

Evaluation of the “Rethink Stress” Mindset Intervention: A Metacognitive Approach to Changing Mindsets

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Experimental research has demonstrated that a stress-is-enhancing mindset can be induced and can improve outcomes by presenting information on the enhancing nature of stress. However, experimental evidence, media portrayals, and personal experience about the debilitating nature of stress may challenge this mindset. Thus, the traditional approach of focusing on the more “desired” mindset without arming participants against encounters with the less desired mindsets may not be sustainable in the face of conflicting information. How might this limitation be resolved? Here, we present three randomized-controlled interventions that test the efficacy of a “metacognitive approach.” In this approach, participants are given more balanced information about the nature of stress along with metacognitive information on the power of their mindsets aimed at empowering them to choose a more adaptive mindset even in the face of conflicting information. In Experiment 1, employees of a large finance company randomized to the metacognitive mindset intervention reported greater increases in stress-is-enhancing mindsets and greater improvements in self-reported measures of physical health symptoms and interpersonal-skill work performance 4 weeks later compared to a waitlist control. Experiment 2, adapted to be distributed electronically via multimedia modules, replicates the effects on stress mindset and symptoms. Experiment 3 compares the metacognitive stress mindset intervention with a more traditional stress mindset manipulation. The metacognitive approach led to greater initial increases in a stress-is-enhancing mindset relative to the traditional intervention, and these increases were sustained after exposure to contradictory information. Taken together, these results provide support for a metacognitive approach to mindset change.

Public Significance Statement

While previous research has shown that a stress-is-enhancing mindset can be beneficial, conflicting information from personal experience and media portrayals may make it challenging to maintain this mindset. The study tested a new approach called the “metacognitive approach,” which provides participants with more balanced information about stress and empowers them to choose a more adaptive mindset even in the face of conflicting information. Results from three experiments showed that the metacognitive approach was effective in increasing stress-is-enhancing mindsets and improving physical health symptoms and work performance. These findings suggest that the metacognitive approach could be a useful tool for mindset change in areas where the effects are ambiguous or paradoxical, such as stress.

Keywords: stress, mindset, metacognition, intervention, coping

For there is nothing either good or bad, but thinking makes it so.
(William Shakespeare)

A key tenet of psychology is that experiences are subjectively interpreted and that these interpretations can influence resulting behaviors and outcomes (Nisbett & Ross, 1991). In attempts to improve people’s

lives, a range of interventions over the past two decades have been designed to shift how people think about themselves or the underlying nature of how the world works. That is, they target *mindsets*—core assumptions that orient an individual to a particular set of expectations, attributions, and goals—that alter not only how people interpret their experience but also their behavioral and physiological responses

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(Blackwell et al., 2007; Crum, Leibowitz, et al., 2017; Dweck & Yeager, 2019). For example, the persistence and performance of lower-performing students improved after they were taught about the malleable nature of intelligence in school settings (e.g., Blackwell et al., 2007; Burnette et al., 2022; Yeager et al., 2019). Participants provided with a leading questionnaire that portrayed willpower as a nonlimited resource experienced reduced cognitive and physiological depletion after strenuous tasks (Job et al., 2010, 2013). Employees informed about the enhancing nature of stress reported higher performance and improved health under stress (e.g., Crum, Akinola, et al., 2017; Crum et al., 2013). The methods of changing mindsets in these myriad domains have varied: Some have involved subliminal priming (e.g., a leading or “biased questionnaire”; Job et al., 2010); some have more explicitly tried to orient people toward mindset-consistent information in a short passage or brief film clip (e.g., documenting research and anecdotes on the enhancing nature of stress; Crum, Akinola, et al., 2017; Crum, Leibowitz, et al., 2017); and some have entailed more extensive educational programs (e.g., learning about the malleable nature of intelligence in a variety of ways over the course of 8 weeks or in a digital 1-hr program; Blackwell et al., 2007; Yeager et al., 2019).

Although the delivery method and duration vary, most existing mindset interventions provide information focused primarily on the more “desirable” mindset, often without a strategy or approach for grappling with information that may contradict that mindset. While this approach may be appropriate for mindsets supported by strong evidence, it may be problematic for shifting mindsets in domains riddled with ambiguous or paradoxical information, such as mindsets about stress. Although the dominant cultural narrative is that stress is detrimental and should be avoided or mitigated, research has also found that stress can be enhancing and beneficial in certain circumstances (e.g., Brooks, 2014; Cahill et al., 2003; Dienstbier, 1989; Epel et al., 1998; C. L. Park & Helgeson, 2006; Tedeschi & Calhoun, 2004; for review, see Crum et al., 2013). Consistent with prior designs, “stress-is-enhancing” mindset interventions have provided one-sided information about the enhancing nature of stress, and these interventions have indeed been shown to lead to better performance and improved health under stress (e.g., Crum, Akinola, et al., 2017; Crum et al., 2013). Yet even when these interventions shift an individual’s mindset in the short term through information primarily focused on the enhancing nature of stress, that individual is likely to encounter significant evidence of the negative effects of stress in public health messages, media coverage, and through their own experiences. Efforts to enact long-lasting changes in mindset may be undermined when this contradictory information is encountered, unless participants receive a more holistic understanding of mindsets and thus are inoculated to future challenges.

Here we present and test an alternative approach to mindset change: one that teaches people about the power of their mindsets. Across three randomized, controlled trials, we test whether stress mindsets can be changed metacognitively by teaching participants about the *nature* of mindset and the ways in which the mindsets they hold about stress can have self-fulfilling effects, for better or for worse. This approach provides evidence for and against an adaptive mindset and empowers participants to choose a particular mindset because it may be more *useful* (not necessarily because it is *unilaterally true*). We first discuss limitations of a traditional stress-mindset intervention approach by reviewing existing research and theory on stress mindset. Next, we describe the theory and methods for a metacognitive approach to changing mindsets. We then report our methods and results from two experiments that test the effects of our metacognitive approach on self-

reported mindset, health, and performance outcomes over the course of 4 weeks for employees in a real-world business setting. In a third experiment, we compare the metacognitive stress mindset intervention to a more traditional stress mindset manipulation and test the sustainability of mindsets in the face of contradictory information. We conclude with a discussion of how this research informs not only the field of stress management but the field of mindset change more broadly.

Stress Mindset: Existing Theory and Research

Stress, defined as the experience or anticipation of encountering adversity in one’s goal-related efforts (Carver & Connor-Smith, 2010), is an unavoidable aspect of human existence. Public health and media attention focuses largely on the potentially debilitating effects of experiencing stress on physical health (e.g., Sapolsky, 1996; Schneiderman et al., 2005), mental well-being and cognition (e.g., Hammen, 2005; McEwen & Seeman, 1999; Schwabe & Wolf, 2010; Wang, 2005), and work performance (e.g., Atkinson, 2004; Schneiderman et al., 2005). However, a large body of research also supports the notion that our cognitive, physiological, and behavioral responses to stress can have *enhancing* effects on health, well-being, and performance (e.g., Cahill et al., 2003; Dienstbier, 1989; Epel et al., 1998; C. L. Park & Helgeson, 2006; Tedeschi & Calhoun, 2004; for review, see Crum et al., 2013).

This paradoxical nature of stress has been reconciled by research showing that performance, health, and well-being effects are driven not solely by whether we experience stress, but also by the chronicity or severity of stress and how we respond to life’s inevitable stressors (Holmes & Rahe, 1967; Lazarus & Folkman, 1984; Selye, 1975; Yerkes & Dodson, 1908). Prior research demonstrates that the effects of stress can be made less debilitating by employing adaptive responses to stressors, such as accepting stress (e.g., Hofmann et al., 2009), reappraising stress as excitement (Billings & Moos, 1981; Brooks, 2014; Carver et al., 1989; Folkman & Lazarus, 1980; Penley et al., 2002), or appraising stress as a challenge as opposed to a threat (Blascovich & Mendes, 2010; Jamieson, 2017; Seery, 2011). More recently, stress mindset has been proposed as a distinct and meaningful construct that can influence the stress response (Crum et al., 2013). Stress mindset is the extent to which an individual believes that stress has either enhancing or debilitating consequences for outcomes such as performance, health, well-being, and growth (Crum, Akinola, et al., 2017). The belief that stress can benefit these outcomes is referred to as a “stress-is-enhancing mindset.” The contrasting mindset, in which stress is seen as working against these outcomes, is referred to as a “stress-is-debilitating mindset.” Stress mindset has proven to be an important moderator of the effects of stress. People who hold or come to hold a stress-is-enhancing mindset (vs. a stress-is-debilitating mindset) exhibit improved cognitive functioning and performance (Akinola et al., 2016; Crum, Akinola, et al., 2017; Jamieson et al., 2010), improved well-being (Crum et al., 2013), and, in some cases, more adaptive physiological responses (Crum, Akinola, et al., 2017; Crum et al., 2013; Jamieson et al., 2010, 2016). The effects and mechanisms of stress mindset, as well as how it is distinct from the amount of stress, appraisal, and coping, are reviewed extensively elsewhere (Crum, Akinola, et al., 2017; Crum et al., 2013; Jamieson et al., 2018).

One’s mindset clearly plays an important role in shaping one’s responses to stress, but how does one come to hold the mindset that stress is enhancing? Cross-sectional studies reveal that most individuals

in the United States hold the mindset that stress is debilitating, including large samples of college students (Goyer et al., 2022), adult employees (Crum et al., 2013), and adolescents (D. Park et al., 2017), whose mean stress mindset scores on the stress mindset measure (SMM) consistently reflect a debilitating view of stress (Crum et al., 2013).

Research also shows that mindsets can be changed quite readily, at least in the short term. Crum et al. (2013), for example, demonstrate that mindsets about stress can be altered simply by watching multimedia film clips selectively oriented toward either a stress-is-enhancing mindset or a stress-is-debilitating mindset. In one experiment, employees watched three videos presenting research and examples of the nature of stress over the course of 1 week, specifically its enhancing or debilitating nature. After watching these videos, participants in the enhancing condition reported a greater stress-is-enhancing mindset, better work performance, and improved health compared to participants who watched either no videos or videos on the debilitating nature of stress (Crum et al., 2013). In another experiment, after watching just one 3-min video showing that stress can enhance cognitive functioning, participants reported a greater stress-is-enhancing mindset and corresponding benefits in cognitive, physiological, and psychological outcomes in response to a Trier Social Stress Test (Crum, Akinola, et al., 2017). Related research focused on more specific mindsets about one component of stress, namely physiological arousal that occurs during a stressor. Jamieson and colleagues showed that students who received a note explaining how arousal can be beneficial to exam performance earned higher scores on aptitude tests such as the Graduate Record Examination (Jamieson et al., 2010).

Challenges With Nonmetacognitive Stress Mindset Interventions

From an empirical and theoretical perspective, these studies represent a proof of concept that stress mindsets can be changed and that such changes can produce improvements in health, performance, and well-being. However, from a practical point of view, existing approaches to changing stress mindsets may have limited impacts on long-term outcomes. The benefits of existing stress-mindset interventions have only been demonstrated on outcomes within hours (Crum, Akinola, et al., 2017; Crum, Leibowitz, et al., 2017) or days (Crum et al., 2013). Some studies, including those on the malleability of intelligence, emotion regulation, and empathy, have shown effects lasting as long as one to 2 years later (Blackwell et al., 2007; Burnette et al., 2022; Yeager et al., 2019), while others, such as those on willpower, have only explored outcomes in the short duration of the experimental study (Job et al., 2010). The sustainability of mindset change may hinge on the degree to which participants encounter evidence that contradicts the mindset in question, and therefore may be particularly fragile when evidence is mixed, as is the case with stress.

One reason for this, as mentioned previously, is that approaches attempting to inspire a more adaptive mindset do not necessarily offer strategies for reconciling information or experiences that may contradict that mindset. This may be especially problematic when research on the topic is inherently more complex, as in the case of stress, where evidence supports both enhancing (Akinola & Mendes, 2012; Cahill et al., 2003; Dienstbier, 1989; Epel et al., 1998) and debilitating (Shapiro et al., 2000, 2007) effects. Given that most societal messaging around stress is negative, even if participants are open and responsive to the stress-is-enhancing information in a laboratory or specific context (which existing research suggests they are), people will inevitably encounter oppositional evidence that stress is debilitating. When

encountering such evidence, their views may fall back toward the prevailing norm.

A Metacognitive Approach to Mindset Change

We propose an alternative approach: Mindsets can be changed through a metacognitive process (e.g., Flavell, 1979; Langer, 1989; Schraw, 1998) in which participants learn what a mindset is, realize they have mindsets about various topics, and are informed about research suggesting that these mindsets are not necessarily true or false but do have self-fulfilling outcomes. The accumulated body of research on mindsets in domains such as intelligence, medicine, exercise, and aging compellingly asserts that, whether or not they are true, mindsets produce self-fulfilling outcomes on health, well-being, and performance (e.g., Crum & Langer, 2007; Dweck, 2008; Levy et al., 2002; Price et al., 2008). We theorize that once someone recognizes the influential (sometimes self-fulfilling) nature of mindsets, they will be motivated to adopt a more adaptive mindset because it is useful, regardless of whether that mindset is fully true. As such, the metacognitive approach is distinct from traditional mindset-change approaches that focus primarily on evoking a particular mindset by providing evidence in support of it. Instead, we hypothesize a metacognitive approach could be more sustainable in the face of paradoxical, complex, or conflicting evidence because it enables the individual to actively choose the mindset that aligns with relevant goals, rather than one that is “true.”

In the current research, our goal was to devise and test a metacognitive stress-mindset intervention. Our intervention was distinct in three important ways. First, contrary to existing stress-mindset manipulations, which only provide information on the enhancing nature of stress (e.g., Crum, Akinola, et al., 2017; Crum et al., 2013), we presented participants with a more balanced account of stress, highlighting both its enhancing and debilitating features. Second, participants were given evidence supporting the importance of mindsets in shaping health and performance in a variety of domains, including medicine (e.g., the placebo effect as a demonstration of the mindset’s ability to heal the body in the absence of any pharmaceutical or chemical substance; Price et al., 2008) and exercise (Crum & Langer, 2007), in addition to existing research showing that mindsets can shape one’s physiological, behavioral, and psychological responses to stress (Crum et al., 2013). Third, rather than simply presenting information to participants, the current intervention provided a three-step approach designed to help them actively and deliberately adopt a stress-is-enhancing mindset as both a daily habit and stress response. This approach is metacognitive in the sense that participants are not asked to adopt a new mindset because it is *true* but instead because it is *useful*. In other words, participants learn to be aware of their mindsets, the ways in which their mindsets can have self-fulfilling effects, and their capacity to actively choose one mindset over another based on its function or utility.¹ In doing so, it allows people to see the value of a particular

¹ This version of metacognition is distinct from “meta-lay theories” (e.g., Rattan et al., 2018), which are focused on people’s metabeliefs about other’s mindsets as opposed to the self-fulfilling nature of mindsets, and may therefore influence motivation through other mechanisms. It is also related to, but distinct from, metamotivational theories, which focus on how people regulate their motivation through knowledge of what types of motivation will be most useful based on the context (e.g., Scholer et al., 2018).

mindset and feel efficacious in shifting toward that mindset, which we suspect will motivate active pursuit of more adaptive mindsets over time (Eccles, 1983; Hulleman & Harackiewicz, 2021). As such, the metacognitive approach builds on decades of clinical psychology research demonstrating that acceptance and reappraisals of emotional experiences (including stress) can impact well-being (e.g., Blackledge & Hayes, 2001; Brooks, 2014; Gross, 2014; Hofmann et al., 2009; Salovey & Mayer, 1990).

Experimental Approach

We first tested the effect of this novel stress-mindset intervention in two different occupational contexts: a Fortune 500 finance company and a large technology company. We used two different modes of delivery: (a) a live, in-person training delivered by experts (Experiment 1) and (b) an online training delivered by a series of multimedia modules (Experiment 2). We explored effects on self-reported health and work performance over the course of 4 weeks. In both experiments, we hypothesized that, compared to control conditions, participants in the mindset intervention condition would (a) change their stress mindset toward a more stress-is-enhancing perspective and (b) show improvements in health, work performance, and life satisfaction. In a third experiment, we compared the metacognitive stress-mindset intervention to a traditional stress-mindset manipulation. We explored the strength of the changes in stress mindset and the sustainability of mindset changes in the face of conflicting information. We also tested the theoretical psychological mechanism in question (changes in metacognitive beliefs about mindset). The initial timeline for preregistered Experiment 3 happened to conclude just weeks before the COVID-19 global pandemic, so we followed up with participants to explore the effects of the stress-mindset intervention on self-reported symptoms and affect in the early months of the global pandemic.

Together, the results from Experiments 1–3 make theoretical and practical contributions to two fields: stress management and mindset change more broadly. First, they provide support for the stress-mindset approach to stress management, one focused on harnessing the benefits of stress by deliberately shifting one's mindset as opposed to avoiding or managing the potentially negative effects of stress. Second, they provide a novel approach to mindset change more broadly, one focused on the metacognitive process of teaching people that a particular mindset is adaptive because it is likely to be self-fulfilling, and therefore useful, as opposed to persuading them that a particular mindset is "true."

Experiment 1

Method

Participants

The experiment was conducted at a large international financial institution in the northeastern United States in the first quarter of 2009, during which time the Fortune 500 financial company experienced massive job layoffs, as it was recoiling from a major recession. Participants were recruited for the experiment through an emailed invitation from the company's Human Resources department, which offered the opportunity to participate in a stress-management training program. Participation was voluntary, and we offered no compensation for participation. We invited employees from several

divisions (e.g., wealth management, investment banking, and asset management) and recruited as many participants as possible, given the constraints of a real-world setting. Three hundred seventy-five employees completed baseline measures, and 239 attended the training and completed both baseline and follow-up measures ($n = 127$ in the mindset training and $n = 112$ in the waitlist control).² Consistent with the organization's composition, 53% of participants were male. Mean age of the sample was 38.49 ($SD = 8.40$). Most participants were White/Caucasian (71.7%), followed by Asian (15.8%), Hispanic (6.4%), Black/African American (2.4%), and other (3.7%). Results are analyzed for employees who attended the training and completed both baseline and follow-up surveys. Varying degrees of freedom in the analyses reflect cases in which participants chose not to answer particular questions.

Design and Procedure

Participants were assigned randomly to the metacognitive mindset training or a wait-list control group. Baseline measures were a mean of three measures administered approximately 1 week prior to training; posttest measures were administered 4 weeks after the training program. Assessments for the control group were administered at the same times. Members of the wait-list control group did not receive any information or intervention until after the administration of follow-up measures, at which time they participated in the intervention in its entirety. The intervention, a live, 2-hr training, took place during working hours (see more information on intervention content below). Consent and all measures were collected using Qualtrics Online Survey Software. Participants were not recruited from established work teams; they instead came from a variety of departments in an organization of over 50,000 people. Thus, participants in the intervention group had limited contact with those in the control group. To further safeguard against diffusion of information to the control group, participants in the intervention group were asked not to share the content of the training with other employees. All procedures were reviewed and approved by the university Institutional Review Board (IRB).

Measures

Stress Mindset Measure

The intervention was designed to shift participants' mindsets regarding the nature of stress, independent of their actual and perceived levels of stress. This eight-item measure was developed in previous research to address the extent to which an individual adopts a mindset that the effects of stress are enhancing or debilitating (Crum et al., 2013). Items for evaluation, listed in Appendix,

²Participants were rerandomized from Crum et al. (2013, Study 2), in which they were exposed to three 3-min videos that were either enhancing or debilitating, or no videos, prior to the in-person stress mindset training. The rerandomization assured that that both the waitlist and the active treatment conditions had approximately the same proportion of participants from each prior stress mindset video condition. As a further precaution, to remove the effects of prior video condition, we used mean scores of pre-, during, and postvideo manipulation measures as the baseline for this study. Independent samples' *t*-tests further indicated that there were no differences in any measure between the wait list and active treatment conditions (all *ps* > .2) at baseline. Total *N* for this study reflects participants who completed both baseline measures and follow-up measures 4 weeks later.

indicate a participant's stress mindset (e.g., "The effects of stress are negative and should be avoided") as well as mindsets related to the enhancing and debilitating consequences of stress in the realms of health and vitality, learning and growth, and performance and productivity (e.g., "Experiencing stress improves health and vitality"). Participants rated items on a five-point scale ranging from 0 = *strongly disagree* to 6 = *strongly agree*. SMM scores are obtained by reverse scoring the four negative items and then taking the mean of all eight items. Higher scores on the SMM represent a greater relative endorsement in the mindset that stress is enhancing. Cronbach's alpha was 0.87 in this sample.

Mood and Anxiety Symptom Questionnaire

The Mood and Anxiety Symptom Questionnaire (MASQ) assesses respondents' self-reported symptoms of anxiety and depression (Watson et al., 1995). The 62-item measure includes items dealing with general distress with anxious symptoms, general distress with depressive symptoms, anxious arousal, and anhedonic depression. One item dealing with thoughts of suicide was removed. Participants were asked to rate how much they have experienced a given symptom during the past week on a five-point scale ranging from 1 = *not at all* to 5 = *extremely*. The Cronbach's alpha for the full scale was 0.96, and scores were calculated by computing the mean of all 61 items.

Self-Reported Work Performance Scale (WPS)

For this experiment, we wanted to use a general performance measure that would be applicable to a wide range of employees. Unfortunately, measures designed to capture work performance from this broader perspective are not common. Although several measures do exist, they were by and large inadequate for the current experiment in that they were designed for a specific job or work domain or a single "interpersonal" skill construct (e.g., Borman et al., 2001; Pulakos et al., 2000; Welbourne et al., 1998); they assess work functioning as a single item within metrics of global social functioning (e.g., Ring-Kurtz et al., 2008); they only assess work performance limitations due to health problems (e.g., Reilly et al., 1993); or they rely on supervisor ratings to complete (e.g., Williams & Anderson, 1991). Therefore, following discussions with members of the human resource department of the participating organization, we developed a set of eight work performance domains crucial to the population. We included four questions about "technical" work performance (efficiency, accuracy, quality, and quantity) and four questions about "interpersonal" work performance (enhancement of the work environment, sustained focus/engagement, idea generation, and communication/collaboration). Participants rated their performance on each of the eight domains, using a five-point scale including 0 = *needs much improvement*, 1 = *needs some improvement*, 2 = *satisfactory*, 3 = *good*, and 4 = *excellent*. Exploratory factor analysis using oblimax rotation indicated two factors with eigenvalues > 1 and accounting for 71% of the variance. As anticipated, questions pertaining to "technical" work performance (WPS-technical) loaded together (all items loading > 0.63), and those pertaining to "interpersonal" work performance (WPS-interpersonal) loaded together (all items loading > 0.68). Cronbach's alpha WPS-technical was 0.86 and for WPS-interpersonal was 0.84.

Quality of Life Inventory

We assessed life satisfaction with a short version of the Quality of Life Inventory (QOLI; Frisch, 1992), which taps into satisfaction with health, goals and values, money, work, play, learning, creativity, helping, love, friends, family, self-esteem, and home. Each area is rated by respondents in terms of its importance to their overall happiness and satisfaction (0 = *not at all*, 1 = *important*, 2 = *very important*) and their satisfaction with the particular area (−3 = *very dissatisfied* to 3 = *very satisfied*). The inventory's scoring reflects the idea that one's overall life satisfaction is a composite of satisfaction with particular areas of life weighted by their relative importance to the individual (multiplying the two responses to create a weighted satisfaction ratings range from −6 to 6). Cronbach's alpha for the QOLI was 0.84. For the purposes of this experiment, we were interested in the total life satisfaction score as well as specific scores in the domains of health and work.

Mindset Intervention: Live Training

The purpose of the Mindset Training Program was to provide participants with (a) more balanced information about the nature of stress, (b) information on the power of mindsets in general and in determining the stress response in particular, and (c) a specific skill-set designed to help them actively and deliberately adopt an enhancing mindset in their daily lives. The 2-hr live training was delivered by two instructors with accompanying PowerPoint slides and a participant workbook in which participants completed a series of reflection exercises throughout the course.

In the first training module (*Part 1: The Paradox of Stress*), participants were presented with research supporting two distinct views of stress: that stress is debilitating and that stress is enhancing. The training acknowledges that while the debilitating nature of stress is often emphasized in the cultural milieu, research regarding the enhancing nature of stress is often neglected and that (as delineated in the introduction of this paper) evidence suggests stress can enhance performance (e.g., Cahill et al., 2003), health (e.g., Dienstbier, 1989; Epel et al., 1998), and well-being (e.g., C. L. Park et al., 1996; Tedeschi & Calhoun, 2004). Participants were informed of these research findings and were asked to reflect (in their workbook) on times in their own lives when the experience of stress had, in fact, been beneficial.

In the second training module (*Part 2: The Power of Mindset*), participants learned about research suggesting that *mindsets* produce meaningful psychological and physiological effects. Participants were given several examples where mindsets play an important role, such as in medicine (Price et al., 2008) and exercise (Crum & Langer, 2007). Next, participants were presented with preliminary results from an experiment showing that one's stress mindset can be changed by watching film clips selectively oriented toward either a stress-is-enhancing mindset or a stress-is-debilitating mindset and that these changes can have a significant effect on performance and well-being (Crum et al., 2013). The presentation of these results suggested to participants that one's mindset about stress is an important variable that influences whether stress will produce an enhancing or debilitating outcome. Participants were alerted that, in these studies, mindsets were manipulated to affect health and performance changes. They were told that the purpose of the current intervention was to give them a strategy through which, even in the face of

contradictory or paradoxical information, they could choose to adopt their own stress-is-enhancing mindset consciously and deliberately.

Armed with research on the positive power of stress and the influence of one's mindset on these outcomes, participants were then taught a strategy to help them actively and deliberately adopt a stress-is-enhancing mindset (*Part 3. Three Steps to an Enhancing Stress-Mindset*). First, participants were taught to *acknowledge stress* as opposed to denying it. Specifically, participants were asked to acknowledge a particular stressor that is current or recurring in their lives and simply take note of their individual emotional, behavioral, and physiological responses to it without trying to deny or change it. To substantiate the importance of acknowledging stress, participants were informed about research indicating that attempts to avoid stress can actually increase fear and anxiety (e.g., Wegner, 1994). Participants were also informed of research showing that acknowledging stress can positively impact the stress response by shifting neural activity in the brain from automatic brain regions to more conscious regions (for review, see Lieberman et al., 2007). Second, participants were taught to *welcome stress* as opposed to trying to avoid it. They were encouraged to reconnect with the positive motivation and personal value inherent in stress, to view stress as an indicator that something of value to them is at stake, and to meet stress with a proactive, "bring-it-on" mentality. To substantiate the value of actively welcoming stress, participants were provided with research findings suggesting that welcoming stress reduces anxiety, improves health over time, increases one's sense of control, and is energizing (for review, see Pennebaker, 1997). In the final step, participants were taught to *utilize stress* as opposed to trying to manage or combat it. They were encouraged to explore opportunities accompanied by stress and to use the energy and focus associated with them to meet the underlying demand causing the stress in the first place.

To facilitate the adoption of a stress-is-enhancing mindset into their everyday lives, participants committed to using commonplace objects or events as cues to undertake the three-step process. Examples of these "cues" included, "Every morning when I have my cup of coffee . . ." or "When I start to feel my heart race . . ." Visit <https://mbl.stanford.edu/> for intervention materials.

Results

To examine the effect of the stress mindset training on self-reported health, performance, and well-being in employees in the intervention condition as compared to control, we conducted 2 (condition: intervention, control) \times 2 (time: pre, post) mixed general linear models (GLMs). To further understand the effect of condition over time, simple effects tests were used to examine changes within each group. Figure 1 illustrates these changes over time as a function of condition.

Intervention Check: Change in Stress Mindset (Hypothesis 1)

Mixed-model GLM yielded a reliable Condition \times Time interaction for SMM, $F(1, 237) = 63.37, p < .001, \eta^2 = 0.211$. While a stress-is-enhancing mindset (as measured by the SMM) increased over time for the waitlist control group, $\beta = 0.37, t(111) = 4.61, p < .001$, this effect was much stronger for the group that

participated in the mindset training program, $\beta = 1.29, t(126) = 15.58, p < .001$.

Change in Self-Reported Health, Performance, and Well-Being (Hypothesis 2)

With respect to negative health symptoms (MASQ), mixed-model GLM yielded a reliable Condition \times Time $F(1, 227) = 7.53, p = .007, \eta^2 = 0.032$. The waitlist control participants showed a slight, but not statistically significant, increase in the number of negative symptoms they reported, $\beta = 0.16, t(107) = 1.69, p = .094$. In contrast, negative health symptoms decreased significantly over time for participants in the intervention group, $\beta = -0.20, t(120) = 2.21, p = .029$.

With respect to self-reported technical skills work performance (quality, quantity, efficiency, and accuracy), mixed-model GLM yielded no Condition \times Time interaction, $F(1, 229) = 0.001, p = .976, \eta^2 < 0.001$, because both groups significantly increased their self-reported performance over time, intervention: $\beta = 0.22, t(123) = 2.48, p = .014$; control: $\beta = 0.22, t(106) = 2.18, p = .032$. With respect to self-reported "interpersonal" skill work performance (new ideas, focus, engagement, and collaboration), a significant Condition \times Time interaction did emerge, $F(1, 229) = 5.07, p = .025, \eta^2 = 0.022$. This was due to significant improvement in the intervention condition, $\beta = 0.38, t(123) = 4.57, p < .001$, and no significant improvement in the control condition, $\beta = 0.09, t(106) = 0.85, p = .395$.

With respect to ratings of total life satisfaction and work satisfaction in particular, the Condition \times Time interaction was not statistically significant, $F(1, 210) = 0.65, p = .422, \eta^2 = 0.003$; $F(1, 206) = 2.23, p = .137, \eta^2 = 0.011$. However, in follow-up analyses examining participants' ratings of their satisfaction with health, we found a significant Condition \times Time interaction, $F(1, 211) = 4.50, p = .035, \eta^2 = 0.021$. Simple effects tests illustrate a significant improvement in health satisfaction for employees in the intervention group, $\beta = 0.25, t(109) = 2.45, p = .016$, but not in the control group, $\beta = -0.04, t(102) = 0.40, p = .688$.

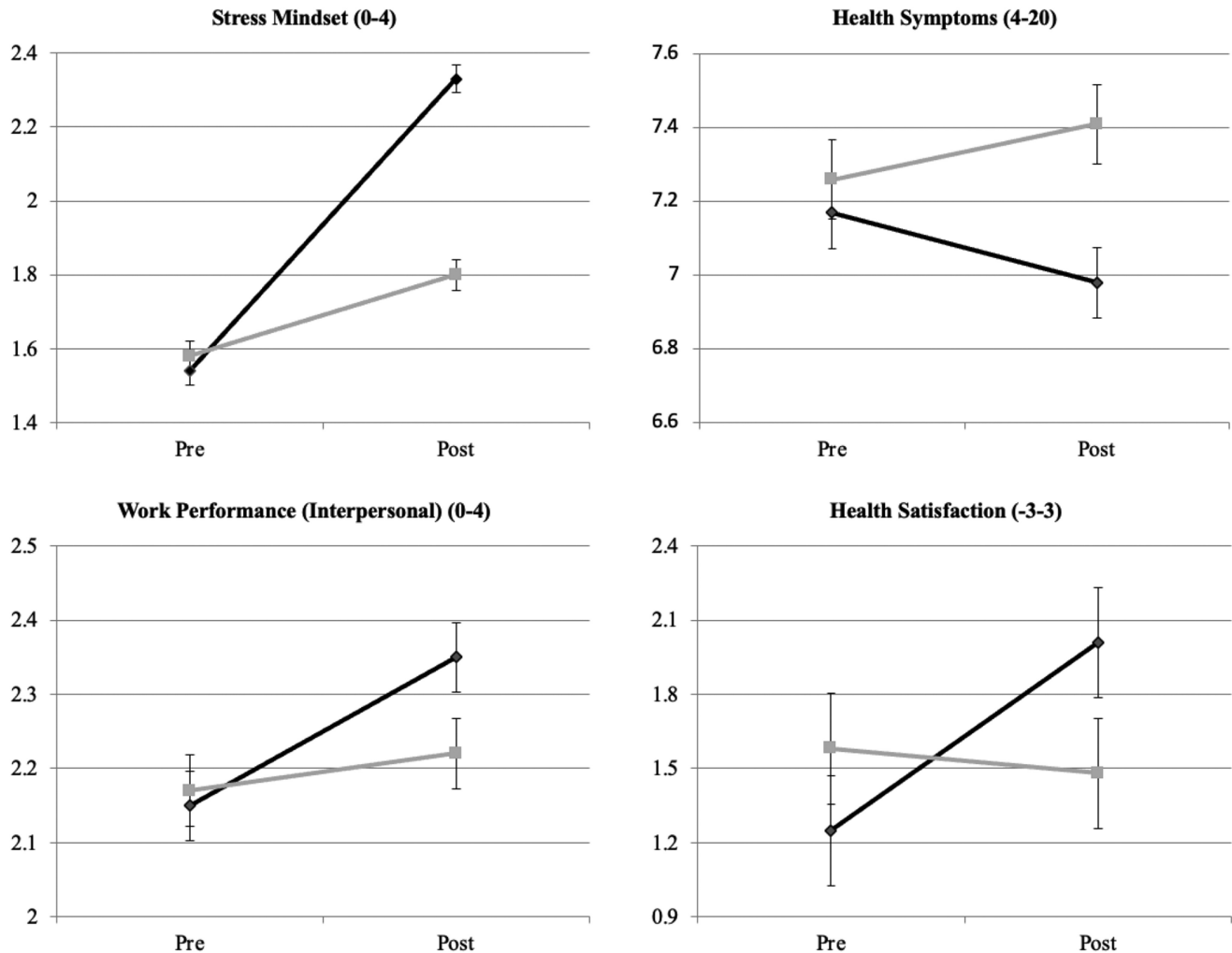
Discussion

As hypothesized, a 2-hr live metacognitive stress mindset training elicited significant changes in mindset as indicated 4 weeks after the training. This training was designed to motivate participants to adopt a stress-is-enhancing mindset by providing them with more balanced information on the nature of stress in conjunction with an understanding of the power of mindset. Compared to a waitlist control, participants in the mindset training program reported reductions in self-reported negative health symptoms associated with stress and anxiety; better performance at work with respect to generating new ideas, sustaining focus, being engaged, and collaborating well with others; and greater overall satisfaction with their health.

Although these findings are promising and our hypotheses were supported, Experiment 1 did not find significant changes with respect to total life satisfaction or "technical" work performance (quantity, quality, efficiency, and accuracy of work). Notably, life satisfaction is influenced by such a wide variety of variables unrelated to stress (e.g., situational factors across a variety of domains for life satisfaction) that detecting changes on this measure would

Figure 1

Effects of the Intervention Condition (Black Lines) and Control Condition Waitlist Control (Light Gray Lines) on Changes in Stress Mindset (SMM), Self-Reported Negative Health Symptoms (MASQ), Interpersonal-Skill Work Performance (WPS-Interpersonal), and Health Satisfaction Over Time, Compared to the Control Group (Light Gray Lines) in Experiment 1



Note. Nonsignificant effects (not illustrated) were found for technical-skill work performance (WPS-technical) and total life satisfaction. MASQ = Mood and Anxiety Symptom Questionnaire; WPS = Work Performance Scale.

be challenging to achieve within a 2-hr training. However, the null effects on “technical” work performance are curious, given research showing that changes in mindset are associated with higher levels of mental functioning in performance situations, including improved focus, higher energy, better memory, and more proactive problem-solving (Crum, Akinola, et al., 2017; Crum et al., 2013) as well as improved performance on standardized tests (Jamieson et al., 2012, 2016). One explanation for these results is that changes in the work environment during this period overshadowed any effects of the stress mindset intervention alone, as participants in both the control and intervention groups reported significant improvements in the quantity, quality, efficiency, and accuracy of work over time.

Experiment 2

Experiment 2 was designed to replicate Experiment 1 in a new work environment (recruiting employees at a large technology company) and context (in a relatively stable economic period) to ensure that the positive impact of the stress mindset intervention is generalizable. Furthermore, for future generalizability and dissemination, we test whether the effects of the intervention content hold when it is not presented by live instructors who could be biased in hypothesis-consistent ways. All basic elements of the study design were the same as in Experiment 1, except that the training was delivered online using multimedia modules rather than an in-person training (both to account for delivery effects and to work toward

a more cost-effective and easily disseminated training). Additionally, Experiment 2 included a more fine-grained measure of well-being in place of the global life satisfaction measure used in Experiment 1.

Method

Participants

Participants in this experiment were employees of a large international technology company headquartered on the West Coast of the United States. The experiment was conducted in the fourth quarter of 2015, during which the large technology company grew its revenues and workforce. Participants were recruited through invitations from the company's Human Resources department offering the opportunity to participate in a stress-management training program.³ We invited employees from a variety of departments. From among the company's 8,000-plus employees, we received participants from engineering and product management (42%), sales (27%), marketing and communications (12%), finance (8%), human resources (8%), and legal (3%). Consistent with the organization's composition, 48.5% of participants were male. The mean age of the sample was 33.97 ($SD = 7.88$). Most participants were White/Caucasian (58.4%), followed by Asian (29.5%), Hispanic (4.8%), Black/African American (2.4%), and other (4.8%). Participation was voluntary; we accepted anyone who wanted to participate and could complete the intervention and measures. As a token of appreciation, participants earned approximately \$30 of "wellness points," which they could redeem at the company's wellness store. Two hundred and thirty-two employees completed baseline measures, and 172 completed both baseline and follow-up measures ($n = 78$ in the mindset training and $n = 92$ in the waitlist control). The results are analyzed for employees who attended the training and completed both baseline and follow-up surveys. Varying degrees of freedom in the analyses reflect cases in which participants chose not to answer particular questions.

Design and Procedure

Participants were assigned randomly to the online mindset training or a waitlist control group. Baseline measures were administered approximately 2 weeks prior to training, and posttest measures were administered 4 weeks following the training program. Assessments for the waitlist control group were administered at the same times. Consent and all measures were collected using Qualtrics Online Survey Software. Participants had limited contact with each other and were asked not to share the content of the training with other employees. All procedures were reviewed and approved by the university IRB.

Measures

Consistent with Experiment 1, participants completed the SMM (Cronbach's $\alpha = 0.83$) and the WPS Technical and Interpersonal skills subscales (Cronbach's $\alpha = 0.85, 0.81$)⁴. We used a shortened 30-item validated version of MASQ (Wardenaar

et al., 2010) to reduce participant fatigue (Cronbach's $\alpha = 0.92$) and scores were computed by calculating the mean of all 30 items.

The Quality of Life scale employed in Experiment 1 measured global perceptions, which were unlikely to change over the course of a week. Thus, we decided to use a more granular measures of psychological well-being: the Positive and Negative Affect Schedule (Watson et al., 1988). Participants rated their feelings over the previous 4 weeks on 20 emotional states (10 positive; 10 negative) on a 1 (*not at all*) to 5 (*a great deal*) scale. Positive (Cronbach's $\alpha = 0.90$) and negative (Cronbach's $\alpha = 0.87$) emotion scales were calculated separately.

Mindset Intervention: Online Training

The content of the online training was nearly identical to the live training but was delivered using short multimedia videos featuring still images and voiceover, accompanied by a series of reflection questions. A total of twelve ~1–8 min videos were shown to participants, followed by reflection questions, using Qualtrics Online Survey Software. To ensure that participants watched each video, participants were only allowed to move on in the training when the video neared completion. The complete online training can be found at <https://mbl.stanford.edu>.

The online training was designed to take participants 60–120 min to complete. Participants were emailed a unique link to take the "Rethink Stress Course," and they were given approximately 2 weeks (12 business days) to complete the course. Throughout the 2-week period, participants who had not completed the course were sent email reminders; by the end of the 2 weeks, a total of seven reminders had been sent. To increase completion rates, we did not require participants to take the course in one sitting and encouraged them to pause the training at any point and return to it later.

Results

To examine the effect of the online metacognitive stress mindset training on each dependent variable, 2 (condition: intervention, control) \times 2 (time: pre, post) mixed GLMs were conducted. Where there were significant two-way interactions, simple effects tests were used to characterize these changes within each group. Figure 2 illustrates these changes over time as a function of condition.

Intervention Check: Change in Stress Mindset (Hypothesis 1)

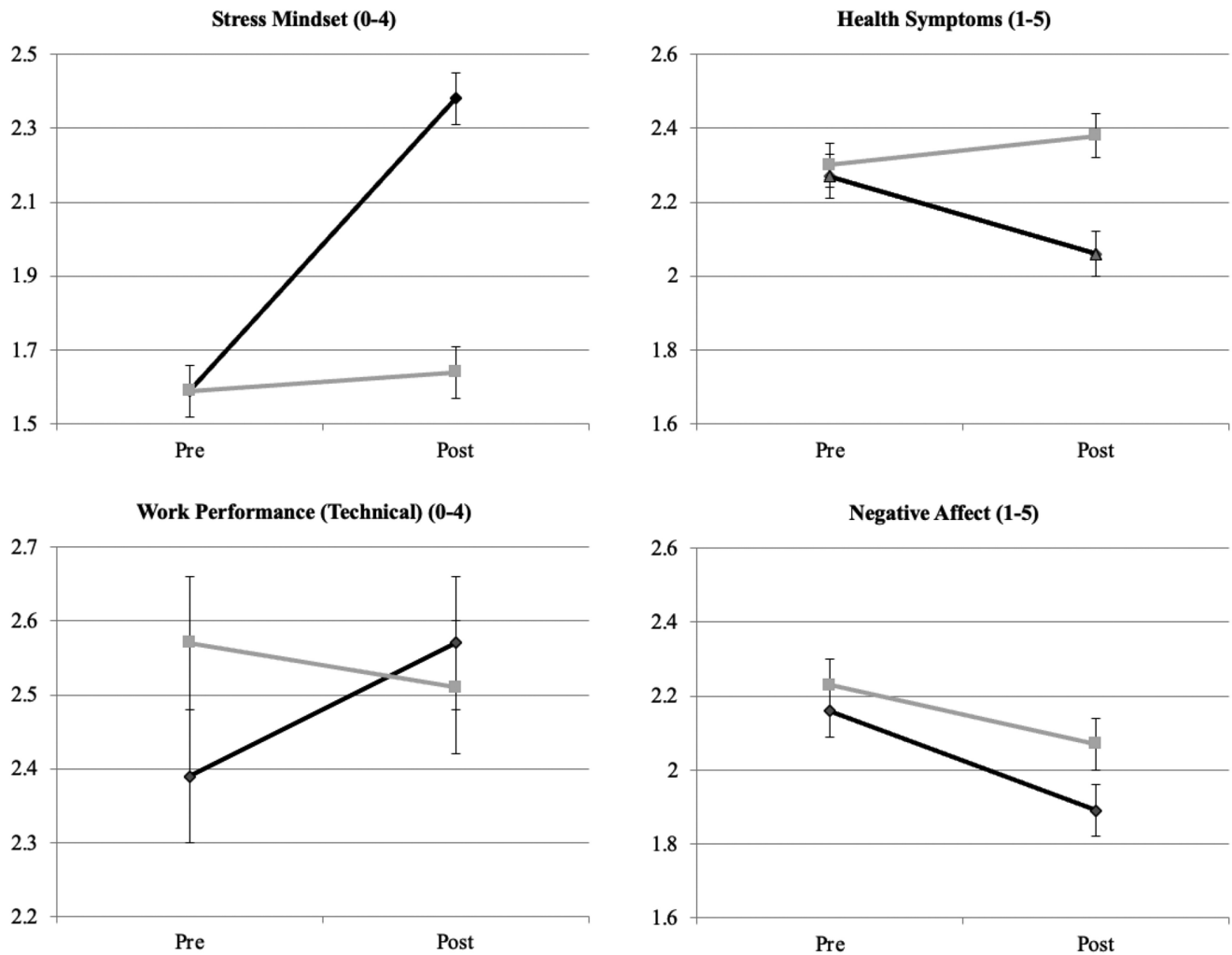
Mixed-model GLM yielded a Condition \times Time interaction on the SMM, $F(1, 168) = 61.19, p < .001, \eta^2 = 0.27$. Participants in the

³ This study was part of a larger project evaluating wellness initiatives in the organization. As such, there were other conditions collected that are not of primary interest to this study and are reported elsewhere: <https://doi.org/10.1037/str0000137>

⁴ The Work Performance Scale in Experiment 2 was measured on a 1–5 scale as opposed to a 0–4 scale as was used in Experiment 1. For ease of interpretation and comparison across experiments we have adjusted the means means one point such that they are on a 0–4 scale and thus consistent with Experiment 1.

Figure 2

Effects of the Intervention Condition (Black Lines) and Control Condition Waitlist Control (Light Gray Lines) on Changes in Stress Mindset (SMM), Self-Reported Negative Health Symptoms (MASQ), Technical-Skill Work Performance (WPS-Technical), and Negative Affect Over Time in Experiment 2



Note. Nonsignificant effects (not reported here) were found for interpersonal-skill work performance (WPS-interpersonal) and positive affect (PANAS). MASQ = Mood and Anxiety Symptom Questionnaire; PANAS = Positive and Negative Affect Schedule; SMM = stress mindset measure; WPS = Work Performance Scale.

mindset training program endorsed significantly higher stress-is-enhancing mindsets over time, $\beta = 1.11$, $t(77) = 10.02$, $p < .001$. Stress-is-enhancing mindsets did not increase over time for the waitlist control group, $\beta = 0.07$, $t(91) = 0.93$, $p = .35$. Effect sizes were comparable to effects of the intervention on SMM from the live training reported in Experiment 1.

Changes in Self-Reported Health, Performance, and Well-Being (Hypothesis 2)

With respect to negative health symptoms (MASQ), mixed-model GLM yielded a statistically significant Condition \times Time interaction, $F(1, 164) = 6.54$, $p = .011$, $\eta^2 = 0.04$. Negative health symptoms decreased significantly over time for the intervention condition, $\beta = -0.54$, $t(75) = 4.42$, $p < .001$. The waitlist control condition

showed no statistically significant change in the number of symptoms participants reported, $\beta = -0.15$, $t(89) = 1.59$, $p = .12$.

With respect to self-reported “technical” skill work performance (quality, quantity, efficiency, and accuracy), mixed-model GLM yielded a marginal Condition \times Time interaction, $F(1, 165) = 3.88$, $p = .051$, $\eta^2 = 0.02$. Those in the intervention condition showed a marginal improvement in performance, $\beta = 0.24$, $t(76) = 1.97$, $p = .053$. There were no significant changes for those in the control condition, $\beta = 0.06$, $t(89) = 1.05$, $p = .29$. With respect to self-reported “interpersonal” skill work performance (new ideas, focus, engagement, and collaboration), a significant Condition \times Time interaction did not emerge, $F(1, 165) = 1.06$, $p = .30$, $\eta^2 < 0.01$. We found a marginal increase in the intervention condition, $\beta = 0.26$, $t(76) = 1.99$, $p = .051$, and no significant

change for those in the control condition, $\beta = 0.10$, $t(89) = 1.06$, $p = .29$.

With respect to Positive and Negative Affect Schedule (PANAS), mixed-model GLM did not reveal a significant change in positive, $F(1, 165) = 0.01$, $p = .91$, $\eta^2 < 0.01$, or negative, $F(1, 165) = 2.00$, $p = .16$, $\eta^2 = 0.01$, emotions. However, both the intervention and control groups reported decreased negative emotions over time, with the intervention effect being directionally steeper, intervention: $\beta = -0.50$, $t(76) = 4.09$, $p < .001$; control: $\beta = -0.26$, $t(89) = 2.86$, $p = .005$.

Discussion

In Experiment 2, an online version of the metacognitive stress mindset training replicated the effects from Experiment 1 with respect to increases in stress-is-enhancing mindset and self-reported health symptoms (MASQ). It is notable that increases in a stress-is-enhancing mindset and reductions in self-reported health symptoms replicated in a different population (technology vs. finance organization) and when deployed using a more cost-effective and accessible medium (online vs. in-person). We again find no significant impact on well-being, as assessed by positive and negative affect reported by participants.

Interestingly, the effects on work performance were positive, but not consistent across studies. In Experiment 1, there was a significant effect on interpersonal skills, whereas in Experiment 2, there was a marginally significant effect ($p = .051$) on technical skills. One explanation is that the stress mindset training alters different performance metrics in different organizational settings in systematic ways. Although both interpersonal and technical skills are valued in finance and tech, technical skills tend to be emphasized more in finance, whereas technology companies often emphasize interpersonal skills. Thus, it may be the case that the changes in stress mindset have the strongest effects on performance outcomes that are less selected for in those environments. Future studies are needed to replicate and understand the nature of the effects of the intervention on important yet complex outcomes, such as work performance.

Experiment 3

Experiments 1 and 2 provide evidence to support the benefit of a metacognitive approach to changing mindsets. This alone is important because it suggests that people can change their mindsets about stress even when directly given contradictory information about the mindset in question (e.g., information that supports both the enhancing and debilitating nature of stress). Experiment 3 was designed to compare the metacognitive training to a more “traditional” approach in which participants are given information about the enhancing nature of stress with no mention of the fact that stress can also be debilitating and no discussion of how one might adopt adaptive mindsets in the face of contradictory information (i.e., without metacognitive awareness). Experiment 3 tests our hypothesis that a metacognitive approach will lead to more sustainable changes in mindset because it enables the individual to actively choose a particular mindset in the face of paradoxical, complex, or conflicting evidence. In particular, we hypothesized that (a) both metacognitive mindset training and a mindset manipulation would significantly increase participants’ stress mindsets immediately following the intervention/manipulation, but that (b) the changes in stress mindsets

following the metacognitive mindset would be more sustainable than the mindset manipulation condition after exposure to conflicting information. Furthermore, we predicted that the sustainability of people’s stress mindsets after receiving contradictory information would be mediated by changes in metacognitive beliefs initiated by the metacognitive intervention.

A few weeks after our preregistered Experiment 3 ended, the first COVID-19 cases occurred in the United States. This allowed us to explore the relative effects of the interventions on self-reported stress symptoms and well-being during a time of acute uncertainty and stress.

Method

All methods, measures, and hypotheses for Study 3 (excluding the exploratory COVID-19 follow-up) were preregistered on the Open Science Framework (https://osf.io/whte9?view_only=5728e201ee2b47f7be0124c99910a96c) and an addendum (https://osf.io/r72vh?view_only=5728e201ee2b47f7be0124c99910a96c).

Participants

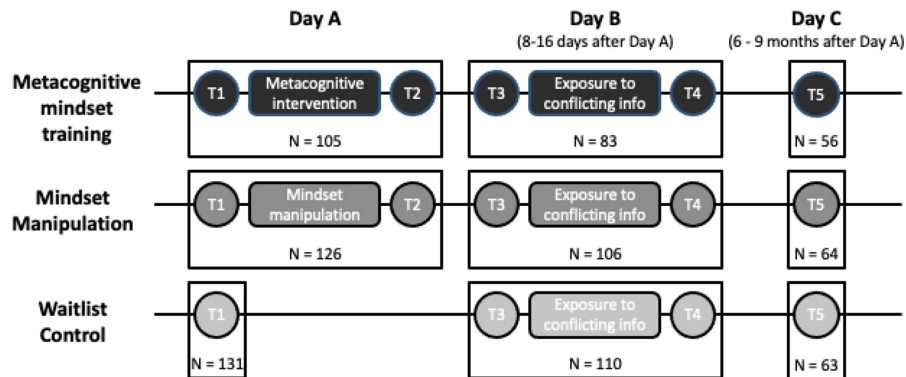
Participants were recruited from Amazon Mechanical Turk via an invitation to take part in a “stress management course.” Participants were told that they would be paid for the time they spent taking surveys. However, they did not believe they would be paid for the time they spent taking the stress-management course because it was advertised as intrinsically beneficial: to “help participants reach new levels of health and performance by moving beyond traditional coping models of stress.” We made this decision in an attempt to mirror the voluntary nature of recruitment in Studies 1 and 2 and to avoid demand effects associated with payment for taking a course.

Based on power analyses and results from Experiments 1 and 2, we aimed to have approximately 100 participants per condition complete all measures between Time 1 and Time 4, after preregistered exclusions. Due to expected differential attrition, we randomized 25% of participants to a control condition, 25% to a mindset manipulation condition, and 50% to a metacognitive intervention condition. Our final sample included 299 participants: 110 in the control condition, 106 in the mindset manipulation condition, and 83 in the metacognitive mindset training condition ($M_{age} = 38.14$, $SD_{age} = 11.98$; 66.22% female, 33.44% male, 0.33% prefer not to answer; 66.11% White/Caucasian, 14.09% Black/African American, 5.37% Asian/Asian American, 4.03% Hispanic/Latino, 0.67% Native American, 0.34% other, 8.72% multiple ethnicities selected, 1.01% prefer to not answer).

Design and Procedure

Figure 3 provides a detailed illustration of the study procedure and timing of measurement. After accepting the task on Amazon Mechanical Turk, participants were asked to complete baseline measures at Time 1 (T1) and were then randomized into three conditions: the metacognitive stress mindset training (“metacognitive mindset training condition”), a traditional stress mindset manipulation (“mindset manipulation condition”), or a waitlist control (“control condition”). The metacognitive mindset training was identical to the training used in Experiment 2, which took approximately 1 hr to complete. The mindset manipulation condition consisted of

Figure 3
Experimental Design for Experiment 3



Note. On Day A, participants completed T1 measures and then were assigned to the metacognitive stress mindset intervention, the mindset manipulation, or the waitlist control. After completing the intervention or the manipulation, participants in those two conditions completed T2 measures. All participants were invited to return 10 days later, at which point they completed T3 measures, were exposed to information about the negative consequences of stress, and then completed T4 measures. After participating on Day B, those who did not receive the metacognitive stress mindset intervention on Day A were then given access to the course but not required to take it. In August 2020, during the early months of the COVID-19 pandemic and between 6 and 9 months after Day A (depending when participants joined the study), participants returned and completed a series of measures (T5). The number of participants at Day A and B reflects the number of participants who completed both pre- and postmeasures.

three videos (~10 min total) presenting true but one-sided information on the enhancing nature of stress without metacognitive components (adapted from Crum et al., 2013, Study 2). Participants in the metacognitive mindset training and the mindset manipulation conditions were asked to complete T2 measures immediately following their respective interventions (note that there were not T2 measures for the control condition because that condition had no intervention; see Figure 3).

Eight to 16 days later, participants who fully completed the T1–T2 measures were invited via Amazon Mechanical Turk to take part in a “new study” about stress and were given 6 days to accept the invitation. All participants, regardless of condition, completed the SMM. They were then exposed to “conflicting information” about the harmful effects of stress. The “conflicting information” was chosen to mirror information focused on the debilitating nature of stress that is common in U.S. media. Specifically, participants viewed a TED-Ed video called “How Stress Affects Your Body” (<https://ed.ted.com/lessons/how-stress-affects-your-body-sharon-horesh-bergquist>) and read an article from the Mayo Clinic entitled “Stress Symptoms: Effects on Your Body and Behavior” (<https://www.mayoclinic.org/healthy-lifestyle/stress-management/in-depth/stress-symptoms/art-20050987>). After exposure to the conflicting information, participants completed the SMM and metacognitive measures again (T4). Approximately 1 week later, participants in the control and mindset manipulation were thanked for their participation and offered a link to access the metacognitive mindset manipulation.

Measures

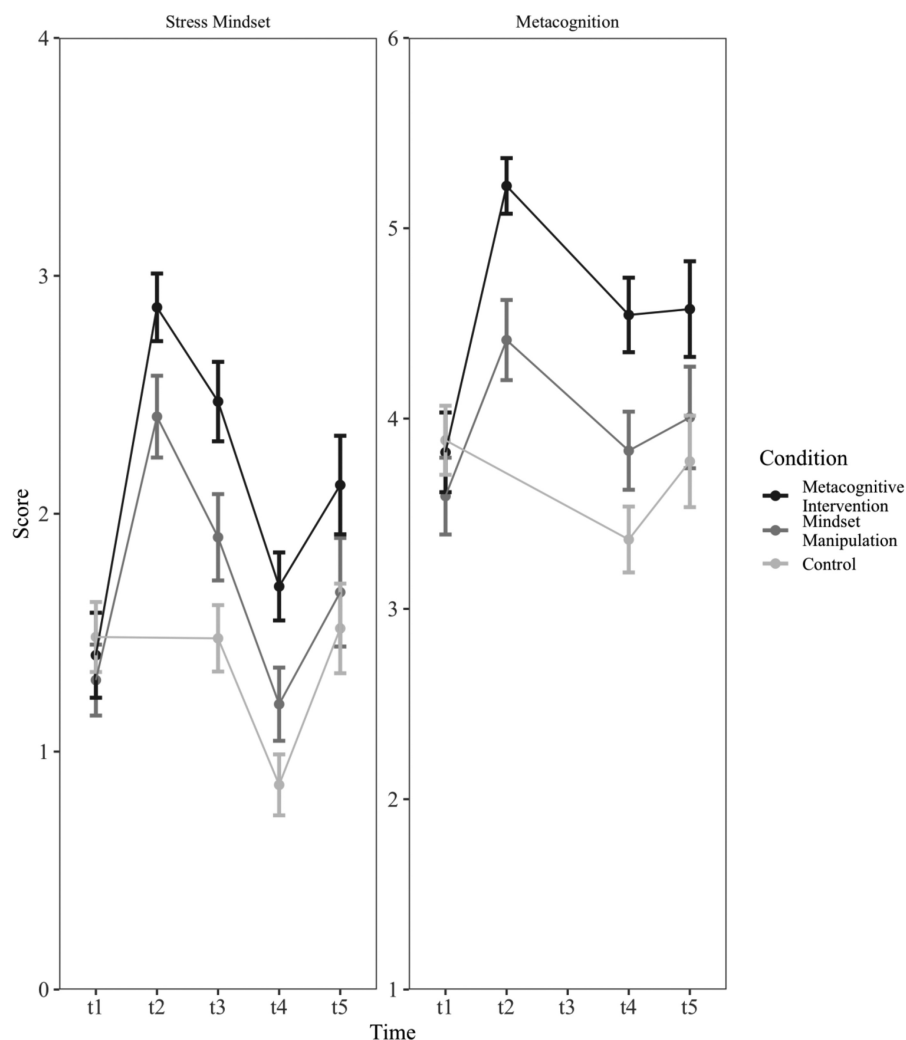
Consistent with Experiments 1 and 2, participants completed the SMM (Cronbach’s $\alpha = 0.87$). We also included a measure designed to test the specific metacognitive mechanism through which we

theorized the metacognitive mindset training would generate more sustainable mindsets. This metacognition mindset measure, specifically designed for the purposes of this study, asked participants to rate the extent to which they agreed or disagreed with 11 statements about mindsets (range: 1–6; see Appendix for complete scale). The statements included beliefs about the self-fulfilling nature of mindsets (e.g., “having the mindset that stress will improve my wellbeing makes it more likely that stress will improve my wellbeing”), one’s ability to control or change their own mindsets (e.g., “If I wanted to, I could choose the mindset that stress is good for me”), and one’s motivation to adopt a stress-is-enhancing mindset (e.g., “I am motivated to adopt the mindset that stress is enhancing, even though stress can sometimes have debilitating effects”). Per our pre-registered plan, we calculated the mean of the total scale, given the alpha level was adequate at T1 (Cronbach’s $\alpha = 0.91$). Participants completed the SMM at all time periods and the metacognitive mindset measure at T1, T2, and T4. In addition to the SMM and metacognitive measure, three measures were assessed for exploratory analyses and not reported below: a one-item measure assessing stress levels (“How much stress are you experiencing in your life right now?”), the Perceived Stress Scale (PSS; Cohen et al., 1983), and a measure of coping (COPE; Carver, 1997) at T1 and T4.

Results

Effect of Metacognitive Stress Mindset and Mindset Manipulation on Stress Mindset (SMM) (Hypothesis 1a and 1b)

We preregistered the hypothesis that both the metacognitive mindset training and the mindset manipulation would significantly increase participants’ stress mindsets. As predicted, using paired

Figure 4*Changes in SMM (Panel A) and Metacognitive Beliefs (Panel B) Over Time in Experiment 3*

Note. Error bars represent 95% confidence intervals. SMM = stress mindset measure.

t-tests examining the difference in SMM between T1 and T2, participants' stress mindset significantly increased in both the metacognitive mindset training, $t(82) = 14.51, p < .001$ (T1: $M = 1.41, SD = 0.82$; T2: $M = 2.87, SD = 0.65$), and the mindset manipulation, $t(105) = 12.48, p < .001$ (T1: $M = 1.30, SD = 0.77$; T2: $M = 2.41, SD = 0.89$). Post hoc analyses showed that SMM at T2 was higher in the metacognitive training (vs. mindset manipulation) condition, controlling for T1 scores, $b = 0.42, SE = 0.11, t(186) = 3.84, p < .001$ (see Figure 4, Panel A).

Effect of Metacognitive Mindset Training on Metacognition (Hypothesis 1c)

To test our preregistered hypothesis that the metacognitive mindset training would significantly increase participants' metacognitive beliefs, we conducted a paired *t*-test examining the difference in metacognitive beliefs between T1 and T2. As hypothesized, participants' metacognitive beliefs significantly increased as a result of the

metacognitive mindset training, $t(82) = 15.59, p < .001$ (T1: $M = 3.82, SD = 0.96$; T2: $M = 5.22, SD = 0.67$). Although post hoc analyses revealed that participants' metacognitive beliefs also significantly increased in the mindset manipulation condition, $t(105) = 11.3, p < .001$ (T1: $M = 3.59, SD = 1.05$; T2: $M = 4.41, SD = 1.09$), metacognitive beliefs at T2 were greater in the metacognitive training (vs. mindset manipulation) condition, controlling for T1 scores, $b = 0.67, SE = 0.10, t(186) = 6.59, p < .001$ (see Figure 4, Panel B).

Sustainability of Stress Mindset by Condition (Hypothesis 2)

To test our preregistered hypothesis that SMM scores would be higher in the metacognitive mindset training compared to the mindset manipulation condition at T4 (after conflicting information) compared to T1 (baseline levels), we conducted a linear regression model predicting T4 stress mindset scores by condition, controlling for T1 scores. As predicted, participants in the

metacognitive mindset training had higher SMM scores at T4 compared to SMM scores in the mindset manipulation condition, $b = 0.45$, $SE = 0.10$, $t(186) = 4.66$, $p < .001$. Post hoc analyses revealed that the differences in SMM by condition at T4 were driven by larger increases in SMM from T1 to T2 in the metacognitive mindset training (vs. mindset manipulation) (see Figure 4, Panel A).

Mediation of Metacognition (Hypothesis 3)

We also test the preregistered hypothesis that the sustainability of people's stress mindsets after receiving contradictory information would be mediated by changes in metacognitive beliefs initiated by the metacognitive mindset training. We thus conducted a mediation model in which we predicted the effect of condition (metacognitive mindset training vs. mindset manipulation) on changes in SMM between T1 and T4, as mediated by changes in metacognition between T1 and T2.⁵ This model indicated a significant indirect effect (indirect effect estimate = 0.11, $SE = 0.05$, $z = 2.32$, $p = .021$) in support of the theory that changes in metacognition initiated by the intervention explain the sustainability of mindsets at T4 (see Figure 5).

Exploratory Follow-Up Survey (After Onset of the COVID-19 Pandemic)

Soon after finishing data collection, per our preregistered plan in February 2020, the World Health Organization designated COVID-19 as a pandemic. Given that the great stress the pandemic was causing many people, we decided to follow up with the participants to explore whether people's health and well-being might differ based on their exposure to the stress-mindset trainings. All participants who completed the T4 timepoint were recruited, of whom 60% completed the follow-up survey (T5). Retention rates did not differ by condition. As participants in the control and mindset manipulation condition were given access to the metacognitive mindset training, we excluded participants in the control and manipulation conditions who reported receiving the link and viewing the videos from the metacognitive mindset training (five out of 68 in the control and four out of 68 in the mindset manipulation). Our total sample of participants who completed at least the stress-mindset measure included 56 in the metacognitive training, 64 in the manipulation condition, and 63 in the control condition. All participants filled out the SMM, metacognitive mindset measure, MASQ, and PANAS (as described in Experiment 2). In addition, participants completed a measure of mental and physical health, the COPE (Carver, 1997), the PSS (Cohen et al., 1983), and several COVID-19-specific questions related to their experiences with and behaviors during the pandemic (we report a subset of the results below; to see results for all measures, see online materials).

First, we tested the long-term sustainability of stress mindset. We predicted SMM scores at T5 as a function of condition and T1 stress-mindset scores. The results suggested that at T5, now 8 months after participants received the original intervention, those who received the stress-mindset metacognitive training still had more enhancing stress mindsets ($M = 2.12$, $SD = 0.77$) than those in both the mindset manipulation condition, $b = 0.44$, $SE = 0.12$, $t(179) = 3.64$, $p < .001$, $M = 1.67$, $SD = 0.91$, and the control condition, $b = 0.63$, $SE = 0.12$, $t(179) = 5.17$, $p < .001$, $M = 1.52$, $SD = 0.75$.

Next, we tested whether participants' self-reported mood and anxiety symptoms (MASQ) and affect (PANAS) during the Pandemic (T5) differed based on their condition. Results are reported in Figure 6. Compared to the control, participants in the metacognitive mindset training reported fewer negative symptoms associated with stress, $b = -0.25$, $SE = 0.11$, $t(177) = -2.19$, $p = .030$; less negative affect, $b = -0.27$, $SE = 0.13$, $t(178) = -2.06$, $p = .041$; and marginally higher positive affect, $b = 0.29$, $SE = 0.15$, $t(178) = 1.92$, $p = .056$. Compared to the mindset manipulation condition, improvements were greater in magnitude in all cases, but only significantly different for positive affect, $b = 0.31$, $SE = 0.15$, $t(178) = 2.04$, $p = .043$. There were no differences in perceived stress levels by condition (all $ps > .12$).

General Discussion

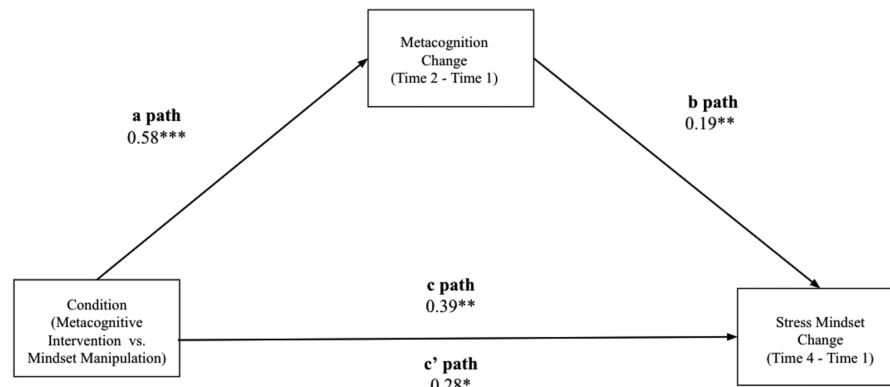
The findings from these three experiments suggest that a metacognitive intervention approach can be an effective and sustainable way to change stress mindsets. People benefited from receiving balanced information about stress in conjunction with metacognitive information on the power of mindset, which was fundamentally different than traditional mindset-change interventions (e.g., those focused primarily on providing information in support of a particular mindset without also providing strategies to reconcile information that may contradict that mindset). Indeed, we find supporting evidence in all three experiments that the metacognitive approach was successful in changing stress mindsets, and in Experiment 3, we demonstrate that it outperformed a traditional mindset intervention in producing sustained changes in mindset after both being exposed to contradictory information and during a particularly salient stressor of a global pandemic.

Contributions to Research on Mindset Change

These findings build on the growing body of research demonstrating that "psychologically wise" changes in mindset or construal (e.g., Walton & Crum, 2020) can provoke self-fulfilling effects in a wide range of domains, including intelligence, emotion regulation, medicine, and health behaviors (Blackwell et al., 2007; Crum et al., 2013; Crum, Leibowitz, et al., 2017; Kaptchuk et al., 2010; Walton, 2014; Walton & Cohen, 2007; Yeager et al., 2019). This particular mindset intervention adds to this literature by demonstrating a novel approach to mindset change. In contrast to approaches that shift mindsets by providing evidence suggesting that a particular mindset is true, this study demonstrates that people can be motivated to change their mindset by becoming metacognitively aware that they have mindsets, that mindsets matter, and that some mindsets are more adaptive. By creating a metacognitive intervention that provides more complete information on both the positive and negative

⁵ In our preregistered analytical plan, we reported that we would investigate the mediation of the effect of condition on SMM at T4 (controlling for T2 SMM) by metacognition at T2 (controlling for T1 metacognition). This model resulted in a null indirect effect of metacognition as a mediator. However, we realized post hoc that a better and more parsimonious test of our theory—that is, *changes* in metacognition would mediate the sustainability of an increase in SMM—would be to look at T1 to T4 changes in SMM and T1 to T2 changes in metacognition. This had the additional benefit of aligning with our tests of Hypothesis 2. Note that we did not use bootstrapping, as it failed to converge.

Figure 5
Experiment 3 Mediation Model



Note. Results of the mediation of metacognitive intervention (vs. mindset manipulation) on changes in stress mindset, mediated by changes in metacognition.

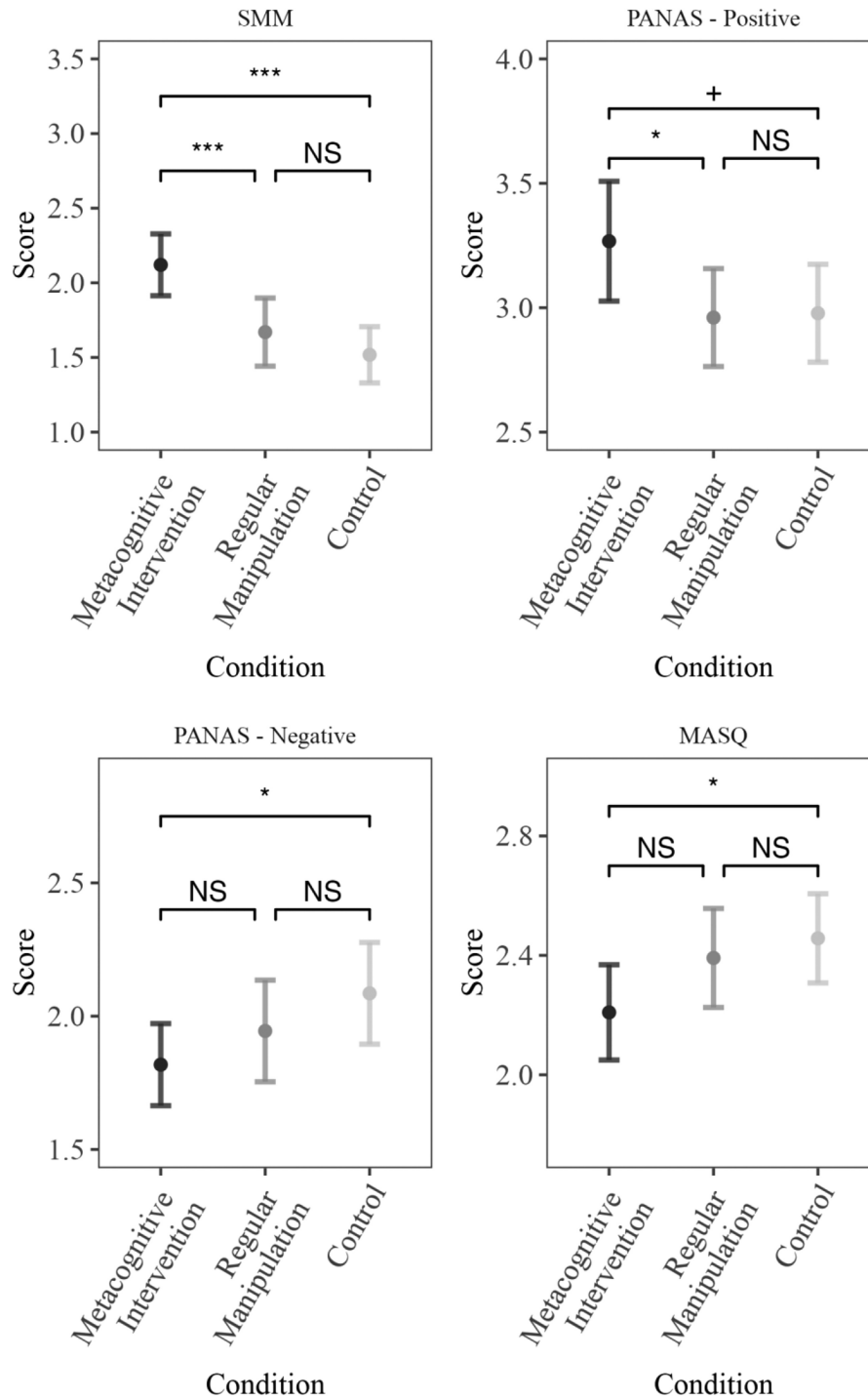
nature of stress, this research shows that participants can be motivated to adopt a stress-is-enhancing mindset because it can be useful (Eccles, 1983), even when they know it is not true in all situations. In fact, Experiment 3, which compared the metacognitive approach to a more traditional stress-mindset manipulation, suggests that the changes in stress mindset were greater in magnitude in response to the metacognitive approach. Moreover, Experiment 3 provided support for the notion that the metacognitive route to mindset change is more sustainable. Although mindset declined in response to contradictory information at a similar rate as in the mindset manipulation condition, the level of stress mindset in the metacognitive condition was still higher than baseline and relatively higher than among participants who were exposed to the traditional mindset manipulation. Furthermore, the sustainability of mindset was mediated by changes in metacognition produced by the intervention. In other words, participants' sustainability of mindset change over time was driven by the metacognitive information that their mindsets mattered and could be actively influenced.

This novel metacognitive approach to mindset change builds on related research on metacognition and motivation (Hofmann et al., 2009; Hulleman & Harackiewicz, 2021; Rattan et al., 2018) and opens up new possibilities for mindset intervention and research. For instance, it will be interesting to see whether this metacognitive approach has similar effects in other areas of mindset change, such as intelligence, willpower, and health. It may be that one approach is more adaptive than the other, given the different type of mindset in question. For example, the metacognitive approach to mindset change may be unnecessary or even less effective when the adaptive mindset has more evidence to support it, as in the case of mindsets regarding the idea that ability can be developed. On the other hand, this approach may be more useful in the healthcare context where, for example, a medication can have both positive and negative effects (i.e., side effects), and practitioners are usually required to provide all information available (Leibowitz et al., 2021). In this case, telling patients that side effects are possible, while giving them the metacognitive awareness that side effects are often exacerbated when one expects them, might positively change patients' experience with the medication while also informing them fully.

Future research should also seek to understand the relative value of each component of this intervention. The intervention we explored had three parts: (a) more balanced information on the nature of stress (revealing the range of possible mindsets regarding stress), (b) information on the power of mindset (namely, the mindsets we choose can have self-fulfilling effects), and (c) strategies to help participants adopt the more useful mindset consciously and deliberately in their lives. Future research is needed to examine whether all three of these components are necessary and how modifications to the intervention could evoke the most effective changes in mindset. For example, the tested metacognitive condition explicitly stated that participants would encounter conflicting information in their daily lives. What might happen if participants were not given this expectation? Would simply acknowledging the power of mindsets be sufficient for induced mindsets to be resilient to conflicting information in the real world? We suspect all three components are necessary to some degree and could even be expanded upon. For example, providing additional strategies to change one's mindset in the midst of conflicting information or especially challenging circumstances could potentially improve the intervention further.

Contributions to Research on Stress Management

Offering a metacognitive mindset intervention to help people improve stress responses has the potential to make a transformative contribution to research on stress and stress management. For more than 30 years, interventions to manage stress have focused on reducing stressful experiences and their negative consequences. Accumulating evidence demonstrates that this approach is, quite simply, not effective—and can sometimes be counter-effective—for three reasons. First, individuals generally do not have the ability or luxury to control the objective amount of stress they face, as major stressors, such as workload and economic uncertainty, are largely out of individuals' control. Second, avoiding or minimizing stress can cause individuals to miss opportunities to use stress productively to advance meaningful goals, both at the psychological and behavioral level. Stress encountered in pivotal moments or in valued roles can offer an opportunity to enact or rediscover core values and to achieve psychological and physiological growth that would

Figure 6*Outcomes by Condition at T5 During the COVID-19 Pandemic*

Note. Y-axes are truncated. Error bars represent 95% confidence intervals.

not otherwise be possible (e.g., Dienstbier, 1989; Epel et al., 1998; C. L. Park et al., 1996; C. L. Park & Helgeson, 2006; Tedeschi & Calhoun, 2004; Verplanken et al., 2008). Lastly, existing “stress reduction” or “relaxation” approaches tend to reinforce the mindset

that stress is debilitating, a mindset that can ironically can be stressful in itself and *increase* the experience of stress over the long term, especially when a stressor is recurring or becomes more severe over time (e.g., Carver et al., 1989; Wegner, 1994; Wegner et al.,

1993). Luckily, accumulating experimental research on stress mindset (and related research on reappraisal of physiological arousal) has shown that helping individuals engage with stress, rather than attempting to avoid stress or cope with its consequences, can lead to improved health, performance, and well-being (Brooks, 2014; Crum, Akinola, et al., 2017; Crum et al., 2013; Hofmann et al., 2009; Jamieson et al., 2010, 2012, 2016; John-Henderson et al., 2015).

These experiments replicate and extend the accumulated body of research on stress mindset while also overcoming some of the important practical limitations inherent in the early experimental strategies, namely those that aim to change mindsets by presenting selective and partial information. Of note, these experiments show that adaptive mindsets about stress can be adopted even in the face of information about the paradoxical nature of stress and that such mindsets can have sustainable effects on self-reported health and performance as long as 8 months after a brief (1–2 hr) intervention delivered either in person or online.

We also exemplify the robustness and practicality of stress-mindset interventions through the two dissemination methods and populations used in these experiments. We provide evidence that stress mindsets can be altered similarly in online or in-person programs, which has important implications for future mindset interventions. This builds upon evidence that online interventions can elicit meaningful results across a range of targeted mindsets, such as intelligence and emotion (Paunesku et al., 2015; Smith et al., 2018). This delivery mechanism is simple, time-efficient, and cost-effective, and it can be readily scaled to a diverse range of populations.

The impactful findings from these interventions may prompt practitioners to use this intervention for the benefit of their employees. For those interested in adapting these ideas and programs to enact change in their organizations, a few points of clarity are warranted. First, adopting a stress-is-enhancing mindset does not mean that individuals should be encouraged by their employers to seek out more stress. Rather, it suggests that if we are mindful about the various possible mindsets one can hold about stress—and of the potential power of such mindsets—it may be possible to take important, inevitable, or unavoidable stressors and learn how to use that stress more adaptively. In the current training, this clarification was clearly expressed to participants. Second, although this research shows that individuals have the capacity to improve their health and well-being in the face of stressful experiences, organizations need to ensure that their workplaces do not cause excessive levels of stress and provide necessary resources to keep employees healthy and productive. The strongest route to improve health and well-being is to promote individual empowerment while simultaneously promoting positive organizational and structural change.

Limitations

A primary strength of Experiments 1 and 2 is that they were performed in a real-world sample of participants *within* their actual work environment, as opposed to a laboratory setting. Experiment 3, meanwhile, benefitted from its longitudinal comparison of a metacognitive and traditional mindset intervention beyond a specific work setting. Unfortunately, these strengths limited our ability to collect more time-consuming and invasive measures of stress, health, and work performance. Although self-report measures of health and performance are highly related to more objective measures, there remains a possibility that these effects were driven in part by self-inflationary bias and

demand effects (Orne, 1962; Rosenthal, 1966; Rosnow, 2002). Now that we have found that subtle interventions can engender change in both mindset and self-reported health and well-being, future studies should explore the effect of this mindset training on objective measures of health, such as changes in stress hormone levels, sick days, or other physiological variables of interest. As the work performance measure included in this experiment was new and relied on self-reports to assess work performance along both interpersonal- and technical-work performance dimensions, it is particularly important to use more nuanced performance measures—such as supervisor ratings and objective metrics of performance—to determine how changes in stress mindset produce positive changes in work performance. Stress-mindset theory (as articulated in Crum et al., 2013) posits that stress mindset has a significant impact on the way stress is behaviorally approached as well as the manner in which stress is psychologically experienced. It also suggests these short-term effects on physiology and motivation have long-term effects on health and performance outcomes. Designing intervention studies to include robust measures at all points of this mechanistic process is a key priority for future research in this area.

A related limitation of our studies is that they were completed in a diffuse array of settings, spanning over a decade in time. There is value to showing that the approach is effective in the midst of major crises, from financial employees experiencing the 2008 economic recession and the threat of layoffs (Experiment 1) to technology employees in a relatively stable economic context (Experiment 2) to people from a range of backgrounds experiencing the COVID-19 pandemic (Experiment 3). While the intervention afforded some benefit in all these contexts, we have a limited ability to understand more precisely the manner in which this intervention may interact with characteristics of the stressor, the situation, and the person. One notable characteristic of the studies is that all participants were volunteers who chose to sign up for a study that was explicitly intended to help them manage stress. Future research is needed to understand how the intervention might be received by people who are not as motivated to volunteer for such a study. Of course, mandating trainings of this sort has its own issues, and, in any case, many similar real-world trainings are voluntary.

Similarly, as advertised, the metacognitive approach requires significant cognitive aptitude and thus may not be appropriate for younger children or people who do not have the cognitive capacity to learn complex concepts. It may also be too heavy handed, and could potentially even backfire, in situations where it is not needed and a more direct route to mindset change is supported by the evidence. Future research should explore key moderators and boundaries of the effects, such as how effective the approach will be for higher or lower levels of stress and for people with more or fewer resources.

Finally, the metacognitive intervention in Study 3 was longer than the mindset manipulation (approximately 60 vs. 10 min of video) due to the more complex nature of the information conveyed. This was a necessary confound to directly test the metacognitive intervention against an existing mindset manipulation that has been widely and successfully used in previous studies (e.g., Crum et al., 2013). Future research could test whether expanding the mindset manipulation intervention to be equal in time commitment would make the effects of the manipulation larger or more sustainable. That said, some research suggests that the length of interventions is a far less important feature than their content in producing results (Peeters et al., 2020; Shields et al., 2020; Zhang et al., 2020). In the current study, mediation models empirically affirm the theoretical mechanism that metacognition was

responsible for sustaining changes in mindset. Thus, we believe it is unlikely that simply lengthening the information in the mindset manipulation would produce significantly different results.

Conclusion

Stress is ubiquitous in the human experience, but we humans also have the ability to recognize and change our mindsets. The current studies provide initial evidence that a novel, metacognitive approach can change mindsets and improve outcomes responses to increasing stress, even in the face of conflicting information. Given the increasing stress and uncertainty of modern life, continuing to understand and leverage the power of mindset in the context of stress and beyond has the potential for significant public health impacts.

Context of the Research

A range of recent interventions have attempted to change *mindsets*—core assumptions about the nature of how things work, such as how intelligence can be grown or whether stress can be beneficial. In their attempts to improve peoples' lives, most existing mindset interventions provide information aimed at changing peoples' mindsets, often without providing a nuanced understanding of the topic or teaching them about the value of adopting a particular mindset. This approach may be appropriate for situations in which evidence weighs heavily in one mindset's favor. For stress mindset interventions, however, in which evidence supporting both the enhancing and the debilitating nature of stress is more balanced, we provide evidence for a different approach, one in which participants are taught *about* mindsets and the ways they can flexibly shift their mindsets more adaptively. We find that this approach can lead to more sustained changes in peoples' mindsets. Given these promising results, our current and future research focuses on exploring the strengths and limitations of this metacognitive approach within the stress-mindset domain and testing it with other mindsets. Finally, this work has inspired the need to create and validate measures that capture peoples' metacognitive beliefs about mindsets, or "metamindsets," such as (a) the degree to which a person believes that mindsets have self-fulfilling effects and (b) the degree to which a person believes they can change their own mindsets.

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(Appendix follows)

Appendix

Items and Instruction for the Stress Mindset Measure

Please rate the extent to which you agree or disagree with the following statements. Strongly disagree (0), Disagree (1), Neither agree nor disagree (2), Agree (3), Strongly agree (4)

1. The effects of stress are negative and should be avoided.
 2. Experiencing stress facilitates learning and growth.
 3. Experiencing stress depletes health and vitality.
 4. Experiencing stress enhances performance and productivity.
 5. Experiencing stress inhibits learning and growth.
 6. Experiencing stress improves health and vitality.
 7. Experiencing stress debilitates performance and productivity.
 8. The effects of stress are positive and should be utilized.
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Items and Instruction for the Mindset Metacognition Measure

The below statements describe a variety of situations in which having a mindset about something might change its outcome. A mindset is a lens or frame of mind through which people understand the world and form expectations. Please rate the extent to which you agree or disagree with the below statements. Some might make more sense to you than others. Some might seem obvious, while others might seem strange. There are no right answers. Please answer as honestly as you can what you believe to be true, not what you think is right or what you think you should believe. Strongly disagree (1), Disagree (2), Somewhat disagree (3), Somewhat agree (4), Agree (5), Strongly agree (6)

1. Having the mindset that stress will make me sick makes it more likely that stress will make me sick.
 2. Having the mindset that stress will help my performance makes it more likely that stress will help my performance.
 3. Having the mindset that stress will hurt my well-being makes it more likely that stress will hurt my well-being.
 4. Having the mindset that stress will help me makes it more likely that stress will help me.
 5. If I wanted to, I could choose to have the mindset that stress is good for me.
 6. If I noticed myself having the mindset that stress is bad for me, I could change my mindset about stress.
 7. Regardless of how stressed I am, I feel confident in my ability to change my mindset about stress.
 8. It's worth it to pay attention to my mindset about stress so that I can change it when helpful.
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