PERSPECTIVE

The plasticity of well-being: A training-based framework for the cultivation of human flourishing

Cortland J. Dahl[a,1], Christine D. Wilson-Mendenhall[a], and Richard J. Davidson[a,b,c,d,1]

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Research indicates that core dimensions of psychological well-being can be cultivated through intentional mental training. Despite growing research in this area and an increasing number of interventions designed to improve psychological well-being, the field lacks a unifying framework that clarifies the dimensions of human flourishing that can be cultivated. Here, we integrate evidence from well-being research, cognitive and affective neuroscience, and clinical psychology to highlight four core dimensions of well-being—awareness, connection, insight, and purpose. We discuss the importance of each dimension for psychological well-being, identify mechanisms that underlie their cultivation, and present evidence of their neural and psychological plasticity. This synthesis highlights key insights, as well as important gaps, in the scientific understanding of well-being and how it may be cultivated, thus highlighting future research directions.

well-being | meta-awareness | mindfulness | insight | purpose

The importance of enhancing well-being and reducing mental distress is more apparent today than ever. Distractibility, loneliness, depression, and anxiety are all on the rise, creating an emerging crisis in mental health and a growing deficit in our collective well-being (1–3). The scale of this crisis calls for new approaches to the study of well-being and innovative solutions to strengthen it. To further research in this area, we present a novel framework focused on the plasticity of well-being, highlighting four dimensions of well-being that can be cultivated through various forms of mental training.

Over the past few decades, research on psychological well-being has yielded great insights by studying the factors that constitute optimal levels of human flourishing and their relationship to physical health, work performance, social relationships, and a range of other outcomes (4, 5). Related areas of research have studied interventions that improve well-being through the use of various forms of self-regulation (6), including psychotherapy (7, 8), positive psychology interventions (9, 10), and contemplative practices like meditation (11–17). However, despite tremendous advances in well-being research, these fields lack a unifying framework that clarifies dimensions of well-being that exhibit training-induced plasticity and the psychological and biological mechanisms through which training-induced changes may endure. Such a framework provides a common language and set of constructs to orient the wide range of research efforts and interventions in this area, and also stimulates collaboration and cross-pollination within and across related fields of research.

To address this need, we present a framework comprising four dimensions of well-being: awareness, connection, insight, and purpose (*SI Appendix*, Table S1). These dimensions are central to the subjective experience of well-being and can be strengthened through training. In this respect, they can be likened to skills, and the cultivation of well-being to building a repertoire of skills. The cultivation of well-being thus involves the use of self-regulatory processes to learn, practice, and apply these skills in daily life.

In the sections that follow, we describe each dimension and specify the mechanisms through which it may be strengthened through training. We review evidence that each dimension is central to well-being and summarize data concerning its neurobiological underpinnings. We conclude each section by presenting

[a]Center for Healthy Minds, University of Wisconsin, Madison, WI 53703; [b]Department of Psychology, University of Wisconsin, Madison, WI 53706; [c]Waisman Laboratory for Brain Imaging and Behavior, University of Wisconsin, Madison, WI 53705; and [d]Department of Psychiatry, University of Wisconsin, Madison, WI 53719

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[1]To whom correspondence may be addressed. Email: cortland.dahl@wisc.edu or rjdavids@wisc.edu.

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research on the trainability of each dimension. Finally, in the last section, we discuss important implications of the framework by highlighting gaps that would benefit from additional research and underscoring the urgency of this task as a public health need.

Awareness

Awareness, in our framework, refers to a heightened and flexible attentiveness to perceptual impressions in one's environment, as well as internal cues, such as bodily sensations, thoughts, and emotions. States of heightened awareness are thus typified by being fully aware of what one is doing, whom one is with, and of one's own internal states, whereas diminished levels of awareness entail being distracted or absorbed in a given activity or situation. Such states are also flexible in that they allow for the volitional control of the scope and orientation of attentional focus. To use a common example, being fully aware during a conversation would enable one to remain attentive to one's companions and also to notice when one's attention begins to drift, and to thus avoid being distracted. Higher levels of awareness support both hedonic and eudaimonic well-being, in the sense that being aware is both a positive subjective experience, especially when contrasted with states of distraction (18), and also allows for self-regulation and goal-directed behavior (19), thereby contributing to success in meaningful pursuits and supportive interactions with other people.

Although heightened states of awareness occur spontaneously in daily life, the occurrence and duration of awareness can be increased by training in meta-awareness and through the intentional self-regulation of attention. Meta-awareness refers to an awareness of the processes of conscious experience, such as the recognition that one is experiencing an emotion, a thought, or a sensory perception as it occurs in real time (11, 19, 20). Meta-awareness is involved when one suddenly recognizes an emotion before it provokes a reaction, for example, and also when one suddenly realizes that one has been "on autopilot" while engaged in a daily routine. The self-regulation of attention similarly contributes to awareness by enabling one to direct and sustain attention, to notice and disengage from distractors, and to alter the scope of attentional focus.

Relationship to Well-Being. The ability to be aware and attentive has important implications for healthy psychological functioning. A large-scale study of more than 5,000 people from 83 countries revealed that, on average, people spend an estimated 47% of their waking life in a state of distraction and that states of distraction are typified by lower levels of well-being (18). Distraction, moreover, impairs executive function (21) and is associated with a variety of adverse psychological outcomes, including stress and anxiety (22), attention deficit hyperactivity disorder symptoms (23), and depression (24). It is also related to biomarkers of poor physical health, such as stress-related increased levels of cortisol and α-amylase (25) and reduced telomere length (26), although these variables may be related because each is related to a third factor, such as perceived stress.

Meta-awareness enables one to recognize the occurrence of distracted mind wandering and redirect attention back to one's current activity (19). This capacity to notice distraction and redirect one's attentional focus positively impacts a range of real-world outcomes, from academic performance (27) to automotive safety (28). Meta-awareness also enables one to notice the occurrence of emotional cues in the body and mind and thus plays a critical role in the self-regulation of emotion, which has important implications for physical health, mental health, and psychological well-being (29).

Neural and Biological Underpinnings. Awareness of one's mental and emotional state is associated with specific networks in the brain. Bringing awareness to one's thoughts recruits lateral regions of the prefrontal cortex (PFC) that form part of the brain's central-executive network (30). Failures to notice and regulate distraction, on the other hand, are linked to diminished activation of this network, and specifically to decreased activity in the dorsolateral PFC (dlPFC) (31). Abnormal functioning of the central-executive network is also a transdiagnostic marker for schizophrenia, anxiety, depression, and other mental health disorders (32).

The top-down self-regulation of emotion—which necessarily involves the ability to be aware of one's current emotional state—similarly recruits regions of the brain's central-executive network, including the dlPFC (33). A meta-analysis of the neural correlates of emotion regulation indicates that the dlPFC facilitates the regulation of emotion through its more general function in top-down self-regulation (34). Research from our laboratory has found that individual differences in functional connectivity between different sectors of the PFC and amygdala is a significant predictor of objective measures of the regulation of negative emotion (35), with greater inverse connectivity associated with better emotion regulation. In a subsequent study, we found that inhibiting lateral PFC with transcranial magnetic theta burst stimulation interferes with automatic emotion regulation, thus establishing a causal role for the lateral PFC in emotion regulation (36). This may explain why abnormal functioning of the central-executive network, and lateral regions of the PFC more specifically, are associated with a range of psychiatric disorders (32).

Training-Related Changes. Evidence suggests that meta-awareness can be strengthened as a skill through intentional training, and that doing so enhances self-regulation and corresponding networks in the brain. Meta-awareness is the main target in the attentional family of meditation, which includes mindfulness-based practices (11), and also in various forms of psychotherapy (7, 8) and interventions designed to enhance executive function (37). Awareness-based interventions (see *SI Appendix*, Table S2 for examples) improve a range of outcomes related to the self-regulation of attention (15, 38, 39), as well as workplace (40) and educational outcomes (14, 41). One randomized controlled study demonstrated that mindfulness training improves working memory and GRE scores in distraction-prone students, with reductions in mind wandering mediating these improvements (27). Evidence in this area is mixed, however, with some studies failing to find training-related changes in sustained attention (42, 43), as well as important methodological limitations (44).

Attentional meditation and mindfulness interventions also improve outcomes related to the self-regulation of emotion, including lower levels of stress, decreased subjective reactivity to pain, improvements in symptoms related to anxiety, depression, and other mental disorders, and increased positive emotions and overall psychological well-being (45–47). Meta-awareness appears to play a central role in these improvements. Training in meta-awareness decreases stress and improves positive affect (17). When meta-awareness training is paired with an attitude of acceptance, more pronounced effects, including reduced biomarkers of stress reactivity, can be observed (17). Similarly, meta-awareness of anxiety-related symptoms has been found to mediate therapeutic improvement in both cognitive behavioral therapy (CBT) and acceptance and commitment therapy (ACT) (48).

These training-related changes correspond to altered patterns of brain activity and connectivity in nodes of the central-executive network, including the dlPFC (49). Interestingly, different forms of

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awareness-based meditation are associated with specific patterns of brain function. Focused attention meditation, for instance, is linked to reduced activations in regions of the default-mode network (DMN), a network associated with mind wandering and self-referential thought, while open monitoring meditation is not, suggesting that meta-awareness may lead to reduced mind wandering in some cases and to meta-aware mind wandering in others (49).

Connection

Connection here refers to a subjective sense of care and kinship toward other people that promotes supportive relationships and caring interactions. This may occur through positive social perceptions, such as gratitude and appreciation, as well as perspectives of shared humanity toward those outside of one's immediate social circles. For instance, when encountering someone from a different culture or race, or with different religious or political beliefs, one might acknowledge differences in life experience and attempt to understand and empathize with their unique perspective, while recognizing shared characteristics and viewing them as a fellow human being worthy of respect.

These perceived connections can be strengthened and sustained by generating prosocial "person construals" that shape how we perceive other people and thereby promote positive, caring interactions (50). For example, focusing on a shared characteristic or trait when encountering someone for the first time may lead to a feeling of affiliation rather than apprehension. Antisocial and neutral construals, on the other hand, can lead to adverse social outcomes, such as apathy, intergroup bias, and perceived social isolation (51). Prosocial construals may be accompanied by corresponding motivations that are oriented toward the well-being of others and reflect a willingness to engage in prosocial behaviors.

Relation to Well-Being. The capacity for caring relationships and positive social interactions figures prominently in scientific conceptions of well-being (5) and is an important determinant of physical health. Social relationships are better predictors of health than various biological and economic factors (52). Positive social relationships are vital for healthy psychological functioning and serve as a buffer against psychological disorders, such as depression (53) and anxiety (54), while poor social relationships can be more harmful than excessive drinking and smoking (55).

Evidence suggests that prosocial construals may play an important role in promoting strong social relationships, and thereby support overall well-being. Focusing on the positive qualities and beneficial actions of other people is a defining characteristic of appreciation and gratitude, both of which are linked to a variety of well-being–related outcomes (9). Gratitude leads to higher levels of perceived social support and to lower levels of stress and depression in students experiencing their first semester at college (56). Maladaptive construals undermine feelings of social connection. Construing people and situations as potential social threats, for instance, is associated with loneliness (51), which is a major risk factor for poor mental (57) and physical health (2). Similarly, those with emotional disorders, including generalized anxiety disorder and depression, typically construe ambiguous situations more negatively than healthy individuals (58).

Prosocial motivations make similar contributions to well-being by promoting caring feelings and behaviors (59, 60). Daily diary studies show that people with higher levels of empathic concern also experience higher levels of well-being (61). Similarly, compassionate goals predict increased self-esteem, more constructive approaches to interpersonal problems, and more positive social emotions (62). The Gallup World Poll surveyed more than one million people across 150 countries and found that generosity, as measured by charitable donations, is one of the most robust predictors of life satisfaction (63).

Neural and Biological Correlates.

Threat and emotion-regulation circuitry. Distinct brain networks underlie our capacity to form and maintain healthy relationships, with important implications for physical health and psychological well-being (64). For instance, many of the same neural systems involved in experiences of physical threat and safety are also involved in social experiences, including both rejection and social connection (65). Brain networks involved in reducing fear due to physical threats, for example, are involved in social support (64). An early study from our laboratory showed that holding the hand of one's spouse while being exposed to painful electric shock reduced activation in parts of the pain matrix, including the anterior insula, as well as regulatory regions of the PFC (66). These regulatory prefrontal regions are also recruited when down-regulating negative emotion and stress responses (67, 68) and may thereby promote physical health and psychological well-being.

Perspective taking and theory of mind-related circuitry. The different ways in which we construe social situations is reflected in varying patterns of brain activity (69). Our perception of other people commonly recruits brain regions associated with mentalizing, or theory of mind, including the medial PFC (mPFC), temporoparietal junction (TPJ), temporal pole, and precuneus (70). For instance, making inferences about someone we construe to be similar to ourselves activates the vmPFC (71), which is central to the perception of social safety and feelings of social connection. Making inferences about someone we construe to be different activates a neighboring region, the dorsomedial PFC (dmPFC) (71). In some cases, these differences may be even more pronounced. Research on social perception has shown that the mPFC fails to activate altogether when individuals view images of homeless people, drug addicts, and other social outgroups. Instead, brain regions associated with disgust become active, including the amygdala and insula (72). Other findings show similar patterns of brain activity in relation to racial bias and discrimination (73), with corresponding reductions in prosocial behaviors (74).

Empathy and prosocial motivation. Although there is no single empathy region in the brain, the anterior insula, dorsal anterior cingulate cortex, anterior midcingulate cortex, and supplemental motor area are commonly activated in various forms of empathy, including the vicarious experience of pain, fear, happiness, and disgust (75). Empathy, however, can lead to feelings of distress and corresponding activity in regions of the brain's pain network, while compassion is associated with activity in regions of the reward network, such as the medial orbitofrontal cortex and ventral striatum (76). Interestingly, these areas are not associated with distress, but rather with positive emotions and feelings of social connection (76). These differences in the neural correlates of empathy and compassion may help explain why empathy only leads to caring behaviors when coupled with a compassionate motivation (77).

Training-Related Changes. Intentionally strengthening prosocial qualities improves overall well-being, with training-related changes reflected in the brain, peripheral biology, and behavior. Meta-analyses of connection-based interventions (see *SI Appendix*, Table S2 for examples), such as kindness and compassion meditation, find training-related decreases in depression, anxiety, and psychological distress, and increases in positive emotions and

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overall well-being (78). Similar findings have been obtained with connection-based positive psychology interventions (9). Such interventions strengthen feelings of social connection (79), as well as prosocial behaviors in both laboratory (80) and real-world situations (81), although important issues exist concerning methodological rigor in these areas of research (82, 83).

There is also evidence that connection-based meditation practices may improve behaviors that directly contribute to societal well-being. Pioneering studies have found that kindness meditation practices reduce implicit bias and discrimination toward marginalized groups (84, 85). These findings require replication and extension with longer follow-up given evidence that such training-related changes may be unstable (86).

Additional evidence suggests that training in connection-based practices like compassion meditation may also strengthen the capacity for self-regulation and recruit the brain's central-executive network, similar to awareness training. Work from our laboratory found that compassion training increases altruistic behavior, which is related to greater connectivity between the dlPFC, a core region of the central-executive network, and ventral striatum, which is involved in regulating positive affect and response to reward (87). Other related research indicates that compassion training increases activation in networks important for positive affect and affiliation (88).

Insight

Insight, in our framework, refers to self-knowledge concerning the manner in which emotions, thoughts, beliefs, and other factors are shaping one's subjective experience, and especially one's sense of self. States of insight thus reflect an experiential understanding of one's own psychological processes and how the dynamic interplay of these processes influences experience. For example, when experiencing an anxious thought, insight would enable one to recognize how one's fearful expectations are being shaped by memories and self-critical thoughts and are thus overly focused on negative outcomes. With diminished insight, one would accept these expectations and thoughts as reality, with little understanding of the factors that are influencing one's perception.

Although moments of insight can occur spontaneously, training in self-inquiry promotes the occurrence of insight and enables one to sustain and integrate moments of insight with a range of daily life experiences. Self-inquiry refers to the intentional, curiosity-driven investigation of self-related beliefs and psychological processes (11). Self-inquiry strategies enable one to examine the implicit beliefs that inform self-related narratives, expectations, and goals. For example, self-inquiry may be used to examine a line of anxious thoughts to gain insight into how these thoughts trigger emotional reactions and self-defeating behaviors. Self-inquiry strategies thus help to clarify and challenge maladaptive self-related beliefs.

Relation to Well-Being. Although insight into self-related beliefs and psychological processes does not figure prominently in scientific models of well-being (4, 5), it is central to perspectives on human flourishing in the world's humanistic and contemplative traditions (89) and also contemporary psychiatry and psychotherapy (7, 90). Maladaptive conceptions of self are linked to negative physical and mental health outcomes. Rigid and negative beliefs are linked to a range of psychological disorders, from eating disorders (91) to psychosis (92) and depression (93), while compassionate, accepting, and growth-oriented beliefs about the self (7, 94, 95) are associated with lower levels of depression and anxiety (96), higher levels of well-being (97), and real-world outcomes like improved academic performance (98).

Insight into one's own mind and mental processes is an important predictor of overall psychological well-being and life satisfaction (99). More specifically, self-knowledge concerning self-related beliefs, referred to as "self-concept clarity," is central to healthy psychological functioning (100). Trait-level clarity of self-concept is related to reduced daily fluctuations in mood and self-esteem (101), mediates the relationship between stress and subjective well-being (102), and mediates the impact of childhood adversity on psychopathology, indicating that such insight is protective of mental health (103).

Despite the strong links between insight and well-being, the role that self-reflection plays in this process is complex. Intentional self-reflection spurred by openness and curiosity, which we refer to here as self-inquiry, is associated with a range of well-being–promoting factors, from the ability to perceive social cues to effective emotion regulation (104). Other research suggests that the ability to self-reflect from a distanced perspective may be a critical component of healthy self-inquiry (105), and even that cultural forces may support or undermine this capacity (106). However, self-reflection that is automatic, overly negative, and self-critical is linked to mental disorders (104). In a sample of undergraduate students, for instance, ruminative self-reflection was associated with decreased capacity to take a distanced perspective and increased depressive symptoms, while healthy self-inquiry exhibited the opposite pattern (107).

Neural and Biological Underpinnings.

Self-related processes and the default-mode network. Neuroscientific research is beginning to reveal how self-related processes are reflected in the brain. An important finding from scientific studies of the self is that there does not appear to be a single, unitary network that is uniquely associated with self-processing in the brain (108). The subjective sense of a unitary self may thus be an illusion brought about by the ongoing personal narrative that synthesizes disparate experiences into a cohesive, unified whole. This "narrative self" has been linked to activity in the left cerebral hemisphere in split brain patients (109) and to cortical midline regions in the brain's DMN, such as the mPFC and posterior cingulate cortex (110, 111).

DMN and central-executive network connectivity. Optimal well-being may be reflected in patterns of connectivity between regions within the DMN and central-executive networks involved in self-regulation (112, 113). Research on both healthy and clinical populations suggests that self-reflection recruits regions in the DMN, such as the mPFC, and central-executive regions, such as the ventrolateral PFC (vlPFC), a region associated with a broad range of cognitive and affective functions, including self-reflection (114). This region seems to be activated during constructive self-inquiry, for instance when healthy subjects reflect on themselves and their personal goals (115), while ruminative self-reflection commonly activates the mPFC, and the DMN more broadly, reflecting patterns of activity linked to various forms of psychopathology (116).

Training-Related Changes. Psychotherapy, deconstructive meditation, and other insight-based interventions (see *SI Appendix*, Table S2 for examples), appear to relieve mental distress and bolster psychological well-being by altering the content and functioning of self-related beliefs. Strategies to enhance growth mindset, for instance, have been found to alter both mindset and behavioral self-regulation (117). Similarly,

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CBT, which enables individuals to identify maladaptive beliefs about the self and replace them with more adaptive beliefs, has been shown to alleviate stress and reduce symptoms of depression, anxiety, and other psychiatric disorders (118). These changes are reflected in neuroplastic changes in the brain, including heightened activation in self-regulatory regions of the central-executive network, such as the dorsolateral and dorsomedial PFC (119).

Research on deconstructive meditation, an important insight-based strategy, is limited (11). However, the ReSource Project, a pioneering large-scale longitudinal study, found that deconstructive meditation, contrasted with awareness- and connection-based practices, increased the flexible use of adaptive emotion regulation strategies like cognitive reappraisal and perspective taking, enhanced theory of mind capacity, and altered emotional self-concepts, leading to corresponding changes in the brain [summarized in Singer and Engert (12)].

Evidence also suggests that long-term exposure to insight-related deconstructive meditation may lead to enduring changes in self-related processing in the brain. Narrative and experiential modes of self-related processing are related to different patterns of brain activity (120). Single subject research indicates that expert meditators are able to induce experiential modes of reduced self-focus (121) that exhibit decreased activation in the DMN (122), with important implications for long-term brain health, including age-related neural atrophy (123). Indeed, altered DMN function has emerged as a biomarker in meditation-related interventions (124), with research indicating that long-term meditation practice may lead to trait-like changes in the DMN, with reduced activity and functional connectivity within this network (113). Given the central role of the DMN in stress (125) and psychopathology (116), deconstructive meditation and other forms of self-inquiry may thus prove effective in bolstering well-being by strengthening healthy modes of self-related processing in the brain.

Research on other forms of insight, such as creative problem-solving, suggest that moments of insight may be associated with bursts of high-frequency gamma-band oscillations (126). Similar patterns of gamma activity have also been observed in long-term meditators (127) and during lucid dreaming (128), both of which may involve neurophenomenological shifts in self-related processing. Recent findings highlight the importance of abnormalities in gamma oscillations as a marker for depression and also reveal that baseline differences in gamma oscillations may predict treatment response, thus suggesting an important link to well-being (129).

Purpose

Purpose here refers to a sense of clarity concerning personally meaningful aims and values that one is able to apply in daily life. Heightened states of purpose thus foster the self-perception that one both has aims and values and is also able to embody them. This self-perception, in turn, leads one to perceive meaning and significance in one's life and pursuits. States of diminished purpose may involve a lack of clarity concerning one's aims and values, or the perception that one has clear values and aims yet is unable to embody them.

As a dimension of well-being, purpose thus involves both aims and values. Life aims serve to organize and stimulate goals and provide an overarching narrative that helps individuals make sense of their lives (130). Such aims involve the formation of personal values, the concepts that guide behavior by enabling individuals to assess actions and situations, and to persevere in the face of challenges, by orienting themselves to what is personally meaningful and important (131). Whereas a life aim is aspirational and rarely achieved in any given situation, a value is embodied in specific, pragmatic ways. For example, a teacher may aspire to help every child reach their potential to learn as a central life purpose. This aspiration may then be linked to specific values, such as patience and kindness, that guide their behavior in specific situations in a manner that aligns with this overarching life aim. The alignment of personally relevant aims with one's core values, and the embodiment of these aims and values in everyday life, leads individuals to perceive meaning and significance in their lives and pursuits (130).

Relation to Well-Being. Purpose is an important component of influential scientific models of well-being and is central to perspectives of human flourishing in the world's contemplative and humanistic traditions (5, 89). Purpose and meaning in life shape our personal narratives (132) and are associated with a range of outcomes related to psychological well-being and physical health. A strong sense of purpose is associated with improved health outcomes and behaviors, including increased physical activity (133), decreased incidence of stroke (134), fewer cardiovascular events (135), reduced risk of death (136), lower health care utilization (137), and even better financial health (138).

Purpose is also central to healthy psychological functioning, including memory, executive function, and overall cognitive ability (139), and also psychological resilience across the life span (140), including both teens (141) and the elderly (142). In a sample of African Americans at high-risk for psychiatric disorders, purpose in life emerged as a key factor predicting resilience and recovery from traumatic events (143). On the other end of the spectrum, low levels of purpose are associated with various psychological disorders (144).

The relationship between values and well-being is more complex. Although values generally exhibit strong relationships with both individual and societal well-being across cultures (145), some values exhibit negative associations with healthy psychological functioning while others seem to bolster well-being. Extrinsic materialistic values are associated with lower levels of well-being (146), with especially strong associations to risky health behaviors and economic decisions, as well as negative self-appraisals and reduced overall well-being (147). On the other hand, intrinsic values and goals, especially those that are self-transcendent, support well-being. A study of more than 25,000 young adults from 58 countries found that intrinsically meaningful values related to social connections and contributing to one's community were more strongly associated with well-being than extrinsic values related to power and financial gain, although the nature of these relationships varied across countries (148).

Neural and Biological Underpinnings.

Peripheral biology. Empirical studies are beginning to address the pathways through which purpose and values are protective of both physical health and psychological well-being. One such pathway is the role that purpose plays in stress resilience (149). Higher levels of purpose at baseline have been found to predict decreased allostatic load—signifying the negative impact of chronic stress—10 y later (150). Similarly, higher purpose in life buffers elevated inflammation in those with comorbid health conditions (151) and also predicts accelerated recovery from stress in the elderly, as measured by salivary cortisol levels (152).

Emotion- and threat-related circuitry. The protective role of purpose also extends to emotional stress. A recent study from our laboratory demonstrated that higher purpose in life was associated with better emotional recovery 2 y later, as indexed by smaller eyeblink startle reflex in response to negative images

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(153). Higher levels of purpose are also associated with less emotional reactivity to negative stimuli and more effective brain-related emotion regulation, as evidenced by increased recruitment of the dorsal anterior cingulate cortex and reduced activity in the left amygdala (154).

Although values have been shown to influence a variety of well-being–related outcomes, research on related brain networks is lacking. A pioneering study found that prioritizing self-transcendent values over nontranscendent values is associated with less brain-related threat response to health messages in the left and right amygdala and left anterior insula (155), suggesting that self-transcendent values may reduce defensiveness and promote openness.

Decision-making circuitry. Data also suggest that purpose facilitates efficient decision-making and related brain function concerning health behaviors. In a study of 220 sedentary adults, those with higher levels of purpose were able to endorse challenging health messages more readily than those with lower levels of purpose (156). This relationship was mediated by reduced activity in brain regions involved in self-regulation, including the dorsal anterior cingulate cortex, anterior insula, and dorsolateral and ventrolateral PFC, suggesting that those with higher levels of purpose may experience less cognitive conflict when receiving challenging health messages, thereby reducing defensiveness and increasing receptivity.

Training-Related Changes. A growing body of evidence indicates that purpose and values can be clarified and strengthened through purpose-based interventions (see *SI Appendix*, Table S2 for examples), and that doing so increases resilience, promotes healthy behaviors, and alters the brain and peripheral biology in meaningful ways. ACT, for instance, which includes both acceptance and values-based practices, has been shown to be an effective treatment for those dealing with chronic pain, improving both emotional resilience and physical functioning (157). Affirming personal values has also been found to decrease psychological distress and depression (158) and to bolster resilience to psychosocial stress, as evidenced by reduced cortisol response (159).

While self-transcendent values serve to bolster well-being, inducing self-oriented materialistic values leads to negative outcomes, such as decreased prosocial behavior (160), even in young children (161). Affirming self-transcendent personal values, on the other hand, is linked to positive outcomes, including increased self-control (162), reduced self-focused rumination (163), and less bias against personally challenging information (164). Kang et al. (165) found that inducing self-transcendent values led to healthier behaviors in the following month, as well as corresponding activity in a region of the vmPFC linked to positive evaluations and reward processing.

In addition to affirming values, research further suggests that enacting values in everyday situations may play an especially important role in human flourishing (166). Behaving in a way that is inconsistent with personal values is associated with higher levels of negative affect and lower overall well-being (167). Experimental studies suggest that enacting one's purpose and values, conversely, supports well-being. A study of the relationship between purpose and academic achievement found that a brief, one-time induction of a self-transcendent purpose for learning led to a variety of positive learning outcomes, whereas an induction of a more self-oriented purpose produced no positive outcomes (168). Similarly, studies of volunteering have found that self-transcendent motivations are related to more beneficial outcomes relative to those that are self-oriented (169). Such interventions buffer age-related declines in brain function in at-risk adults (170) and improve self-regulation, with increased activity in the lateral PFC and anterior cingulate cortex associated with gains in executive function (171).

Summary and Future Directions

We have proposed four dimensions of well-being that can be strengthened through intentional training, viewing this framework as a starting point for investigating a dynamic, skill-based perspective on well-being. The data summarized here reveal key insights as well as important gaps in our current understanding of well-being. First, and most importantly, there is overwhelming evidence that well-being can be learned and that core dimensions of well-being may thus be likened to skills and trained through various forms of self-regulation. Nevertheless, while it is clear that the four dimensions of well-being in our framework can be cultivated, we know relatively little about the most effective ways to go about training them, and whether it is best to train each dimension in isolation or to target more than one dimension through multidimensional interventions. The precise relationships between proximal components of well-being and distal outcomes that are produced as a consequence of well-being (e.g., physical health, mental health) remain elusive and in need of additional study. It is also likely that individual differences in baseline characteristics play an important role in moderating the impact of strategies to cultivate well-being. We envision a future "precision-medicine" approach that tailors training protocols for different types of individuals based on baseline individual differences.

Another key insight from the neuroscience data reviewed here is that the different dimensions of well-being are instantiated in partially separable brain circuits, each of which exhibits plasticity. The causal status of specific components of these networks in different aspects of well-being has hardly been studied. One example of how this might be approached is recent collaborative work from our group in which transcranial magnetic stimulation was used to transiently disrupt a key prefrontal node central to meta-awareness, thus establishing a causal role for lateral PFC in certain forms of meta-awareness (172). Similarly, despite decades of research, there have been few substantive improvements in the measurement of well-being that go beyond self-report measures. Although self-report measures across all four domains are abundant, there are few valid and reliable behavioral measures. The advent of mobile technology along with machine learning approaches is opening new doors to studying well-being at scale through the use of new methodologies, including experience sampling (or ecological momentary assessment) and the use of mobile sensors and other passively collected data (173). Finally, well-being research is often carried out in a manner such that both researchers and research participants do not adequately reflect the racial, socioeconomic, and cultural diversity of the general population. As a result, we know comparatively little about the role that individual and societal contexts play in the cultivation of well-being. For this reason, including diverse perspectives in both research and training initiatives may improve the development and research process from beginning to end.

Conclusion

In presenting this framework, we wish to further research on the cultivation of well-being by highlighting dimensions of well-being that are trainable and considering the psychological and neural pathways through which training can occur. We do not view this as an exhaustive model, but rather envision that future research will refine and expand upon what we have presented here. Nevertheless, it is our sincere aspiration that this humble effort will spur further research in this area, stimulate development of new well-being

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measures, and most importantly, contribute to the development of robust interventions to reduce suffering and improve well-being around the world. With the COVID-19 pandemic, the continued prevalence of racial and other forms of discrimination, and upheavals due to climate change and economic hardship, there have been few periods in recent human history when the need for evidence-based, scalable interventions has been more urgent than it is today.

Data Availability. There are no data underlying this work.

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1 Blue Cross Blue Shield Association, "Major depression: The impact on overall health" (2018). https://www.bcbs.com/the-health-of-america/reports/major-depression-the-impact-overall-health?utm_source=bcbscom&utm_medium=infographic&utm_content=&utm_campaign=hoa-DepRep. Accessed 1 June 2020.
2 J. Holt-Lunstad, T. B. Smith, M. Baker, T. Harris, D. Stephenson, Loneliness and social isolation as risk factors for mortality: A meta-analytic review. *Perspect. Psychol. Sci.* **10**, 227–237 (2015).
3 G. Xu, L. Strathearn, B. Liu, B. Yang, W. Bao, Twenty-year trends in diagnosed attention-deficit/hyperactivity disorder among US children and adolescents, 1997–2016. *JAMA Netw. Open* **1**, e181471 (2018).
4 E. Diener, S. Oishi, L. Tay, Advances in subjective well-being research. *Nat. Hum. Behav.* **2**, 253–260 (2018).
5 C. D. Ryff, Psychological well-being revisited: Advances in the science and practice of eudaimonia. *Psychother. Psychosom.* **83**, 10–28 (2014).
6 R. J. Davidson, B. S. McEwen, Social influences on neuroplasticity: Stress and interventions to promote well-being. *Nat. Neurosci.* **15**, 689–695 (2012).
7 S. C. Hayes, J. B. Luoma, F. W. Bond, A. Masuda, J. Lillis, Acceptance and commitment therapy: Model, processes and outcomes. *Behav. Res. Ther.* **44**, 1–25 (2006).
8 Z. V. Segal, J. M. G. Williams, J. D. Teasdale, *Mindfulness-Based Cognitive Therapy for Depression* (Guilford Press, 2012).
9 N. L. Sin, S. Lyubomirsky, Enhancing well-being and alleviating depressive symptoms with positive psychology interventions: A practice-friendly meta-analysis. *J. Clin. Psychol.* **65**, 467–487 (2009).
10 M. E. P. P. Seligman, T. A. Steen, N. Park, C. Peterson, Positive psychology progress: Empirical validation of interventions. *Am. Psychol.* **60**, 410–421 (2005).
11 C. J. Dahl, A. Lutz, R. J. Davidson, Reconstructing and deconstructing the self: Cognitive mechanisms in meditation practice. *Trends Cogn. Sci.* **19**, 515–523 (2015).
12 T. Singer, V. Engert, It matters what you practice: Differential training effects on subjective experience, behavior, brain and body in the ReSource Project. *Curr. Opin. Psychol.* **28**, 151–158 (2019).
13 A. Lutz, A. P. Jha, J. D. Dunne, C. D. Saron, Investigating the phenomenological matrix of mindfulness-related practices from a neurocognitive perspective. *Am. Psychol.* **70**, 632–658 (2015).
14 A. B. Morrison, M. Goolsarran, S. L. Rogers, A. P. Jha, Taming a wandering attention: Short-form mindfulness training in student cohorts. *Front. Hum. Neurosci.* **7**, 897 (2014).
15 K. A. MacLean *et al.*, Intensive meditation training improves perceptual discrimination and sustained attention. *Psychol. Sci.* **21**, 829–839 (2010).
16 Y.-Y. Tang *et al.*, Short-term meditation training improves attention and self-regulation. *Proc. Natl. Acad. Sci. U.S.A.* **104**, 17152–17156 (2007).
17 E. K. Lindsay, J. D. Creswell, Mindfulness, acceptance, and emotion regulation: Perspectives from monitor and acceptance theory (MAT). *Curr. Opin. Psychol.* **28**, 120–125 (2019).
18 M. A. Killingsworth, D. T. Gilbert, A wandering mind is an unhappy mind. *Science* **330**, 932 (2010).
19 C. M. Zedelius, J. M. Broadway, J. W. Schooler, Motivating meta-awareness of mind wandering: A way to catch the mind in flight? *Conscious. Cogn.* **36**, 44–53 (2015).
20 Y. Hadash, Y. Lichtash, A. Bernstein, Measuring decentering and related constructs: Capacity and limitations of extant assessment scales. *Mindfulness* **8**, 1674–1688 (2017).
21 M. J. Kane, J. C. McVay, What mind wandering reveals about executive-control abilities and failures. *Curr. Dir. Psychol. Sci.* **21**, 348–354 (2012).
22 P. Seli, R. E. Beaty, J. Marty-Dugas, D. Smilek, Depression, anxiety, and stress and the distinction between intentional and unintentional mind wandering. *Psychol. Conscious. Theory Res. Pract.* **6**, 163–170 (2019).
23 M. S. Franklin *et al.*, Tracking distraction. *J. Atten. Disord.* **21**, 475–486 (2017).
24 F. Hoffmann, C. Banzhaf, P. Kanske, F. Bermpohl, T. Singer, Where the depressed mind wanders: Self-generated thought patterns as assessed through experience sampling as a state marker of depression. *J. Affect. Disord.* **198**, 127–134 (2016).
25 V. Engert, J. Smallwood, T. Singer, Mind your thoughts: Associations between self-generated thoughts and stress-induced and baseline levels of cortisol and alpha-amylase. *Biol. Psychol.* **103**, 283–291 (2014).
26 E. S. Epel *et al.*, Wandering minds and aging cells. *Clin. Psychol. Sci.* **1**, 75–83 (2012).
27 M. D. Mrazek, M. S. Franklin, D. T. Phillips, B. Baird, J. W. Schooler, Mindfulness training improves working memory capacity and GRE performance while reducing mind wandering. *Psychol. Sci.* **24**, 776–781 (2013).
28 C. Galéra *et al.*, Mind wandering and driving: Responsibility case-control study. *BMJ* **345**, e8105 (2012).
29 J. J. Gross, Emotion regulation: Current status and future prospects. *Psychol. Inq.* **26**, 1–26 (2015).
30 R. G. McCaig, M. Dixon, K. Keramatian, I. Liu, K. Christoff, Improved modulation of rostrolateral prefrontal cortex using real-time fMRI training and meta-cognitive awareness. *Neuroimage* **55**, 1298–1305 (2011).
31 S. Forster, A. O. Nunez Elizalde, E. Castle, S. J. Bishop, Unraveling the anxious mind: Anxiety, worry, and frontal engagement in sustained attention versus off-task processing. *Cereb. Cortex* **25**, 609–618 (2015).
32 M. W. Cole, G. Repovš, A. Anticevic, The frontoparietal control system: A central role in mental health. *Neuroscientist* **20**, 652–664 (2014).
33 A. Etkin, C. Büchel, J. J. Gross, The neural bases of emotion regulation. *Nat. Rev. Neurosci.* **16**, 693–700 (2015).
34 N. Kohn *et al.*, Neural network of cognitive emotion regulation—an ALE meta-analysis and MACM analysis. *Neuroimage* **87**, 345–355 (2014).
35 H. Lee, A. S. Heller, C. M. van Reekum, B. Nelson, R. J. Davidson, Amygdala-prefrontal coupling underlies individual differences in emotion regulation. *Neuroimage* **62**, 1575–1581 (2012).
36 R. C. Lapate *et al.*, Inhibition of lateral prefrontal cortex produces emotionally biased first impressions: A transcranial magnetic stimulation and electroencephalography study. *Psychol. Sci.* **28**, 942–953 (2017).
37 A. Diamond, Executive functions. *Annu. Rev. Psychol.* **64**, 135–168 (2013).
38 P. Sedlmeier *et al.*, The psychological effects of meditation: A meta-analysis. *Psychol. Bull.* **138**, 1139–1171 (2012).
39 B. W. Mooneyham *et al.*, States of mind: Characterizing the neural bases of focus and mind-wandering through dynamic functional connectivity. *J. Cogn. Neurosci.* **29**, 495–506 (2017).
40 D. J. Good *et al.*, Contemplating mindfulness at work: An integrative review. *J. Manage.* **42**, 114–142 (2015).
41 L. Flook, S. B. Goldberg, L. Pinger, R. J. Davidson, Promoting prosocial behavior and self-regulatory skills in preschool children through a mindfulness-based Kindness Curriculum. *Dev. Psychol.* **51**, 44–51 (2015).

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42 D. G. MacCoon, K. A. MacLean, R. J. Davidson, C. D. Saron, A. Lutz, No sustained attention differences in a longitudinal randomized trial comparing mindfulness based stress reduction versus active control. *PLoS One* **9**, e97551 (2014).
43 A. Diamond, D. S. Ling, "Review of the evidence on, and fundamental questions about, efforts to improve executive functions, including working memory" in *Cognitive and Working Memory Training: Perspectives from Psychology, Neuroscience, and Human Development*, J. M. Novick, M. F. Bunting, M. R. Dougherty, R. W. Engle, Eds. (Oxford University Press, 2019), pp. 143–431.
44 R. J. Davidson, A. W. Kaszniak, Conceptual and methodological issues in research on mindfulness and meditation. *Am. Psychol.* **70**, 581–592 (2015).
45 M. Goyal *et al.*, Meditation programs for psychological stress and well-being: A systematic review and meta-analysis. *JAMA Intern. Med.* **174**, 357–368 (2014).
46 S. B. Goldberg *et al.*, Mindfulness-based interventions for psychiatric disorders: A systematic review and meta-analysis. *Clin. Psychol. Rev.* **59**, 52–60 (2018).
47 S. B. Goldberg *et al.*, Awareness, connection, and insight: Testing a multi-component, self-guided, smartphone-based meditation app in a three-armed randomized controlled trial. *JMIR Ment. Heal.*, in press.
48 J. J. Arch, K. B. Wolitzky-Taylor, G. H. Eifert, M. G. Craske, Longitudinal treatment mediation of traditional cognitive behavioral therapy and acceptance and commitment therapy for anxiety disorders. *Behav. Res. Ther.* **50**, 469–478 (2012).
49 K. C. R. Fox *et al.*, Functional neuroanatomy of meditation: A review and meta-analysis of 78 functional neuroimaging investigations. *Neurosci. Biobehav. Rev.* **65**, 208–228 (2016).
50 J. B. Freeman, N. Ambady, A dynamic interactive theory of person construal. *Psychol. Rev.* **118**, 247–279 (2011).
51 J. T. Cacioppo, L. C. Hawkley, Perceived social isolation and cognition. *Trends Cogn. Sci.* **13**, 447–454 (2009).
52 G. E. Vaillant, *Aging Well: Surprising Guideposts to a Happier Life from the Landmark Study of Adult Development* (Little, Brown and Company, 2008).
53 Z. I. Santini, A. Koyanagi, S. Tyrovolas, C. Mason, J. M. Haro, The association between social relationships and depression: A systematic review. *J. Affect. Disord.* **175**, 53–65 (2015).
54 A. R. Teo, R. Lerrigo, M. A. M. Rogers, The role of social isolation in social anxiety disorder: A systematic review and meta-analysis. *J. Anxiety Disord.* **27**, 353–364 (2013).
55 J. Holt-Lunstad, T. B. Smith, J. B. Layton, Social relationships and mortality risk: A meta-analytic review. *PLoS Med.* **7**, e1000316 (2010).
56 A. M. Wood, J. Maltby, R. Gillett, P. A. Linley, S. Joseph, The role of gratitude in the development of social support, stress, and depression: Two longitudinal studies. *J. Res. Pers.* **42**, 854–871 (2008).
57 S. Cacioppo, A. J. Grippo, S. London, L. Goossens, J. T. Cacioppo, Loneliness: Clinical import and interventions. *Perspect. Psychol. Sci.* **10**, 238–249 (2015).
58 C. R. Hirsch, F. Meeten, C. Krahé, C. Reeder, Resolving ambiguity in emotional disorders: The nature and role of interpretation biases. *Annu. Rev. Clin. Psychol.* **12**, 281–305 (2016).
59 J. Crocker, A. Canevello, A. A. Brown, Social motivation: Costs and benefits of selfishness and otherishness. *Annu. Rev. Psychol.* **68**, 299–325 (2017).
60 J. L. Goetz, D. Keltner, E. Simon-Thomas, Compassion: An evolutionary analysis and empirical review. *Psychol. Bull.* **136**, 351–374 (2010).
61 S. A. Morelli, I. A. Lee, M. E. Arnn, J. Zaki, Emotional and instrumental support provision interact to predict well-being. *Emotion* **15**, 484–493 (2015).
62 A. Canevello, J. Crocker, How self-image and compassionate goals shape intrapsychic experiences. *Soc. Personal. Psychol. Compass* **9**, 620–629 (2015).
63 J. Helliwell, R. Layard, J. Sachs, "World happiness report 2017" (Sustainable Development Solutions Network, New York, 2017).
64 N. I. Eisenberger, S. W. Cole, Social neuroscience and health: Neurophysiological mechanisms linking social ties with physical health. *Nat. Neurosci.* **15**, 669–674 (2012).
65 N. I. Eisenberger, Social pain and the brain: Controversies, questions, and where to go from here. *Annu. Rev. Psychol.* **66**, 601–629 (2015).
66 J. A. Coan, H. S. Schaefer, R. J. Davidson, Lending a hand: Social regulation of the neural response to threat. *Psychol. Sci.* **17**, 1032–1039 (2006).
67 T. D. Wager *et al.*, Brain mediators of cardiovascular responses to social threat: Part I: Reciprocal dorsal and ventral sub-regions of the medial prefrontal cortex and heart-rate reactivity. *Neuroimage* **47**, 821–835 (2009).
68 M. D. Lieberman *et al.*, Putting feelings into words: Affect labeling disrupts amygdala activity in response to affective stimuli. *Psychol. Sci.* **18**, 421–428 (2007).
69 J. Zaki, K. N. Ochsner, The neuroscience of empathy: Progress, pitfalls and promise. *Nat. Neurosci.* **15**, 675–680 (2012).
70 E. Weisz, J. Zaki, Motivated empathy: A social neuroscience perspective. *Curr. Opin. Psychol.* **24**, 67–71 (2018).
71 J. P. Mitchell, C. N. Macrae, M. R. Banaji, Dissociable medial prefrontal contributions to judgments of similar and dissimilar others. *Neuron* **50**, 655–663 (2006).
72 S. T. Fiske, L. T. Harris, S. T. Fiske, Dehumanizing the lowest of the low. *Soc. Cogn.* **17**, 215–226 (2018).
73 S. Han, Neurocognitive basis of racial ingroup bias in empathy. *Trends Cogn. Sci.* **22**, 400–421 (2018).
74 G. Hein, G. Silani, K. Preuschoff, C. D. Batson, T. Singer, Neural responses to ingroup and outgroup members' suffering predict individual differences in costly helping. *Neuron* **68**, 149–160 (2010).
75 Y. Fan, N. W. Duncan, M. de Greck, G. Northoff, Is there a core neural network in empathy? An fMRI based quantitative meta-analysis. *Neurosci. Biobehav. Rev.* **35**, 903–911 (2011).
76 T. Singer, O. M. Klimecki, Empathy and compassion. *Curr. Biol.* **24**, R875–R878 (2014).
77 L. A. Winczewski, J. D. Bowen, N. L. Collins, Is empathic accuracy enough to facilitate responsive behavior in dyadic interaction? Distinguishing ability from motivation. *Psychol. Sci.* **27**, 394–404 (2016).
78 J. Galante, I. Galante, M. J. Bekkers, J. Gallacher, Effect of kindness-based meditation on health and well-being: A systematic review and meta-analysis. *J. Consult. Clin. Psychol.* **82**, 1101–1114 (2014).
79 C. A. Hutcherson, E. M. Seppala, J. J. Gross, Loving-kindness meditation increases social connectedness. *Emotion* **8**, 720–724 (2008).
80 H. Y. Weng, A. S. Fox, H. C. Hessenthaler, D. E. Stodola, R. J. Davidson, The role of compassion in altruistic helping and punishment behavior. *PLoS One* **10**, e0143794 (2015).
81 P. Condon, G. Desbordes, W. B. Miller, D. DeSteno, Meditation increases compassionate responses to suffering. *Psychol. Sci.* **24**, 2125–2127 (2013).
82 U. Kreplin, M. Farias, I. A. Brazil, The limited prosocial effects of meditation: A systematic review and meta-analysis. *Sci. Rep.* **8**, 2403 (2018).
83 C. A. White, B. Uttl, M. D. Holder, Meta-analyses of positive psychology interventions: The effects are much smaller than previously reported. *PLoS One* **14**, e0216588 (2019).
84 Y. Kang, J. R. Gray, J. F. Dovidio, The nondiscriminating heart: Lovingkindness meditation training decreases implicit intergroup bias. *J. Exp. Psychol. Gen.* **143**, 1306–1313 (2014).
85 A. J. Stell, T. Farsides, Brief loving-kindness meditation reduces racial bias, mediated by positive other-regarding emotions. *Motiv. Emot.* **40**, 140–147 (2016).
86 C. K. Lai *et al.*, Reducing implicit racial preferences: II. Intervention effectiveness across time. *J. Exp. Psychol. Gen.* **145**, 1001–1016 (2016).
87 H. Y. Weng *et al.*, Compassion training alters altruism and neural responses to suffering. *Psychol. Sci.* **24**, 1171–1180 (2013).
88 O. M. Klimecki, S. Leiberg, C. Lamm, T. Singer, Functional neural plasticity and associated changes in positive affect after compassion training. *Cereb. Cortex* **23**, 1552–1561 (2013).
89 D. Lobel, *Philosophies of Happiness: A Comparative Introduction to the Flourishing Life* (Columbia University Press, 2017).
90 A. T. Beck, E. A. P. Haigh, Advances in cognitive theory and therapy: The generic cognitive model. *Annu. Rev. Clin. Psychol.* **10**, 1–24 (2014).
91 B. M. Williams, C. A. Levinson, Negative beliefs about the self prospectively predict eating disorder severity among undergraduate women. *Eat. Behav.* **37**, 101384 (2020).
92 H. R. Cowan, D. P. McAdams, V. A. Mittal, Core beliefs in healthy youth and youth at ultra high-risk for psychosis: Dimensionality and links to depression, anxiety, and attenuated psychotic symptoms. *Dev. Psychopathol.* **31**, 379–392 (2019).
93 J. Evans, J. Heron, G. Lewis, R. Araya, D. Wolke; ALSPAC Study Team, Negative self-schemas and the onset of depression in women: Longitudinal study. *Br. J. Psychiatry* **186**, 302–307 (2005).
94 C. S. Dweck, *Self-Theories: Their Role in Motivation, Personality, and Development* (Psychology Press, 2000).
95 K. D. Neff, Self compassion: An alternative conceptualization of a healthy attitude toward oneself. *Self. Ident.* **2**, 85–101 (2003).

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96 P. Muris, C. Meesters, A. Pierik, B. de Kock, Good for the self: Self-compassion and other self-related constructs in relation to symptoms of anxiety and depression in non-clinical youths. *J. Child Fam. Stud.* **25**, 607–617 (2016).
97 L. K. Barnard, J. F. Curry, Self-Compassion: Conceptualizations, correlates, & interventions. *Rev. Gen. Psychol.* **15**, 289–303 (2011).
98 N. B. Ortiz Alvarado, M. Rodríguez Ontiveros, E. A. Ayala Gaytán, Do mindsets shape students' well-being and performance? *J. Psychol.* **153**, 843–859 (2019).
99 R. Harrington, D. A. Loffredo, Insight, rumination, and self-reflection as predictors of well-being. *J. Psychol.* **145**, 39–57 (2011).
100 J. D. Campbell, Self-esteem and clarity of the self-concept. *J. Pers. Soc. Psychol.* **59**, 538–549 (1990).
101 J. B. Nezlek, R. M. Plesko, Day-to-day relationships among self-concept clarity, self-esteem, daily events, and mood. *Pers. Soc. Psychol. Bull.* **27**, 201–211 (2001).
102 T. D. Ritchie, C. Sedikides, T. Wildschut, J. Arndt, Y. Gidron, Self-concept clarity mediates the relation between stress and subjective well-being. *Self. Ident.* **10**, 493–508 (2011).
103 M. Nakajima, K. Takano, Y. Tanno, Adaptive functions of self-focused attention: Insight and depressive and anxiety symptoms. *Psychiatry Res.* **249**, 275–280 (2017).
104 C. L. Philippi, M. Koenigs, The neuropsychology of self-reflection in psychiatric illness. *J. Psychiatr. Res.* **54**, 55–63 (2014).
105 E. Kross, O. Ayduk, Self-distancing: Theory, research, and current directions. *Adv. Exp. Soc. Psychol.* **55**, 81–136 (2017).
106 I. Grossmann, E. Kross, The impact of culture on adaptive versus maladaptive self-reflection. *Psychol. Sci.* **21**, 1150–1157 (2010).
107 M. Mori, Y. Tanno, Mediating role of decentering in the associations between self-reflection, self-rumination, and depressive symptoms. *Psychology (Irvine)* **06**, 613–621 (2015).
108 D. Legrand, P. Ruby, What is self-specific? Theoretical investigation and critical review of neuroimaging results. *Psychol. Rev.* **116**, 252–282 (2009).
109 L. J. Volz, M. S. Gazzaniga, Interaction in isolation: 50 years of insights from split-brain research. *Brain* **140**, 2051–2060 (2017).
110 H. F. Araujo, J. Kaplan, A. Damasio, Cortical midline structures and autobiographical-self processes: An activation-likelihood estimation meta-analysis. *Front. Hum. Neurosci.* **7**, 548 (2013).
111 M. E. Raichle, The brain's default mode network. *Annu. Rev. Neurosci.* **38**, 433–447 (2015).
112 J. A. Brewer *et al.*, Meditation experience is associated with differences in default mode network activity and connectivity. *Proc. Natl. Acad. Sci. U.S.A.* **108**, 20254–20259 (2011).
113 C. C. C. Bauer, S. Whitfield-Gabrieli, J. L. Díaz, E. H. Pasaye, F. A. Barrios, From state-to-trait meditation: Reconfiguration of central executive and default mode networks. *eNeuro* **6**, ENEURO.0335-18.2019 (2019).
114 D. G. V. Mitchell, The nexus between decision making and emotion regulation: A review of convergent neurocognitive substrates. *Behav. Brain Res.* **217**, 215–231 (2011).
115 U. Herwig, T. Kaffenberger, L. Jäncke, A. B. Brühl, Self-related awareness and emotion regulation. *Neuroimage* **50**, 734–741 (2010).
116 S. Whitfield-Gabrieli, J. M. Ford, Default mode network activity and connectivity in psychopathology. *Annu. Rev. Clin. Psychol.* **8**, 49–76 (2012).
117 A. J. Mrazek *et al.*, Expanding minds: Growth mindsets of self-regulation and the influences on effort and perseverance. *J. Exp. Soc. Psychol.* **79**, 164–180 (2018).
118 S. G. Hofmann, A. Asnaani, I. J. J. Vonk, A. T. Sawyer, A. Fang, The efficacy of cognitive behavioral therapy: A review of meta-analyses. *Cognit. Ther. Res.* **36**, 427–440 (2012).
119 P. R. Goldin *et al.*, Impact of cognitive behavioral therapy for social anxiety disorder on the neural dynamics of cognitive reappraisal of negative self-beliefs: Randomized clinical trial. *JAMA Psychiatry* **70**, 1048–1056 (2013).
120 N. A. Farb, P. A. Desormeau, L. A. Dinh-Williams, "The neuroscience of hypo-egoic processes" in *The Oxford Handbook of Hypo-Egoic Phenomena*, K. W. Brown, M. R. Leary, Eds. (Oxford University Press, 2016), pp. 109–131.
121 Y. Ataria, Y. Dor-Ziderman, A. Berkovich-Ohana, How does it feel to lack a sense of boundaries? A case study of a long-term mindfulness meditator. *Conscious. Cogn.* **37**, 133–147 (2015).
122 U. Winter *et al.*, Content-free awareness: EEG-fcMRI correlates of consciousness *as such* in an expert meditator. *Front. Psychol.* **10**, 3064 (2020).
123 N. Adluru, C. H. Korponay, D. L. Norton, R. I. Goldman, R. J. Davidson, BrainAGE and regional volumetric analysis of a Buddhist monk: A longitudinal MRI case study. *Neurocase* **26**, 79–90 (2020).
124 R. Simon, M. Engström, The default mode network as a biomarker for monitoring the therapeutic effects of meditation. *Front. Psychol.* **6**, 776 (2015).
125 R. K. Sripada, J. E. Swain, G. W. Evans, R. C. Welsh, I. Liberzon, Childhood poverty and stress reactivity are associated with aberrant functional connectivity in default mode network. *Neuropsychopharmacology* **39**, 2244–2251 (2014).
126 J. Kounios, M. Beeman, The cognitive neuroscience of insight. *Annu. Rev. Psychol.* **65**, 71–93 (2014).
127 A. Lutz, L. L. Greischar, N. B. Rawlings, M. Ricard, R. J. Davidson, Long-term meditators self-induce high-amplitude gamma synchrony during mental practice. *Proc. Natl. Acad. Sci. U.S.A.* **101**, 16369–16373 (2004).
128 U. Voss, R. Holzmann, I. Tuin, J. A. Hobson, Lucid dreaming: A state of consciousness with features of both waking and non-lucid dreaming. *Sleep* **32**, 1191–1200 (2009).
129 P. J. Fitzgerald, B. O. Watson, Gamma oscillations as a biomarker for major depression: An emerging topic. *Transl. Psychiatry* **8**, 177 (2018).
130 P. E. McKnight, T. B. Kashdan, Purpose in life as a system that creates and sustains health and well-being: An integrative, testable theory. *Rev. Gen. Psychol.* **13**, 242–251 (2009).
131 A. Bardi, S. H. Schwartz, Values and behavior: Strength and structure of relations. *Pers. Soc. Psychol. Bull.* **29**, 1207–1220 (2003).
132 J. M. Adler *et al.*, Variation in narrative identity is associated with trajectories of mental health over several years. *J. Pers. Soc. Psychol.* **108**, 476–496 (2015).
133 S. A. Hooker, K. S. Masters, Purpose in life is associated with physical activity measured by accelerometer. *J. Health Psychol.* **21**, 962–971 (2016).
134 E. S. Kim, J. K. Sun, N. Park, C. Peterson, Purpose in life and reduced incidence of stroke in older adults: "The health and retirement study." *J. Psychosom. Res.* **74**, 427–432 (2013).
135 R. Cohen, C. Bavishi, A. Rozanski, Purpose in life and its relationship to all-cause mortality and cardiovascular events: A meta-analysis. *Psychosom. Med.* **78**, 122–133 (2016).
136 A. Alimujiang *et al.*, Association between life purpose and mortality among US adults older than 50 years. *JAMA Netw. Open* **2**, e194270 (2019).
137 S. Musich, S. S. Wang, S. Kraemer, K. Hawkins, E. Wicker, Purpose in life and positive health outcomes among older adults. *Popul. Health Manag.* **21**, 139–147 (2018).
138 P. L. Hill, N. A. Turiano, D. K. Mroczek, A. L. Burrow, The value of a purposeful life: Sense of purpose predicts greater income and net worth. *J. Res. Pers.* **65**, 38–42 (2016).
139 N. A. Lewis, N. A. Turiano, B. R. Payne, P. L. Hill, Purpose in life and cognitive functioning in adulthood. *Neuropsychol. Dev. Cogn. B. Aging Neuropsychol. Cogn.* **24**, 662–671 (2017).
140 A. Feder, E. J. Nestler, D. S. Charney, Psychobiology and molecular genetics of resilience. *Nat. Rev. Neurosci.* **10**, 446–457 (2009).
141 E. Sagone, M. E. De Caroli, Relationships between psychological well-being and resilience in middle and late adolescents. *Procedia Soc. Behav. Sci.* **141**, 881–887 (2014).
142 T. D. Windsor, R. G. Curtis, M. A. Luszcz, Sense of purpose as a psychological resource for aging well. *Dev. Psychol.* **51**, 975–986 (2015).
143 T. N. Alim *et al.*, Trauma, resilience, and recovery in a high-risk African-American population. *Am. J. Psychiatry* **165**, 1566–1575 (2008).
144 F. R. Goodman, J. D. Doorley, T. B. Kashdan, "Well-being and psychopathology: A deep exploration into positive emotions, meaning and purpose in life, and social relationships" in *Handbook of Well-Being*, E. Diener, S. Oishi, L. Tay, Eds. (DEF Publishers, 2018), pp. 1–25.
145 V. H. Fetvadjiev, J. He, The longitudinal links of personality traits, values, and well-being and self-esteem: A five-wave study of a nationally representative sample. *J. Pers. Soc. Psychol.* **117**, 448–464 (2019).
146 T. Kasser, Materialistic values and goals. *Annu. Rev. Psychol.* **67**, 489–514 (2016).

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147 H. Dittmar, R. Bond, M. Hurst, T. Kasser, The relationship between materialism and personal well-being: A meta-analysis. *J. Pers. Soc. Psychol.* **107**, 879–924 (2014).
148 A. Van Den Broeck, B. Schreurs, K. Proost, A. Vanderstukken, M. Vansteenkiste, I want to be a billionaire: How do extrinsic and intrinsic values influence youngsters' well-being? *Ann. Am. Acad. Pol. Soc. Sci.* **682**, 204–219 (2019).
149 C. D. Ryff, A. S. Heller, S. M. Schaefer, C. van Reekum, R. J. Davidson, Purposeful engagement, healthy aging, and the brain. *Curr. Behav. Neurosci. Rep.* **3**, 318–327 (2016).
150 S. Zilioli, R. B. Slatcher, A. D. Ong, T. L. Gruenewald, Purpose in life predicts allostatic load ten years later. *J. Psychosom. Res.* **79**, 451–457 (2015).
151 E. M. Friedman, C. D. Ryff, Living well with medical comorbidities: A biopsychosocial perspective. *J. Gerontol.B Psychol. Sci. Soc. Sci.* **67**, 535–544 (2012).
152 N. Fogelman, T. Canli, "Purpose in Life" as a psychosocial resource in healthy aging: An examination of cortisol baseline levels and response to the trier social stress test. *NPJ Aging Mech. Dis.* **1**, 15006 (2015).
153 S. M. Schaefer *et al.*, Purpose in life predicts better emotional recovery from negative stimuli. *PLoS One* **8**, e80329 (2013).
154 C. M. van Reekum *et al.*, Individual differences in amygdala and ventromedial prefrontal cortex activity are associated with evaluation speed and psychological well-being. *J. Cogn. Neurosci.* **19**, 237–248 (2007).
155 Y. Kang *et al.*, Self-transcendent values and neural responses to threatening health messages. *Psychosom. Med.* **79**, 379–387 (2017).
156 Y. Kang, V. J. Strecher, E. Kim, E. B. Falk, Purpose in life and conflict-related neural responses during health decision-making. *Health Psychol.* **38**, 545–552 (2019).
157 K. E. Vowles, L. M. McCracken, J. Z. O'Brien, Acceptance and values-based action in chronic pain: A three-year follow-up analysis of treatment effectiveness and process. *Behav. Res. Ther.* **49**, 748–755 (2011).
158 K. Bramwell, T. Richardson, Improvements in depression and mental health after acceptance and commitment therapy are related to changes in defusion and values-based action. *J. Contemp. Psychother.* **48**, 9–14 (2018).
159 J. D. Creswell *et al.*, Affirmation of personal values buffers neuroendocrine and psychological stress responses. *Psychol. Sci.* **16**, 846–851 (2005).
160 K. D. Vohs, N. L. Mead, M. R. Goode, The psychological consequences of money. *Science* **314**, 1154–1156 (2006).
161 A. Gasiorowska, T. Zaleskiewicz, S. Wygrab, Would you do something for me? The effects of money activation on social preferences and social behavior in young children. *J. Econ. Psychol.* **33**, 603–608 (2012).
162 A. Burson, J. Crocker, D. Mischkowski, Two types of value-affirmation: Implications for self-control following social exclusion. *Soc. Psychol. Personal. Sci.* **3**, 510–516 (2012).
163 S. L. Koole, K. Smeets, A. Van Knippenberg, A. Dijksterhuis, The cessation of rumination through self-affirmation. *J. Pers. Soc. Psychol.* **77**, 111–125 (1999).
164 D. K. Sherman, G. L. Cohen, Accepting threatening information: Self-affirmation and the reduction of defensive biases. *Curr. Dir. Psychol. Sci.* **11**, 119–123 (2002).
165 Y. Kang *et al.*, Effects of self-transcendence on neural responses to persuasive messages and health behavior change. *Proc. Natl. Acad. Sci. U.S.A.* **115**, 9974–9979 (2018).
166 K. M. Sheldon, L. S. Krieger, Walking the talk: Value importance, value enactment, and well-being. *Motiv. Emot.* **38**, 609–619 (2014).
167 M. Chrystal, J. A. Karl, R. Fischer, The complexities of "minding the gap": Perceived discrepancies between values and behavior affect well-being. *Front. Psychol.* **10**, 736 (2019).
168 D. S. Yeager *et al.*, Boring but important: A self-transcendent purpose for learning fosters academic self-regulation. *J. Pers. Soc. Psychol.* **107**, 559–580 (2014).
169 A. A. Stukas, R. Hoye, M. Nicholson, K. M. Brown, L. Aisbett, Motivations to volunteer and their associations with volunteers' well-being. *Nonprofit Volunt. Sector Q.* **45**, 112–132 (2016).
170 M. C. Carlson *et al.*, Impact of the Baltimore Experience Corps trial on cortical and hippocampal volumes. *Alzheimers Dement.* **11**, 1340–1348 (2015).
171 M. C. Carlson *et al.*, Evidence for neurocognitive plasticity in at-risk older adults: The Experience Corps program. *J. Gerontol. A Biol. Sci. Med. Sci.* **64**, 1275–1282 (2009).
172 R. C. Lapate, J. Samaha, B. Rokers, B. R. Postle, R. J. Davidson, Perceptual metacognition of human faces is causally supported by function of the lateral prefrontal cortex. *Commun. Biol.* **3**, 360 (2020).
173 E. Nosakhare, R. Picard, Toward assessing and recommending combinations of behaviors for improving health and well-being. *ACM Trans. Comput. Healthc.* **1**, 1–29 (2020).

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