly disagree*) to 5 (*strongly agree*) scale, and item responses were averaged to create an overall weekly state forgiveness score, with higher scores indicating more forgiveness at the time of measurement. The Rye Forgiveness Scale has shown very good reliability ($\alpha = .87$), and acceptable convergence with the Enright Forgiveness Inventory (rs > .52) and divergence with religiousness ($r = .16$), anger ($r \leq -.41$), and social desirability ($r = .16$) [2]. Alphas for this study across all five time points were very good, $\alpha \geq .84$.

Perceived Stress In keeping with prior research on forgiveness, stress, and health [4, 36], participants' present levels of perceived stress were measured using the 10-item version of the Perceived Stress Scale [26, 27], which is the most widely used instrument for assessing perceived stress. The scale assesses how uncontrollable and unpredictable respondents view their lives at the time of measurement. An example item is, "During the past week, how often have you felt confident about your ability to handle your personal problems?" Responses to each item were provided on a 0 (*never*) to 4 (*very often*) scale, and all responses were averaged to create an overall weekly stress score, with higher scores indicating more stress. The Perceived Stress Scale has shown acceptable reliability ($\alpha = .78$), convergence with self-reported levels of average stress ($r = .39$) and number of life events ($r = .32$), and divergence with impact of events ($r = -.09$) and work stress ($r = .06$) [26, 27]. Alphas for this study across all five time points were very good, $\alpha \geq .86$.

Mental Health Symptoms Mental health symptoms were measured using the Kessler-6 scale [28, 29], which is a widely used six-item measure of non-specific psychological distress. An example item is, "During the past week, how often did you feel so sad that nothing could cheer you up?" Responses to each item were provided on a 1 (*never*) to 5 (*very often*) scale, and all responses were averaged to create an overall weekly mental health symptom score, with higher scores indicating more mental health complaints at the time of measurement.

The Kessler-6 has shown very good reliability (αs ≥ .89) and convergence with DSM-IV-based measures of mental health symptoms (AUC = .87–.88) [28, 29]. Alphas for this study across all five time points were very good, $\alpha \geq .88$.

Physical Health Symptoms Physical health symptoms were measured using the Physical Health Questionnaire [30, 31], which assesses the frequency of somatic symptoms and minor health conditions, such as colds. An example item is, "During the past week, how often have you experienced headaches?" Responses to 11 items on this measure were provided on a seven-point, 1 (*never*) to 7 (*all the time*), scale, and responses to three items were also provided on a seven-point scale, including 0 (*0 times*), 1 (*1–2 times*), 2 (*3 times*), 3 (*4 times*), 4 (*5 times*), 5 (*6 times*), and 6 (*7+ times*). All responses were averaged to create an overall weekly physical health symptom score, with higher scores indicating more physical health complaints at the time of measurement. The Physical Health Questionnaire has shown acceptable reliability (αs ≥ .70), convergence with general health (*r*s = .23 - .62), and divergence with work stress (*r*s = .002 - .12) [30, 31]. Alphas for this study across all five time points were acceptable, $\alpha \geq .79$.

Data Analyses

A primary aim of the study was to examine within-person changes in state levels of forgiveness, stress, and mental and physical health across the 5-week study period. To do this, we employed latent growth curve modeling using full-information, maximum likelihood estimation to estimate the models, which appropriately models missing data. Latent growth curve models (LGMs) enabled us to examine two unique parameters of change. First, we estimated mean latent intercept (i.e., starting) values for baseline measures of each construct, as well as variance of individual intercept values. Second, we estimated mean slope (i.e., change) across time of each construct, as well as variance of individual slope values. Together, these LGMs permitted an examination of individuals' average starting levels and changes in levels of each construct over time, in addition to variability in individuals' starting levels and changes in each construct over time [32, 33].

To test the hypothesized models involving state levels of forgiveness, stress, and mental and physical health symptoms, we estimated a parallel process LGM that allowed for the simultaneous estimation of multiple LGMs for each of these four variables of interest. Figure 1 depicts the LGM for state forgiveness as an example. The parallel process model simultaneously estimated three additional, identical models for perceived stress and mental and physical health symptoms. Although there are many parameters in parallel process LGMs, consistent with the general analytic strategy described by Slater and Hayes [33], we examined parallel process indirect-effects models and focused analyses on the effects of change that were of greatest relevance for the study hypotheses. Therefore, we present the mean and variance statistics for intercept and slope, and report on two LGMs that directly test the hypotheses. All results remained significant when controlling for participants' sex and age.

Results

Preliminary Analyses

Data were first examined to determine if missing data across the five time points were missing completely at random. Using Little's test for this purpose [34], we found no evidence that data were not missing completely at random, $\chi^2(214) = 236.77$, $p = .14$. We also conducted a series of logistic regressions using individuals' scores on a given variable (e.g., forgiveness, stress) to predict their likelihood of missingness on that same variable at either a prior or subsequent time point, while applying false discovery rate corrections due to multiple tests. Similar to the results above, these analyses indicated that individuals' scores at a given time did not predict their likelihood of missingness at any other time point, *p*s > .90.

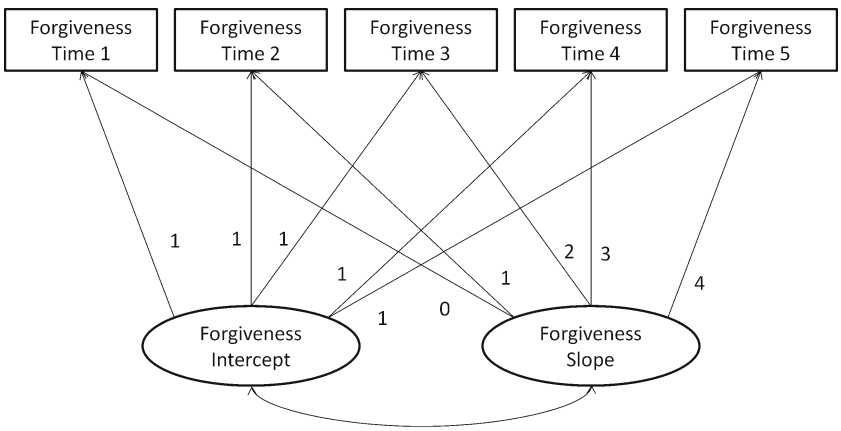

Fig. 1 Conceptual latent growth model of forgiveness over 5 weeks. *Ovals* represent latent intercept and slope variables. *Rectangles* represent observed data collected at each time point. Fixed weights for intercept and slope parameters are indicated along the parameter paths. Error variances/covariances not shown.

Primary Analyses

Table 1 summarizes the means and variances of starting levels and changes in state levels of forgiveness, perceived stress, and mental and physical health symptoms modeled in the parallel process LGM. Although means and variances of starting levels are a necessary part of the LGM, they describe only the average starting point of each variable and the individual variability in starting point at the beginning of the 5 weeks. Participants' starting levels of forgiveness, stress, and mental and physical health symptoms were significantly greater than zero, and significant individual differences among starting levels were observed. Significant average changes were observed for each of the four main variables, indicating that, on average, levels of forgiveness increased in a linear fashion over the 5-week study period ($B = .02$, $p < .001$), and levels of perceived stress ($B = -.05$, $p < .001$), mental health symptoms ($B = -.04$, $p < .001$), and physical health symptoms ($B = -.08$, $p < .001$) decreased over this time period. More importantly, there were also significant individual differences in changes in levels of forgiveness ($s^2 = .01$, $p < .01$), perceived stress ($s^2 = .01$, $p < .001$), and physical health symptoms ($s^2 = .01$, $p < .01$) over the 5 weeks, and marginally significant differences in changes in mental health symptoms ($s^2 = .01$, $p < .10$) over this time period. In sum, at the beginning of the 5-week study period, starting levels of all constructs were greater than zero and showed significant individual variability. Moreover, over the 5-week time period, each of the four main constructs (i.e., forgiveness, perceived stress, mental health symptoms, and physical health symptoms) showed significant change over time and also significant or marginally significant individual variability in change over time.

Hypothesis-driven structural models of change across the 5-week study period were tested in two models, which are depicted in Figs. 2 and 3. Similar to the approach taken by Orth et al. [25] in their LGM of forgiveness and adjustment, cross-construct covariances were estimated at each time point for observed variables, because doing so significantly improved overall model fit. The first model tested the primary hypothesis that increases in forgiveness are associated with decreases in perceived stress, which are in turn related to decreases in mental and physical health symptoms (i.e., increases in forgiveness → less perceived stress → better mental and physical health). The second model was constructed to examine the reverse effects hypothesis, whereby decreases in mental and physical health symptoms are associated with decreases in stress, which are in turn related to increases in forgiveness (i.e., better mental and physical health → less perceived stress → increases in forgiveness).

Table 1 Parallel process latent growth model of forgiveness, stress, and health: intercept and slope means and variances

	Mean	Variance
Intercept		
Forgiveness	3.54***	0.20***
Perceived stress	2.59***	0.21***
Mental health symptoms	2.18***	0.36***
Physical health symptoms	2.55***	0.38***
Slope		
Forgiveness	0.02***	0.01**
Perceived stress	−0.05***	0.01***
Mental health symptoms	−0.04***	0.01†
Physical health symptoms	−0.08***	0.01**

† $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

As depicted in Fig. 2, the first structural model demonstrated that increases in forgiveness across the 5-week study period were associated with decreases in perceived stress ($B = -.54$, $p = .001$) and that decreases in perceived stress were related to decreases in mental health symptoms ($B = .52$, $p < .01$) but not physical health symptoms ($B = .02$, $p > .05$). Model fit was acceptable, $\chi^2 = 202.06$, $p = .003$, CFI = .99, RMSEA = .03 (90 % C.I. = .02–.04), AIC = 7820.79. The indirect effect of increases in forgiveness relating to decreases in mental health symptoms through reductions in perceived stress was statistically significant ($B = -0.28$, $p < .05$), and no indirect effect was observed linking increases in forgiveness and decreases in physical health symptoms through decreases in perceived stress ($B = -0.01$, $p > .05$).

Testing the second, reverse effects structural model revealed that decreases in mental health symptoms across the 5-week study period were associated with decreases in perceived stress ($B = .64$, $p < .01$), but decreases in physical health symptoms were not related to decreases in perceived stress ($B = -.18$, $p > .05$) (see Fig. 3). Testing this model also revealed that decreases in perceived stress across the 5-week period were associated with increases in forgiveness ($B = -.48$, $p < .01$). Model fit was acceptable $\chi^2 = 204.53$, $p = .002$, CFI = .99, RMSEA = .03 (90 % C.I. = .02–.04), AIC = 7823.26. The indirect effect of decreases in mental health symptoms relating to increases in forgiveness through decreases in perceived stress was statistically significant ($B = -0.31$, $p = .01$), and no indirect effect was observed linking decreases in physical health symptoms and increases in forgiveness through decreases in perceived stress ($B = 0.09$, $p > .05$). In sum, then, across this 5-week study, increases in forgiveness were associated with decreases in perceived stress and associated decreases in mental health symptoms. Additionally, as shown in the second reverse effects structural model, we also found evidence that decreases in mental health symptoms were associated with decreasing levels of perceived stress and increasing levels of forgiveness.

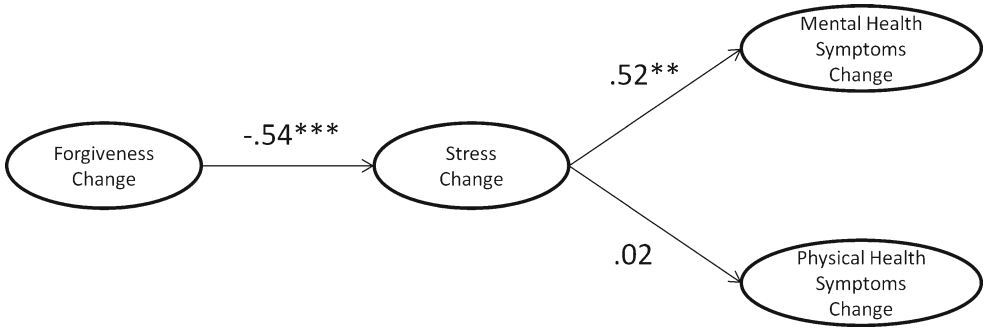

Fig. 2 Five-week, dynamic, parallel process, indirect-effects model of forgiveness predicting perceived stress, and perceived stress in turn predicting mental and physical health symptoms. Increases in forgiveness over the 5-week study period were associated with decreases in perceived stress, which were in turn related to decreases in mental (but not physical) health symptoms. To simplify the graphical presentation, only latent slope variables are shown, because these are the only variables relevant to the study hypotheses. Observed variables and their constant parameter coefficients, error variances/covariances, and latent intercept variables are not shown. Results did not change when controlling for sex and age. $^{**}p < .01$, $^{***}p < .001$

Model Comparison

Because the structural models were not nested, it was not possible to conduct a chi-square difference test to determine which model had a better fit, and including reciprocal effects in a single model made the comprehensive model unidentified. Therefore, the AIC statistic was used to evaluate the relative fit of the two models. Absolute size of AIC values is uninformative due to unknown scaling. Regardless of size, though, lower AIC values indicate better fit [35], and relative differences in AIC of |2| or greater indicate substantially improved fit [35]. Comparing the AIC values for the two models indicated that the best-fitting model was the primary hypothesis model, wherein changes in forgiveness were associated with changes in perceived stress, which were in turn related to changes in mental health symptoms (i.e., increases in forgiveness → less perceived stress → better mental health). AIC difference for the two models equaled 2.5 points.

Discussion

Despite long-standing interest in how stress and coping processes like forgiveness change, influence each other, and relate to individuals' health status over time, to date, no longitudinal studies have been conducted that measure each of these processes. We addressed this issue in the present study by investigating for the first time how levels of forgiveness, perceived stress, and mental and physical health symptoms change and interrelate over 5 weeks using a dynamic, parallel process, indirect-effects model. Several findings are noteworthy. First, the data confirm prior research suggesting that forgiveness is a dynamic state that changes over time [5, 6]. Likewise, levels of perceived stress and mental and physical health symptoms showed statistically significant changes over the 5-week study period. Second, there was significant individual variability in these changes over time. Third, supporting the primary hypothesis, increases in forgiveness were associated with decreases in perceived stress over the 5-week study period, which were in turn related to decreases

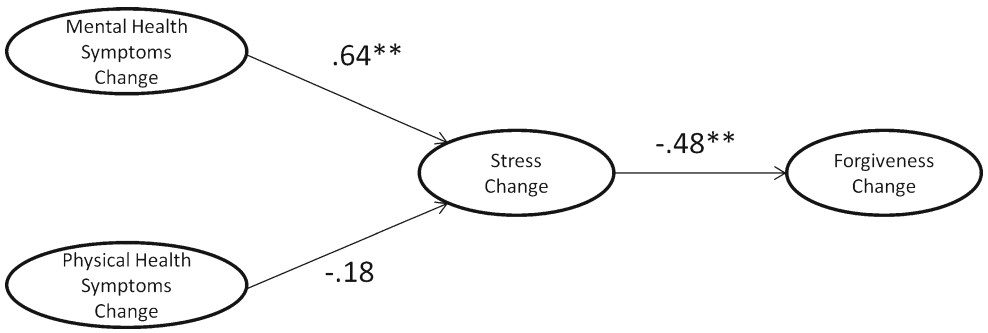

Fig. 3 Five-week, dynamic, parallel process, indirect-effects model of mental and physical health symptoms predicting levels of perceived stress, and levels of perceived stress in turn predicting forgiveness. Decreases in mental (but not physical) health symptoms over the 5-week study period were associated with decreases in perceived stress, which were in turn related to increases in forgiveness. The overall model fit for this alternative model was poorer relative to the fit for the primary model presented in Fig. 2. To simplify the graphical presentation, only latent slope variables are shown, because these are the only variables relevant to the study hypotheses. Observed variables and their constant parameter coefficients, error variances/covariances, and latent intercept variables are not shown. Results did not change when controlling for sex and age. $^{**}p < .01$

in mental (but not physical) health symptoms. Fourth, supporting the reverse effects hypothesis, decreases in mental (but not physical) health symptoms were associated with decreases in perceived stress over the 5-week period, which were in turn related to increases in forgiveness. Fifth, the indirect effects of (a) forgiveness through stress to mental health symptoms and (b) mental health symptoms through stress to forgiveness were statistically significant, suggesting that stress may play an important role as a mechanism linking forgiveness and health. Sixth, although both the primary structural model (forgiveness → perceived stress → health) and the alternative reverse effects structural model (health → perceived stress → forgiveness) showed acceptable fit to the data, the primary model demonstrated better relative fit. The data thus provide the strongest support for the stress and coping model of forgiveness, in which forgiveness is hypothesized to reduce experiences of perceived stress that in turn leads to better mental health [9–11].

One notable aspect of these findings is that we observed support for the stress and coping model of forgiveness in relation to mental but not physical health. Given prior cross-sectional and two-time-point longitudinal studies showing associations between forgiveness and physical health [19, 21, 23], we did not hypothesize a different pattern of results for mental and physical health in the present five-wave study. One possible reason for this patterning may involve the relatively short inter-assessment time period. Specifically, whereas levels of psychological and emotional distress are known to fluctuate on a daily and weekly basis [36, 37], changes in physical health symptoms (as measured here by the possible presence of a cold, flu, infection, pain, etc.) may occur over longer periods of time [38, 39]. Therefore, the timing of the present study design may have been better suited for assessing changes in mental versus physical health. Future research using longer inter-assessment time periods would thus be warranted, especially to examine these dynamics in relation to the development of physical disease (i.e., as opposed to just physical symptoms).

A second notable aspect of these findings is that we observed increases in forgiveness and decreases in perceived stress, mental health symptoms, and physical health symptoms over the 5-week study period. Although we can only speculate regarding the reasons for these specific patterns of change, it is possible that the increases in forgiveness may have something to do with the repeated measurement of this construct. For example, perhaps asking individuals about forgiveness makes this construct more salient or increases the demand characteristics associated with reporting higher levels of forgiveness over time. With respect to levels of perceived stress and mental and physical health symptoms, it is possible that participating in the study had unintended beneficial effects on individuals' stress levels and health, or that these assessments covered a time period marked by naturally occurring decreases in overall stress burden. Because the data we collected do not allow us to adjudicate between these possibilities, additional research is needed to understand these effects.

Putting these issues aside, at least two unique features of this study are important to note. First, as argued by McCullough et al. [1], longitudinal study designs provide the best window into the dynamic experience of state forgiveness, which is a dynamic phenomenon that changes as individuals reflect on and process their experiences. These temporal changes in forgiveness are in turn hypothesized to influence individuals' health and well-being. Second, the present study provides an important and novel test of the stress and coping model of forgiveness [9–11] in the context of health research. Prior research has generally supported the stress and coping model of forgiveness, but these investigations employed study designs that were cross-sectional or limited to only two assessment time points [4, 40, 41]. Consequently, it was generally understood that forgiveness, stress, and health may influence one another, but impossible to determine the temporal sequencing of these effects. The study by Orth et al. [25] is notable for having four assessments over 6 weeks, but this study did not examine whether changes in perceived stress mediate the association between forgiveness and health. Other studies have examined forgiveness and health at only two time points [22, 23], and while these studies revealed important initial information about how these factors are associated, they were not able to provide a rigorous test of the stress and coping model of forgiveness insofar as they did not examine how forgiveness, stress, and health all change over time, how changes in each of these factors relate to subsequent changes in the other factors, or how changes in stress might act as a mechanism that explains the effects of forgiveness on health.

The stress and coping model of forgiveness was built on the transactional model of stress and coping [8], and thus provides for the possibility of reciprocal causation. Despite evidence from the model fit statistics that the forgiveness → perceived stress → health model was a better fit for the present data than the alternative health → perceived stress → forgiveness model, it is still important to examine the alternative reciprocal effects model and consider the implications of these findings. In the primary model, we found that increases in forgiveness were associated with decreases in perceived stress, which were in turn related to decreases in mental health symptoms, suggesting that forgiveness may be a form of coping that helps alleviate perceptions of stress that contribute to poor mental health. However, equally important is the fact that decreases in mental health symptoms were associated with decreases in stress, which is consistent with previous research [15], and that decreases in stress were in turn related to increases in forgiveness.

Given these reciprocal effects, it may be useful for mental health care providers to consider how mental health problems play a role in generating stressful circumstances in patients' lives. There is no reason to believe that individuals with chronic

health conditions are more unforgiving by nature, but health problems can significantly disrupt individuals' social and family functioning [42–44], which may in turn suppress their ability to employ forgiveness as a coping strategy. By enhancing forgiveness capabilities and teaching stress reduction techniques, mental health care providers may be able to facilitate resilience in coping with future stressors and simultaneously improve mental health outcomes in their patients. First, however, researchers will need to conduct carefully designed clinical trials that attempt to manipulate individuals' forgiveness or stress management capabilities in order to provide causal evidence for the associations documented here.

Several limitations of this study should be noted. First, the stress and coping model of forgiveness provides only one view of how forgiveness may be associated with health. Several other theories also provide useful ways of understanding the forgiveness-health connection, including Antonovsky's model of salutogenesis [45], Bandura's model of self-efficacy [46], and Seligman's model of learned helplessness [47]. From these perspectives, forgiveness may represent a generalized resistance resource (Antonovsky), a method of building self-efficacy for dealing with stress (Bandura), or a strategy for increasing perceptions of control and reducing experiences of helplessness in the face of adversity (Seligman). Second, measurement of the main constructs in the present study was limited to self-report. Although this is very common in forgiveness research, future studies could use other measures of mental and physical health to ensure independence, including chart review, clinician health ratings, and the examination of health-related biomarkers. Third, based on the design of Orth et al. [25], we utilized weekly assessments of each of the main constructs, which allowed for ample opportunity for changes to occur in forgiveness, stress, and health. Changes may also occur over shorter time periods, though, and these relations are also worth investigating to provide a more fine-grained analysis of how short-term (e.g., daily) fluctuations in forgiveness relate to experiences of stress and health complaints. Likewise, changes may occur over longer periods of time, and these changes are also important to investigate, especially insofar as physical disease conditions [48, 49] and certain psychiatric outcomes (e.g., onset of a major depressive episode) [50] may only be detectable given more time in between assessments. Fourth, as with all non-randomized studies, potential confounding factors could have influenced the present results. Although controlling for age and sex did not alter the results, to more fully account for potential confounding effects, randomized forgiveness intervention trials examining forgiveness promotion and its effects on stress and health are necessary. Fifth, the stress and health measures used here referenced the "past week," whereas the forgiveness measure may have focused individuals more intently on in-the-moment experiences. This difference in time perspective might have influenced the results. Finally, although we aimed to recruit participants of all ages, additional research is needed to examine the robustness of these effects across the lifespan.

Notwithstanding these limitations, the present study is the first to utilize a 5-week, dynamic, parallel process, indirect-effects model of forgiveness, stress, and health to elucidate how these states change and interrelate over time. Based on data from 332 young, middle-aged, and older adults reporting across a 5-week time span, we found that increases in forgiveness were associated with reductions in perceived stress, which were in turn related to decreases in mental but not physical health symptoms. We also found that decreases in mental (but not physical) health symptoms were associated with decreases in perceived stress, which were in turn related to increases in forgiveness, but this alternative model showed relatively poorer fit to the data. The findings thus provide the first robust, sequentially timed evidence supporting the stress and coping model of forgiveness. Looking forward, additional research is needed to replicate these findings, to evaluate their generalizability, and to test competing models and theories.

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Compliance with Ethical Standards

Authors' Statement of Conflict of Interest and Adherence to Ethical Standards Authors Toussaint, Shields and Slavich declare that they have no conflicts of interest. All study procedures were carried out in accordance with the ethical standards of the University's Institutional Review Board, and with the 1964 Helsinki declaration and its later amendments.

References

1. McCullough ME, Root LM. Forgiveness as change. In: Worthington EL, ed. *Handbook of Forgiveness*. New York: Brunner-Routledge; 2005: 91-107.
2. Rye MS, Loiacono DM, Folck CD, et al. Evaluation of the psychometric properties of two forgiveness scales. *Curr Psychol*. 2001; 20(3): 260-277.
3. Berry JW, Worthington EL Jr, O'Connor LE, et al. Forgivingness, vengeful rumination, and affective traits. *J Pers*. 2005; 73(1): 183-226.
4. Lawler KA, Younger JW, Piferi RL, et al. The unique effects of forgiveness on health: An exploration of pathways. *J Behav Med*. 2005; 28(2): 157-167.
5. McCullough ME, Fincham FD, Tsang J-A. Forgiveness, forbearance, and time: The temporal unfolding of transgression-related interpersonal motivations. *J Pers Soc Psychol*. 2003; 84(3): 540-557.
6. McCullough ME, Bono G, Root LM. Rumination, emotion, and forgiveness: Three longitudinal studies. *J Pers Soc Psychol*. 2007; 92(3): 490-505.
7. McCullough ME, Luna LR, Berry JW, et al. On the form and function of forgiving: Modeling the time-forgiveness relationship

and testing the valuable relationships hypothesis. *Emotion*. 2010; 10(3): 358-376.
8. Lazarus RS, Folkman S. *Stress, appraisal, and coping*. New York: Springer; 1984.
9. Strelan P, Covic T. A review of forgiveness process models and a coping framework to guide future research. *J Soc Clin Psychol*. 2006; 25(10): 1059-1085.
10. Worthington EL. *Forgiving and reconciling: Bridges to wholeness and hope*. Downers Grove: InterVarsity Press; 2003.
11. Worthington EL, Scherer M. Forgiveness is an emotion-focused coping strategy that can reduce health risks and promote health resilience: Theory, review, and hypotheses. *Psychol Health*. 2004; 19(3): 385-405.
12. Cohen S, Janicki-Deverts D, Miller GE. Psychological stress and disease. *JAMA*. 2007; 298(14): 1685-1687.
13. Slavich GM, Irwin MR. From stress to inflammation and major depressive disorder: A social signal transduction theory of depression. *Psychol Bull*. 2014; 140: 774-815.
14. Baum A, Trevino LA, Dougall AL. Stress and the cancers. In: Contrada RJ, Baum A, eds. *The Handbook of Stress Science: Biology, psychology, and health*. New York: Springer; 2011: 411-423.
15. Phillips AC, Carroll D, Der G. Negative life events and symptoms of depression and anxiety: Stress causation and/or stress generation. *Anxiety Stress Coping*. 2015; 28(4): 357-371.
16. Enright RD, Fitzgibbons RP. Forgiveness in depressive disorders. In: Enright RD, Fitzgibbons RP, eds. *Helping clients forgive: An empirical guide for resolving anger and restoring hope*. Washington, DC: American Psychological Association; 2000: 113-133.
17. Toussaint L, Friedman P. Forgiveness, gratitude, and well-being: The mediating role of affect and beliefs. *J Happiness Stud*. 2009; 10(6): 635-654.
18. Toussaint L, Webb JR. Theoretical and empirical connections between forgiveness and mental health and well-being. In: Worthington EL, ed. *Handbook of Forgiveness*. New York: Brunner-Routledge; 2005: 349-362.
19. Witvliet CV, Ludwig TE, Vander Laan KL. Granting forgiveness or harboring grudges: Implications for emotion, physiology, and health. *Psychol Sci*. 2001; 12(2): 117-123.
20. Worthington EL Jr, Witvliet CV, Pietrini P, et al. Forgiveness, health, and well-being: A review of evidence for emotional versus decisional forgiveness, dispositional forgivingness, and reduced unforgiveness. *J Behav Med*. 2007; 30(4): 291-302.
21. Toussaint L, Shields GS, Dorn G, et al. Effects of lifetime stress exposure on mental and physical health in young adulthood: How stress degrades and forgiveness protects health. *J Health Psychol*. 2014. doi:10.1177/1359105314544132.
22. Orcutt HK. The prospective relationship of interpersonal forgiveness and psychological distress symptoms among college women. *J Couns Psychol*. 2006; 53(3): 350-361.
23. Seawell AH, Toussaint LL, Cheadle ACD. Prospective associations between unforgiveness and physical health and positive mediating mechanisms in a nationally representative sample of older adults. *Psychol Health*. 2014; 29(4): 375-389.
24. Toussaint LL, Marschall JC, Williams DR. Prospective associations between religiousness/spirituality and depression and mediating effects of forgiveness in a nationally representative sample of United States adults. *Depress Res Treat*. 2012. doi:10.1155/2012/267820.
25. Ortha U, Berking M, Walkerc N, et al. Forgiveness and psychological adjustment following interpersonal transgressions: A longitudinal analysis. *J Res Pers*. 2008; 42(2): 365-385.
26. Cohen S. Perceived stress in a probability sample of the United States. In: Spacapan S, Oskamp S, eds. *The Social Psychology of Health*. Thousand Oaks: Sage Publications; 1988: 31-67.
27. Cohen ST, Kamarck T, Mermelstein R. A global measure of perceived stress. *J Health Soc Behav*. 1983; 24(4): 385-396.
28. Kessler RC, Andrews G, Colpe LJ, et al. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychol Med*. 2002; 32(6): 959-976.
29. Kessler RC, Green JG, Gruber MJ, et al. Screening for serious mental illness in the general population with the K6 screening scale: Results from the WHO World Mental Health (WMH) survey initiative. *Int J Methods Psychiatr Res*. 2010; 19(S1): 4-22.
30. Schat ACH, Kelloway EK, Desmarais S. The Physical Health Questionnaire (PHQ): Construct validation of a self-report scale of somatic symptoms. *J Occup Health Psychol*. 2005; 10(4): 363-381.
31. Spence JT, Helmreich RL, Pred RS. Impatience versus achievement strivings in the type A pattern: Differential effects on students' health and academic achievement. *J Appl Psychol*. 1987; 72(4): 522-528.
32. Kline RB. *Principles and practice of structural equation modeling*. Guilford: New York, NY; 2005.
33. Slater MD, Hayes AF. The influence of youth music television viewership on changes in cigarette use and association with smoking peers: A social identity, reinforcing spirals perspective. *Commun Res*. 2010; 37(6): 751-773.
34. Little RJA. A test of missing completely at random for multivariate data with missing values. *J Am Stat Assoc*. 1988; 83(404): 1198-1202.
35. Burnham KP, Anderson DR. *Model selection and multimodel inference: A practical information-theoretic approach*. New York: Springer Science & Business Media; 2002.
36. Conway CC, Slavich GM, Hammen C. Daily stress reactivity and serotonin transporter gene (5-HTTLPR) variation: Internalizing responses to everyday stress as a possible transdiagnostic phenotype. *Biol Mood Anxiety Disord*. 2014; 4: 2.
37. Conway CC, Slavich GM, Hammen C. Dysfunctional attitudes and affective responses to daily stressors: Separating cognitive, genetic, and clinical influences on stress reactivity. *Cogn Ther Res*. 2015; 39(3): 366-377.
38. Halfon N, Hochstein M. Life course health development: An integrated framework for developing health, policy, and research. *Milbank Q*. 2002; 80: 433-479.
39. Slavich GM, Cole SW. The emerging field of human social genomics. *Clin Psychol Sci*. 2013; 1: 331-348.
40. Green M, DeCourville N, Sadava S. Positive affect, negative affect, stress, and social support as mediators of the forgiveness-health relationship. *J Soc Psychol*. 2012; 152(3): 288-307.
41. Seybold KS, Hill PC, Neumann JK, et al. Physiological and psychological correlates of forgiveness. *J Psychol Christ*. 2001; 20(3): 250-259.
42. Lutgendorf SK et al. Non-cancer life stressors contribute to impaired quality of life in ovarian cancer patients. *Gynecol Oncol*. 2013; 131(3): 667-673.
43. Lépine J-P, Briley M. The increasing burden of depression. *Neuropsychiatr Dis Treat*. 2011; 7(Suppl 1): 3-7.
44. Monroe SM, Slavich GM, Georgiades K. The social environment and depression: The roles of life stress. In: Gotlib IH, Hammen CL, eds. *Handbook of Depression*. 3rd ed. New York: The Guilford Press; 2014: 296-314.
45. Antonovsky A. The salutogenic model as a theory to guide health promotion. *Health Promot Int*. 1996; 11(1): 11-18.
46. Bandura A. Self-efficacy: Toward a unifying theory of behavioral change. *Psychol Rev*. 1977; 84(2): 191-215.
47. Maier SF, Seligman ME. Learned helplessness: Theory and evidence. *J Exp Psychol Gen*. 1976; 105(1): 3-46.
48. Schrepf A et al. Diurnal cortisol and survival in epithelial ovarian cancer. *Psychoneuroendocrinology*. 2015; 53: 256-267.
49. Miller G, Chen E, Cole SW. Health psychology: Developing biologically plausible models linking the social world and physical health. *Annu Rev Psychol*. 2009; 60: 501-524.
50. Slavich GM, Thornton T, Torres LD, et al. Targeted rejection predicts hastened onset of major depression. *J Soc Clin Psychol*. 2009; 28(2): 223-243.