

# **Comparing Daily Physiological and Psychological Benefits of Gratitude and Optimism Using a Digital Platform**

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Data and syntax are available at

[https://osf.io/3bwsn/?view\\_only=ce59c9fd65c743eab2d07a8ef790f815](https://osf.io/3bwsn/?view_only=ce59c9fd65c743eab2d07a8ef790f815). This research was supported by NIA (R24AG048), NIMH (T32MH019391), Greater Good Science Center, and Samsung Electronics CO. We have no conflicts of interest to report.

### **Abstract**

Gratitude and optimism are positive psychological dispositions associated with beneficial outcomes. To examine their associations with physiological and psychological experiences in daily life, we examined data from an Ecological Momentary Assessment study ( $N = 4,825$ ), including blood pressure, heart rate, and reports of stress, health behaviors, and thoughts. Trait gratitude and trait optimism both predicted lower heart rate and blood pressure, better sleep quality, more exercise, less stress, more positive expectations and reflections, and greater feelings of appreciation towards others. However, gratitude and optimism were not completely overlapping constructs: Gratitude was a stronger predictor of felt appreciation towards others and pleasantness when reflecting on the best part of the day, whereas optimism was a stronger predictor of sleep quality, lower stress, and lower unpleasantness when reflecting on the worst part of the day. These associations reveal both similar and differential influences of positive dispositions on psychological and physiological outcomes that provides insight into health consequences.

*Keywords:* gratitude, optimism, health, EMA, stress, blood pressure

### **Comparing Daily Physiological and Psychological Benefits of Gratitude and Optimism Using a Digital Platform**

How people view the world can have important consequences for their health and well-being. Some people may have relatively positive outlooks on life whereas others may not view the world through such rose-colored lenses. Positive outlooks can be characterized and defined in various ways and are often measured as individual differences or dispositions. Each disposition may provide unique and nuanced benefits and they may interact in distinct ways. Two positive traits that share some similar characteristics, but also some unique aspects, are gratitude and optimism. In the current research, we examine the unique roles of dispositional gratitude and optimism in shaping daily physical and psychological experiences, behaviors, and thoughts.

Gratitude has been linked to various positive physical and psychological outcomes. As a primarily social emotion, gratitude fosters social relationships and can bind people together (Algoe, 2012; Gordon et al., 2012). Not surprisingly, gratitude has been positively associated with well-being (Wood et al., 2010), and experimental and longitudinal studies show that the link from gratitude to well-being is causal (Emmons & McCullough, 2003, 2004; Nezlek et al., 2017; Wood et al., 2010). Gratitude has also been associated with better subjective physical health (Hill et al., 2013).

Similar to other affective constructs, gratitude can be conceptualized as a state or trait (McCullough et al., 2002). Between-persons, people may vary in terms of how frequently or intensely they feel or express gratitude. Gratitude as a trait or disposition is characterized as a higher order factor of daily or momentary states (McCullough et al., 2002). When conceptualized as a trait, gratitude can be thought of as “a generalized tendency to recognize and respond with grateful emotion to the roles of other people’s benevolence in the positive experiences and outcomes that one obtains” (McCullough et al., 2002, pg. 112). Others have considered dispositional gratitude to be akin to a more general positive outlook on life (Wood et al., 2010). That is, people can express gratitude to other people and can be grateful in general without expressing the sentiment to a particular person. In the present study, we measured gratitude with questions that captured people’s general tendencies to feel grateful toward others (e.g., “I am grateful to a wide variety of people”) as well as their general positive outlook on life (e.g., “I have so much in life to be thankful for”).

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Like gratitude, optimism is considered a positive trait. It has been defined as a positive outlook or motivation about expectations regarding future events or prospects of one's life (Carver & Scheier, 2014). Similar to gratitude, optimism has been positively associated with well-being and improved health (e.g., Carver et al., 2010). Given this similarity between the two dispositions, some studies that have examined the effects of gratitude have either compared the effects to optimism or have included optimism as an experimental condition along with gratitude (Dickerhoof, 2007; Lyubomirsky et al., 2011; Millstein et al., 2016). These studies have shown that gratitude and optimism are each associated with higher psychological well-being and greater adherence to health recommendations, which promote physical health.

The goal of the present study was to examine the individual and unique effects of dispositional gratitude and optimism on physical health (i.e., average levels of blood pressure and heart rate and self-reported health behaviors) and psychological thoughts and experiences (i.e., subjective stress and daily expectations and reflections) during daily life. To capture these daily experiences, we relied on an Ecological Momentary Assessment (EMA; Shiffman et al., 2008) method. At each check-in, participants first measured their heart rate and blood pressure (via an optic sensor on their phone) and then, depending on the check-in, responded to questions about their health behaviors, stress, and expectations for and reflections about their day.

We capitalized on several advantages that EMA methods provide. For instance, participants did not need to rely on extensive recall because the questions referred to the present moment or day. Methods that use single assessments often require participants to rely heavily on their memory of how they felt or what they experienced in the past, and these recollections are often fraught with biases and heuristics (Bradburn et al., 1987; Schwarz, 2012). Another advantage of EMA methods is that the repeated assessments over time provide a random sample of time points of a person's life. These time points are considered ecologically valid as they capture moments in natural contexts (Bolger et al., 2003; Brunswik, 1956). These moments that provide a snapshot of people's lives can portray a picture that looks different from self-report assessments people make about their lives at one time (Newman et al., 2020). Moreover, physiological states captured during the natural ebbs and flows of daily life may characterize people more accurately than measurements taken at one time in a doctor's office or research laboratory. Previous studies have yielded mixed or weak effects of positive traits on daily life, perhaps because much of the research on dispositional gratitude and optimism has relied on

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single assessment methods (and often with small sample sizes) to examine well-being and health behaviors (e.g., Jans-Beken et al., 2020). The present research has the potential to clarify these prior findings due to the large sample and methodological advantages provided by EMA.

In addition to methodological advantages provided by EMA, we aimed to advance the theoretical understanding of the nature of gratitude and optimism by examining unique predictive effects in daily life. We propose that gratitude and optimism will predict lower average levels of blood pressure and heart rate, better self-reported health behavior, lower stress, and more positive daily expectations and reflections given the positive nature of these constructs. Gratitude and optimism require people to focus on the positive attributes of their day. However, gratitude orients people to the present and recent past, whereas optimism orients people to the future (McCullough, 2002). Therefore, we anticipated that gratitude would be a stronger predictor of people's reflections of the best and worst aspects of their day, whereas optimism would be a stronger predictor of people's (future-oriented) expectations for the day. Gratitude also orients people towards others and the benefits they have bestowed to them, whereas optimism may orient people to themselves as they focus on their own specific future. Therefore, in a confirmatory manner, we expect that gratitude will be a better predictor of felt appreciation toward other people in daily life.

In addition to determining which disposition may be a stronger predictor of the daily outcomes, we sought to test the interactive or additive effects of trait gratitude and trait optimism. Prior work on positive traits such as gratitude and optimism tend to focus on them as distinct constructs, thus little is known about how they might function together. Therefore, the interactive analyses were exploratory in nature. We examined whether positive traits best fit an additive model, in which each trait builds on the other, conferring greater benefits. Alternatively, they could be represented by a different model in which having just one positive trait is enough to provide beneficial physical and psychological outcomes in daily life.

### **Method**

#### **Participants and Procedure**

The study took place on a digital platform in the form of an app called *MyBPLab* (<https://mybplab.com>) that was initially offered via the Google Playstore in March, 2019. A compatible phone (e.g., Samsung S9) with an embedded infrared optic sensor was required for participation, and the only way that users could measure their blood pressure from the embedded

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sensor was to download the app and join the study. The app allowed participants to measure their blood pressure at any time (e.g., on-demand) as well as measure their heart rate, blood pressure and subjective states following notifications sent three times during the day. Participants received immediate feedback regarding their current heart rate and blood pressure levels as an incentive to participate, and when actively engaged in the study received summarized feedback of their stress and emotion reports at the end of the 21 days. In addition to measuring their heart rate and blood pressure, participants were asked a few questions at each check-in about their present situation, such as if they recently exercised and if they had experienced anything stressful since the last check-in. Participants were asked questions three times a day during three time-windows (7:00am - 10:00am; 10:00am – 4:00pm; and 8:00pm – 11:00pm). The study was intended to last for 21 days, but participants were allowed to continue after the 21-day period. The data collection is ongoing, but the data presented in this manuscript included data that were recorded from March 15, 2019 until December 8, 2020,<sup>1</sup> representing approximately 21 months of data collection. The study was approved by the Human Research Protection Program at the University of California, San Francisco (IRB # 19-27169).

At each check-in, participants were asked a set of questions that remained the same each time. Additionally, different sets of rotating questions were presented to participants once a day (either in the morning, afternoon, or evening) every third day. For example, participants were asked some questions about the best and worst part of their day in the evening every third day. This means that these questions were presented to participants 7 times over the course of the 21-day period<sup>2</sup>. Finally, participants had the opportunity to answer some questions assessing individual differences. These questions were assessed only once, and participants were allowed to complete as many or as few of these surveys as they pleased. For the present study, we were interested in participants who completed trait measures of gratitude and optimism.

Our dataset to address the current questions includes 4,825 participants ( $M_{\text{age}} = 42.79$ ,  $SD = 13.25$ ; 64.15% male, 34.46% female, 1.38% other). Participants were required to be at least 18

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<sup>1</sup> The primary analyses presented here—associations between optimism/gratitude and daily psychological and physiological responses—did not differ meaningfully between those who participated before the onset of the Covid-19 pandemic and those who participated during the pandemic.

<sup>2</sup> Sleep quality was initially asked every third day but was later included every day, which meant that some people answered this question more than 7 times over the course of the study.

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years or older and speak English fluently (confirmed by an English proficiency test presented prior to joining the study). A post-hoc power analysis indicated we had sufficient power (80%) to detect effects as small as  $r = .04$ . The study was approved for global use so we did not restrict participants based on geographic location. This noted, the app was based in the US, and other countries (i.e., the UK, Australia, Canada, India, Singapore, Hong Kong, and New Zealand) offered the app on their Google Playstore so the majority of participants were from those eight countries. See Table 1 for a full set of descriptive statistics.

Table 1. Participant demographics.

	<i>N</i>	Percentage	Gratitude <i>M (SD)</i>	Optimism <i>M (SD)</i>
<b><u>Gender</u></b>				
Male	2,826	64.15%	5.24 (1.17)	3.23 (0.75)
Female	1,518	34.46%	5.50 (1.13)	3.07 (0.79)
Other	61	1.38%	4.95 (1.39)	2.95 (0.83)
<b><u>Age</u></b>				
18-29 years old	740	16.89%	5.08 (1.23)	2.98 (0.75)
30-39 years old	1,108	25.30%	5.29 (1.13)	3.05 (0.77)
40-49 years old	1,206	27.53%	5.29 (1.18)	3.14 (0.73)
50-64 years old	1,046	23.88%	5.45 (1.16)	3.36 (0.75)
65+ years old	280	6.39%	5.80 (0.92)	3.57 (0.64)
<b><u>Country</u></b>				
United States	2,711	62.36%	5.48 (1.16)	3.19 (0.79)
United Kingdom	512	11.78%	5.05 (1.19)	3.00 (0.80)
Australia	362	8.33%	5.15 (1.17)	3.24 (0.71)
Canada	307	7.06%	5.28 (1.09)	3.22 (0.72)
India	129	2.97%	4.85 (0.97)	3.15 (0.51)
Singapore	68	1.56%	5.11 (1.09)	3.20 (0.53)
Hong Kong	39	0.90%	4.84 (1.12)	3.14 (0.41)
New Zealand	24	0.55%	5.40 (1.27)	3.29 (0.58)
Other	195	4.49%	4.90 (1.08)	3.16 (0.65)
<b><u>Education</u></b>				
Elementary School (No High School)	116	2.71%	4.73 (1.24)	2.85 (0.71)
High School or GED	659	15.41%	5.01 (1.22)	3.01 (0.74)
Some college	1,041	24.34%	5.30 (1.21)	3.06 (0.80)
2-Year Degree	487	11.39%	5.46 (1.11)	3.21 (0.76)
4-Year Degree	1,018	23.80%	5.45 (1.08)	3.26 (0.73)
Graduate School	956	22.35%	5.49 (1.11)	3.33 (0.73)



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<b><u>Race/Ethnicity</u></b>				
Non-Hispanic White	2,878	65.84%	5.35 (1.16)	3.15 (0.79)
Non-Hispanic Black	178	4.07%	5.78 (1.14)	3.34 (0.76)
Non-Hispanic Asian	298	6.82%	5.03 (1.11)	3.21 (0.57)
Hispanic/Latino	454	10.39%	5.36 (1.16)	3.24 (0.75)
Multiple Races	409	9.36%	5.21 (1.17)	3.17 (0.68)
Other	154	3.52%	5.21 (1.28)	3.09 (0.81)

### Measures

**Trait measures.** Trait gratitude was measured with the 6-item Gratitude Questionnaire (McCullough et al., 2002). Example items are “I have so much in life to be thankful for” and “I am grateful to a wide variety of people.” Responses were recorded on a 7-point scale (1 = *strongly disagree*, 7 = *strongly agree*;  $M = 5.33$ ,  $SD = 1.17$ , Cronbach  $\alpha = .83$ ). Trait optimism was measured with the 6-item Life Orientation Test-Revised scale (Scheier et al., 1994). Example items include “In uncertain times, I usually expect the best” and “I’m optimistic about the future.” One filler item (“it’s easy for me to relax”) was included with the other items but was not scored. Responses were recorded on a 5-point scale (1 = *strongly disagree*, 5 = *strongly agree*;  $M = 3.18$ ,  $SD = .77$ , Cronbach  $\alpha = .78$ ).

**Physiologic measures.** At every check-in, we measured heart rate and systolic and diastolic blood pressure. Heart rate and blood pressure were obtained from the optic sensor embedded in the phone (Gordon & Mendes, 2021); the sole purpose of the optic sensor is to measure physiologic levels. Participants were encouraged to calibrate their blood pressure preferably with an external cuff and could only view their blood pressure levels if they calibrated the sensor with an external source. We only include participants with calibrated blood pressure values. Of the participants who completed measures of gratitude and optimism, 72.9% provided calibrated data and 27.1% did not and were not included in these analyses. Among the people who calibrated their blood pressure, they recalibrated .97 ( $SD = 2.11$ ) times on average over the course of the 21-day study.

**Health behaviors.** Two items that were administered in the evening every third day were used to assess exercise. Participants were asked, “Today, how much time did you spend doing the following? Moderate physical activity (e.g., brisk walking, strength training, gentle swimming)? Vigorous physical activity (e.g., aerobics class, jogging, running, power walking,

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team sports)?” Responses were recorded on a 6-point scale (1 = *none*, 2 = *less than 15 minutes*, 3 = *15-29 minutes*, 4 = *30-44 minutes*, 5 = *45-60 minutes*, 6 = *more than 60 minutes*). Every third morning, sleep quality was measured with a single item, “How would you rate the quality of your sleep last night?” Responses were recorded on a 4-point scale (1 = *very bad*, 2 = *fairly bad*, 3 = *fairly good*, 4 = *very good*).

**Stress.** Participants answered questions about stress at every check-in. Stress was measured with a single item, “Have you experienced any particularly stressful event since your last check-in?” (yes/no). If they answered yes, they were asked, “How stressful was it?” Responses were recorded on a 5-point scale (1 = *not at all*, 2 = *a little bit*, 3 = *somewhat*, 4 = *moderately*, 5 = *extremely*).

**Expectations and Reflections.** Every third day, participants answered questions about their *expectations for the day*, the best and worst part of the day, and gratitude felt toward a close other that day. To assess participants’ expectations for the day, they were asked in the morning, “To what extent are you dreading versus really looking forward to today’s events?” Responses were recorded on a 5-point scale (1 = *really dreading*, 2 = *fairly dreading*, 3 = *neutral looking forward to*, 4 = *fairly looking forward to*, 5 = *really looking forward to*).

To reflect on the *best part of the day*, participants were instructed in the evening as follows: “Think back on your day and remember the very best part of your day, the part of the day where you were the happiest, or proudest, or most content, or calmest, or living your day to its maximum potential. Think about that time for a few minutes and then answer the following questions:” They were asked, “what time of day was it?”, “where were you?”, and “who were you with?” The item of interest for present purposes was, “Rate that time in terms of how much you enjoyed it.” Responses were recorded on a 10-point scale (1 = *no enjoyment*, 10 = *greatest enjoyment*). For the *worst part of the day*, participants were instructed as follows: “Think back on your day and zero in the very worst part of your day, the part of the day where you were unhappy, stressed, angry, bored, frustrated, overwhelmed, or simply just trying to get to the next thing. Think about that time for a few minutes and then answer the following questions:” They were similarly asked questions about the time of day, where they were, and who they were with. The question of interest was, “How much did you dislike that time?” Responses were recorded on a 10-point scale (1 = *very pleasant experience*, 10 = *very unpleasant experience*). To assess participants’ *appreciation for a close person* in their life that day, they were asked, “To what

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extent did you feel very appreciative of this person today?”<sup>3</sup> Responses were recorded on a 10-point scale (1 = *not at all*, 10 = *a lot*).

### Data cleaning

One of the key strengths of an Ecological Momentary Assessment method is that it can capture thoughts, feelings, behaviors, and physiological states in naturalistic contexts (Shiffman et al., 2008). One of the assumptions is that the time points or check-ins constitute a reasonable and random sample of time points from someone’s life (Newman & Stone, 2019). If participants only complete a few check-ins, it creates a potentially biased sample of time points. In addition to this consideration, we wanted to take advantage of the large sample size and include as many participants as we could within reason. Because some of the questions were presented to participants seven times over the course of the 21-day period, we decided to drop data from participants who completed less than three check-ins for each variable. Doing so provided a reasonable sample of time points while still allowing us to capitalize on the large sample size. If we had required more completions, we would have drastically reduced the sample size. Moreover, the completion of just one or two check-ins does not seem to reasonably capture someone’s daily experiences (for discussions and examples of data cleaning decisions in EMA studies, see Nezlek, 2012; Nezlek et al., 2019). The descriptive statistics, including sample sizes for each variable, are presented in Table 2.

Table 2. Descriptive statistics.

Outcome variable	Total # of entries	Total # of people	Mean	Variance	
				Between- person	Within- person
<u>Physiology</u>					
Heart Rate	82,266	4,004	76.45	107.99	79.93
Systolic blood pressure	56,300	2,907	127.45	223.63	46.76
Diastolic blood pressure	56,300	2,907	79.68	108.72	29.09
<u>Health Behaviors</u>					
Sleep quality	13,975	1,923	2.88	.17	.31

<sup>3</sup> Prior to this question, participants were asked to think of a close person in their life and to list how much time they spent interacting with this person.

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Moderate physical exercise	6,933	1,533	2.92	1.21	1.72
Vigorous physical exercise	6,947	1,534	1.83	.78	1.21
<u>Stress</u>					
Stress frequency	83,246	4,025	.16*		
Stress intensity	11,539	3,089	3.55	.24	.62
<u>Expectations and Reflections</u>					
Expectations for day	5,197	1,162	3.37	.32	.50
Best part of day	8,810	2,001	7.77	1.28	1.63
Worst part of day	8,267	1,916	5.85	1.35	3.51
Appreciation toward others	7,390	1,674	7.25	3.03	2.84

Note: Total number of entries refers to the number of entries completed by people who provided at least three responses for that variable. Total number of people refers to the number of people who completed at least three entries for that variable.

\*The mean of stress frequency represents the proportion of instances people reported something particularly stressful on average.

We eliminated extreme values of heart rate (< 30 and > 200), systolic blood pressure (< 80 and > 210), and diastolic blood pressure (< 50 and > 180). Blood pressure values were also omitted if the participant indicated they exercised within the last 30 minutes given exercise acutely raises blood pressure. Moreover, in all analyses that examined between-person variation in blood pressure, we used calibrated data only.

The materials and data to reproduce these analyses are stored at [https://osf.io/3bwsm/?view\\_only=ce59c9fd65c743eab2d07a8ef790f815](https://osf.io/3bwsm/?view_only=ce59c9fd65c743eab2d07a8ef790f815).

## Results

### Analytic Plan

Because the data were nested in structure, we used multilevel modeling for the analyses. We nested check-ins within persons and used the *lme4* package (Bates et al., 2015) in R for all analyses.

### Descriptive Statistics

We began with unconditional models, which provide estimates of the means and variances of each variable. Most of physiological variables had more between-person variance than within-person variance, whereas most of the health behaviors, daily reflections and expectations, and stress had more within- than between-person variance (see Table 2). Critical

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for our interests, there was substantial between-person variance to examine between-person relationships.

### **Primary Analyses**

To examine between-person effects of trait gratitude and optimism on the daily or momentary variables, we entered trait gratitude and trait optimism as predictors at the person-level in separate models. The trait predictors were standardized and entered uncentered at level-2 to aid in the interpretation of the effects. A 1-point increase in gratitude or optimism translates to an increase in one standard deviation. The intercepts were allowed to vary randomly as follows:

Check-in level:  $y_{ij}$  (outcome variable) =  $\beta_{0j} + r_{ij}$

Person level:  $\beta_{0j} = \gamma_{00} + \gamma_{01}$  (trait gratitude or trait optimism) $_j + u_{0j}$

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Table 3. The effects of trait gratitude and trait optimism on daily outcomes.

Outcome variable	Separate Predictors								Simultaneous Predictors						Comparison	
	Gratitude				Optimism				Gratitude			Optimism				
	<i>b</i>	<i>t</i>	<i>p</i>	$r_b^{(f)}$	<i>b</i>	<i>t</i>	<i>p</i>	$r_b^{(f)}$	<i>b</i>	<i>t</i>	<i>p</i>	<i>b</i>	<i>t</i>	<i>p</i>	<i>z</i>	<i>p</i>
<u>Physiology</u>																
Heart Rate	-1.18	7.13	< .001	.13	-1.25	7.51	< .001	.19	-.71	3.52	< .001	-.85	4.23	< .001	.42	.676
Systolic blood pressure	-1.12	3.93	< .001	.05	-1.02	3.53	< .001	.02	-.81	2.37	.018	-.57	1.63	.103	-.40	.689
Diastolic blood pressure	-.94	4.69	< .001	.09	-.58	2.82	.005	.05	-.91	3.75	< .001	-.07	.27	.786	-1.96	.051
<u>Health Behaviors</u>																
Sleep quality	.09	8.45	< .001	.24	.13	11.66	< .001	.34	.03	2.65	.008	.11	8.34	< .001	-3.27	.001
Moderate physical exercise	.14	4.26	< .001	.12	.15	4.44	< .001	.14	.09	2.16	.031	.10	2.50	.013	-.21	.832
Vigorous physical exercise	.10	3.63	< .001	.08	.09	3.32	< .001	.10	.07	2.16	.031	.05	1.57	.116	.32	.752
<u>Stress</u>																
Stress frequency*	.87	6.45	< .001		.80	10.95	< .001		.99	.44	.658	.80	8.83	< .001	4.44	< .001
Stress intensity	-.05	3.73	< .001	.06	-.10	8.45	< .001	.22	.02	1.11	.268	-.11	7.64	< .001	4.98	< .001
<u>Expectations and Reflections</u>																
Expectations for day	.22	12.55	< .001	.45	.24	13.46	< .001	.49	.13	6.34	< .001	.17	7.88	< .001	-.92	.356
Best part of day	.44	15.68	< .001	.39	.31	10.60	< .001	.26	.39	11.55	< .001	.09	2.63	.009	4.97	< .001
Worst part of day	-.23	6.93	< .001	.20	-.41	12.21	< .001	.38	-.02	.40	.690	-.40	9.92	< .001	5.45	< .001
Appreciation toward others	.65	14.37	< .001	.39	.40	8.32	< .001	.24	.62	11.53	< .001	.06	1.09	.275	5.88	< .001

Note: \*For the models that included stress frequency as a dichotomous outcome, we calculated odds ratios using a multilevel model for binomial outcomes (odds ratios and *z* statistics replace *b* and *t* statistics for this outcome). In the far right columns, we created a contrast that subtracted optimism from gratitude. A positive sign indicates that the gratitude coefficient is more positive than the optimism coefficient, and a negative sign indicates that the optimism coefficient is more positive than the gratitude coefficient. Effect size estimates were calculated using a method explained by Rights and Sterba (2019). The  $r_b^{(f)}$  statistic is analogous to the square root

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of the reduction in variance method initially described by Raudenbush and Bryk (2002), akin to a correlation. Due to space constraints, 95% confidence intervals are reported in Supplemental Table 1.

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Age, gender, and race/ethnicity predictors were additionally included as control variables in all models<sup>4</sup>. The coefficients are presented in Table 3. These analyses showed that gratitude predicted lower heart rate and systolic and diastolic blood pressure, better sleep quality, more moderate and vigorous exercise, lower stress frequency,<sup>5</sup> less stress intensity, greater expectations for the day, higher ratings of pleasantness of the best experience of the day, lower ratings of unpleasantness of the worst experience of the day, and greater feelings of appreciation toward a particularly close other. The relationships using optimism as a predictor followed the same patterns as those using gratitude. Thus, these results suggest that both trait gratitude and optimism are associated with beneficial physiological and psychological outcomes in daily life.

Next, to determine the unique predictive effects of gratitude and optimism, we entered gratitude and optimism as predictors in the same model. Between-persons, gratitude and optimism were positively related,  $r(4823) = .55, p < .001$ . Although they were moderately correlated, multicollinearity was not a concern as the variance inflation factor scores ranged from 1.41 to 1.48. The models were as follows:

Day level:  $y_{ij}$  (outcome variable) =  $\beta_{0j} + r_{ij}$

Person level:  $\beta_{0j} = \gamma_{00} + \gamma_{01}$  (trait gratitude)<sub>j</sub> +  $\gamma_{02}$  (trait optimism)<sub>j</sub> +  $u_{0j}$

As can be seen in the right portion of Table 3, the effects of gratitude and optimism were somewhat attenuated when both predictors were entered simultaneously in the models. We also compared the strengths of the coefficients using the *multcomp* package (Hothorn et al., 2008). Consistent with our hypotheses about the nature of gratitude as a social-oriented emotion with a focus on the past and present, trait gratitude was a stronger predictor of ratings of the best part of the day and feelings of appreciation towards a close other than optimism. Contrary to our hypothesis about the nature of optimism as a future-oriented outlook on life, trait optimism was not a significantly stronger predictor of expectations of the day than trait gratitude (although the

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<sup>4</sup> We additionally ran models that controlled for country. These models yielded results that were very similar to those without controls. Given the large number of variables in the model, we present analyses without them for simplicity's sake.

<sup>5</sup> We used generalized linear mixed effects models for any model that involved stress frequency because it was measured as a dichotomous variable.



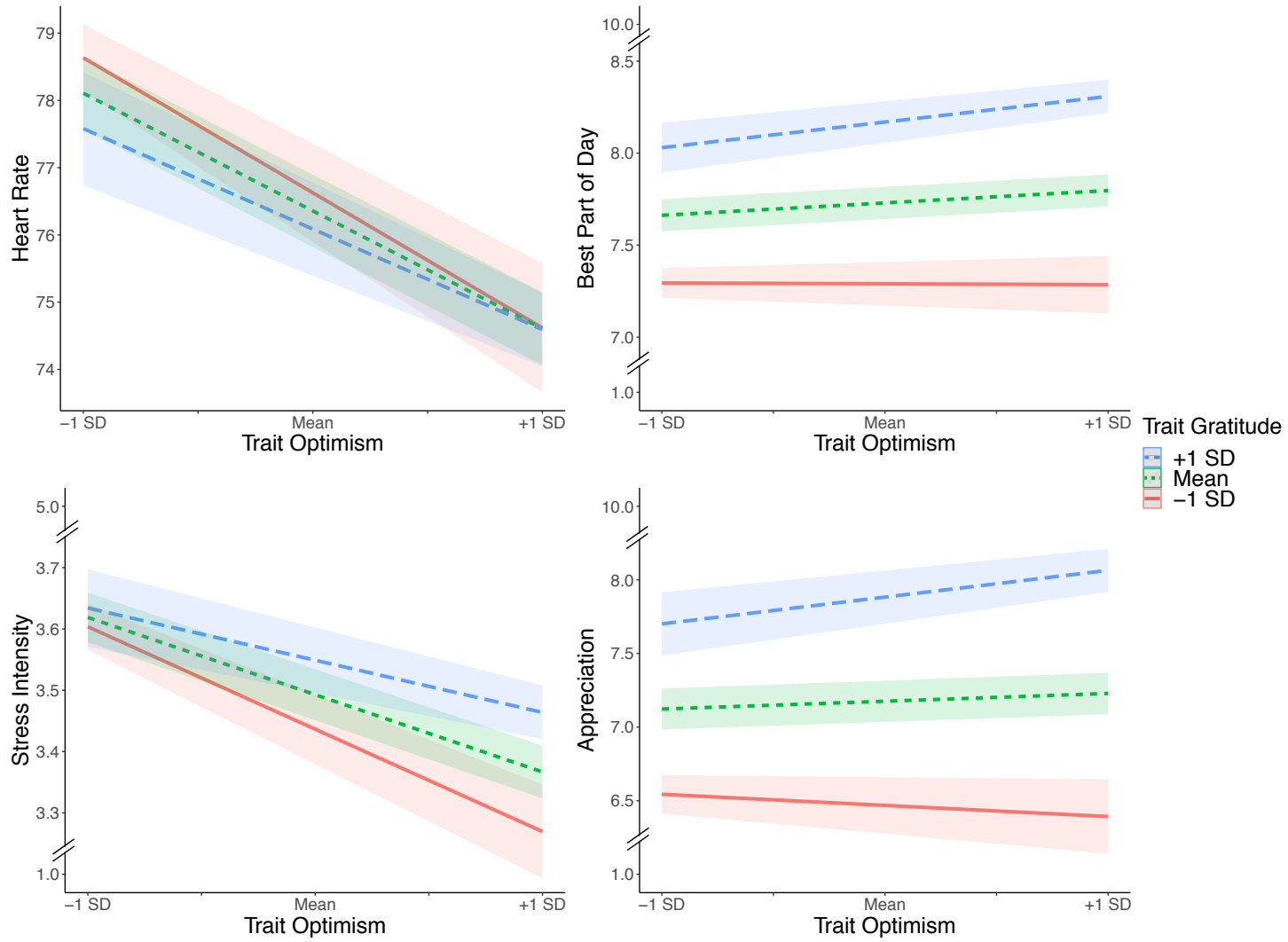
effect was trending in that direction). Interestingly, optimism was a stronger predictor of sleep quality, ratings of unpleasantness of the worst part of the day, and stress frequency and intensity than gratitude.

### **Trait Interactions**

We also examined interactions between trait gratitude and trait optimism to determine if there were any additive effects on daily outcomes. To do so, we added an interaction term at the trait level to the prior models. There were significant interactions (though some associations were small and may be unreliable) for heart rate,  $b = .32, t = 2.23, p = .026$ , stress intensity,  $b = .03, t = 3.09, p = .002$ , the best part of the day evaluations,  $b = .07, t = 2.98, p = .003$ , and felt appreciation toward a close person,  $b = .12, t = 3.08, p = .002$ . All other interactions were not significant, suggesting the effects of trait gratitude and trait optimism are largely independent of each other, and thus additive. The handful of significant interactions indicated that the effects of optimism on the positively-valenced outcomes (evaluation of best part of day and appreciation) were stronger among those high vs. low in trait gratitude. The opposite pattern was observed for heart rate and stress intensity. See Figures 1.

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Figure 1. Interactive effects of trait gratitude and trait optimism.



Note: Gratitude and optimism are standardized.

### Discussion

Using a digital platform and EMA approach, we amassed a dataset of almost 5,000 participants and examined how positive psychological dispositions—gratitude and optimism—related to blood pressure, stress, and health behaviors in daily life. Both gratitude and optimism were associated with lower average heart rate and blood pressure, better sleep quality, more frequent exercise, lower stress, more positive expectations for the day and reflections on the day, and greater feelings of appreciation towards others. When entered together as predictors, gratitude was a stronger predictor of felt appreciation towards others and reflections of the best part of the day, as expected.

Contrary to our hypothesis that higher optimism would be associated with forward-looking responses and interpretations of positive events, optimism more than gratitude predicted the ratings of the unpleasantness of the worst part of the day (a backward-looking response focused on a negative event). Specifically, highly optimistic people were likely to think their worst part of the day was relatively less unpleasant than were less optimistic people. Additionally, optimism was not a stronger predictor of positive expectations for the day. The latter finding may be due to the shorter future perspective here of a single day rather than a longer temporal window of months or years that is typically examined. Optimism was also a better predictor of sleep quality and stress frequency and intensity than gratitude.

Finally, we took a unique approach to studying positive traits and examined how gratitude and optimism worked together. We found that for some outcomes the benefits were additive (i.e., two main effects), but for others, gratitude and optimism interacted such that the beneficial effects of optimism on evaluations about the best part of the day and feelings of appreciation towards others were strongest among those high in trait gratitude.

These findings provide some insights into the nature of gratitude and optimism and how they may be beneficial. The fact that gratitude was a stronger predictor of the ratings of the best part of the day than optimism suggests that grateful people might focus on the positive events of their day and view them positively. This may be a key factor in explaining why gratitude is positively related to well-being and health. Moreover, grateful people express appreciation towards others, which may help them feel connected to others, a key determinant in fostering well-being (Diener et al., 2018). Thus, our findings dovetail nicely with some of the research that proposes that gratitude's positive effects are primarily due to its social nature (Roberts, 2004).

Optimism appears to work in a similar manner in the sense that optimistic people are likely to focus on positive aspects of their lives. Additionally, an important mechanism that we have learned about optimism from the present study is that highly optimistic people are more likely to view their worst part of the day as relatively less unpleasant than less optimistic people, and this effect was stronger than gratitude's effect. This particular result dovetails nicely with a recent study showing that dispositional optimism buffers the negative effect of stress on negative feelings (Majeed, et al., in press). Taken together, these findings suggest that being optimistic about the future may hinder people from noticing or dwelling on the negative experiences of the day. Viewing negative events of the day as mildly unpleasant as opposed to horrible may allow people to realize the potential positive outcomes in the future. Although speculative, our results suggest that whereas gratitude focuses on highlighting the positive aspects of daily life, optimism focuses on minimizing the negative aspects of daily life.

### **Limitations and Future Directions**

Some of the effect sizes were relatively modest or weak compared to some of the effects of gratitude and optimism on well-being and health in prior studies (McCullough et al., 2002; Wood et al., 2010). One reason for this could be because people were asked to reflect on their lives generally when they answered questions about gratitude and optimism whereas they reflected on the present day or situation when answering questions about their health, stress, and evaluations about the day. The inputs that influence global evaluations about life differ from the inputs that influence thoughts about the present moment (Schwarz & Strack, 1999). Moreover, blood pressure and heart rate are not self-report measures and thus may reflect different processes. Much of the previous research that has reported stronger correlations between gratitude and well-being and health often relies on similar methods of measuring all constructs (e.g., McCullough et al., 2002). Another possibility is that some of the earlier studies may have reported somewhat exaggerated effect sizes. Recent meta-analyses have documented weak or mixed effects (Jans-Beken et al., 2020; Scheier et al., 2020).

Regarding future directions, it is worth highlighting that the primary analyses concerned between-person relationships in which gratitude and optimism were assessed at one time. Our data do not provide insights into the dynamic nature of gratitude and optimism as they vary over time within-persons. Between- and within-person relationships are mathematically independent and often represent distinct psychological processes (Affleck et al., 1999; Nezlek, 2001). In

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future studies, researchers could fruitfully examine how daily or momentary states of gratitude and optimism relate to health behaviors, stress, evaluations of the day, and physiological reactions to these daily experiences. It would also behoove researchers in this area to continue to rely on heterogeneous methods to offset weaknesses with particular methods (e.g., McGrath, 1982).

One common concern with studying individual differences is the possible overlap with other relevant variables. For example, the effects of gratitude could be attributed to a general positive disposition as opposed to a specific grateful disposition. Controlling for other positive dispositions, such as positive affect, can mitigate these concerns. In this study, we found that some of the positive associations between gratitude and daily outcomes were better explained by levels of dispositional optimism. We also found that while optimism and gratitude operated largely independently of each other, there were several interactive effects. These findings shed light on the importance of considering positive dispositions in tandem in order to isolate the unique contributions of different dispositional tendencies. In future studies of gratitude and optimism, it could be beneficial to similarly consider potential confounds.

### **Conclusion**

Using data from a large, diverse sample of adults, we found that dispositional gratitude and optimism were positively related to numerous physiological and psychological benefits in daily life. We surmise that some of the positive effects of gratitude that have been documented in prior studies may be partially attributed more generally to having a positive outlook on life, as some of the effects of gratitude were no longer significant after controlling for optimism. Our findings provide important advances to our understanding of gratitude and optimism by showing that gratitude contributes to accentuating the positive aspects of the day, whereas optimism functions by minimizing the negative aspects of the day.

**Open Practices Statement**

The materials are available to the public at the OSF ([https://osf.io/3bwsn/?view\\_only=ce59c9fd65c743eab2d07a8ef790f815](https://osf.io/3bwsn/?view_only=ce59c9fd65c743eab2d07a8ef790f815)). The data are also publicly available at the same link for the purpose of verification of the results presented in this manuscript.

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