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Mini Review

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Neurological, Physiological, and Social Perspectives on the Impact of Gratitude on Well-Being

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Abstract

This review explores the evolving relationship between gratitude and well-being, focusing on its neural, physiological, and social effects. Drawing from both Indian spiritual perspectives and contemporary neuroscience, we discuss how gratitude engages specific brain regions, including those linked to moral cognition, empathy, and reward systems. Studies have shown that gratitude interventions, such as journaling, can increase neural sensitivity to gratitude and promote positive social behaviors, including altruism and support-giving. Furthermore, gratitude has been associated with beneficial effects on physical health, particularly in reducing cardiovascular reactivity to stress. Despite some inconsistencies in findings, research suggests that gratitude can have long-term benefits on both mental and physical health. Future studies should investigate the mechanisms underlying these effects, explore cross-cultural differences, and examine the long-term impact of gratitude practices on health outcomes. This comprehensive understanding may lead to interventions that leverage gratitude for improving individual and societal well-being.

Keywords: Gratitude; Well-Being; Neural Mechanisms; Social Bonds;Cardiovascular Health

Abbreviations

VMPFC: Ventromedial Prefrontal Cortex; PCC: Posterior Cingulate Cortex; MVPA: Multivariate Pattern Analysis; CVR: Cardiovascular Reactivity; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; HR: Heart Rate; CO: Cardiac Output; and TPR: Total Peripheral Resistance.

Introduction and Background

यः प्रांण॒तो निंमिष॒तो मंहि॒त्वैक॒ऽइद्राजा॒ जगंतो ब॒भूवं।
यऽईशेंऽअ॒स्य द्वि॒पद॒श्चतुंष्पद॒ः कस्मैं दे॒वायं ह॒विषां विधेम ॥३ ॥

Yajurveda (Adhyaya 23, Mantra 3)

The mantra praises the supreme power that rules over everything in the universe, both humans and animals. It acknowledges that there is no other god more worthy of our devotion and offerings.

येन॒ द्यौरु॒ग्रा पृंथि॒वी चं दृ॒ढा येन॒ स्व स्तभि॒तं येन॒ नाकंः।
योऽ अ॒न्तरिंक्षे॒ रजंसो वि॒मान॒ः कस्मैं दे॒वायं ह॒विषां विधेम ॥६ ॥

Yajurveda (Adhyaya 32, Mantra 6)

The mantra honors a supreme power that created and supports the sky, earth, and heavens. It recognizes this divine force as the one that controls the entire universe, and it emphasizes that there is no one more deserving of our devotion and offerings.

For studying Indian spirituality, these mantras reflect an attitude of gratitude and thankfulness towards all aspects of existence. In practicing Gratitude Sadhana, a sadhak (practitioner) employs techniques of gratitude, which have direct or indirect effects on neural processes. However, scientific research exploring this connection remains limited. We reviewed studies on gratitude and neuroscience, primarily from a non-Indian perspective.

In recent decades, researchers have shown increasing interest in investigating neural activity associated with gratitude and its underlying mechanisms [1]. measured brain activity and identified regions where activity correlated with participants' self-reported experiences of gratitude during a task. This analysis controlled for related constructs such as guilt, motivation, and the desire to help. The regions identified were largely distinct from those associated with empathy or theory of mind. Additionally, their cross-sectional study revealed that a simple gratitude writing intervention was associated with significantly greater and more enduring neural sensitivity to gratitude [1]. Fox et al. [2] found that ratings of gratitude were associated with increased brain activity in the anterior cingulate cortex and medial prefrontal cortex. These findings offer insight into the neural circuits involved in moral cognition and the positive emotions linked to experiencing goodwill from others [2]. Balconi et al. [3] observed that cognitive performance improved after the exchange of gifts, as evidenced by greater accuracy and faster response times in task execution. Hemodynamic responses also indicated an increase in oxygenated hemoglobin, particularly in the dorsolateral prefrontal cortex, following the gift exchange [3]. Karns et al. [4] identified gratitude as both an emotion and a trait linked to well-being, health, and moral value. Their study tested two hypotheses on the role of neural reward systems in gratitude and altruism. First, they found that self-reported gratitude and altruism were associated with "neural pure altruism" in the ventromedial prefrontal cortex (VMPFC) and nucleus accumbens, reflecting the neural valuation of charitable giving over self-benefit. Second, a three-week gratitude journaling intervention increased neural pure altruism in the VMPFC. The researchers suggested that the VMPFC adapts with gratitude practice, enhancing responses to benefits for others [4]. Yu et al. [5] investigated how voluntary help during times of need fosters interpersonal gratitude, leading to positive social and personal outcomes like improved relationships, increased reciprocity, and reduced distress. In both a behavioral and fMRI experiment, participants played a game in which they received pain stimulation. An anonymous partner either intentionally or unintentionally (via computer program) alleviated part of their pain. Participants then evaluated their pain intensity (behavioral experiment) or allocated money to the partner (fMRI experiment).

Intentional help, compared to unintentional help, resulted in less pain, higher reciprocity, and greater interpersonal closeness. fMRI results showed that, in response to intentional help, the ventromedial prefrontal cortex (vmPFC), a value-related area, showed the highest activation, while areas like the primary sensory cortex and anterior insula exhibited lower activation during pain delivery. vmPFC activation predicted reciprocal behavior, while posterior cingulate cortex (PCC) activation correlated with self-reported gratitude. Additionally, multivariate pattern analysis (MVPA) revealed that activation in the septum/hypothalamus, linked to social bonding, and value-related structures differentiated intentional from unintentional help conditions [5]. Saunders et al. [6] explored whether gratitude could enhance self-regulation, specifically in neural performance monitoring and conflict-driven self-control, by reducing impulsivity in decision-making. In their study, 61 participants were randomly assigned to either a gratitude or happiness condition and completed a pre-induction flanker task. They then recalled an autobiographical event in which they had felt either grateful or happy, followed by a post-induction flanker task. Despite following established protocols, participants in the gratitude condition did not report higher levels of gratefulness compared to the happiness group. Furthermore, there was no significant link between gratitude—whether measured by experimental condition or as a continuous predictor—and any control metrics, including flanker interference, post-error adjustments, or neural monitoring (error-related negativity, ERN). These findings suggest that while gratitude may influence economic patience, it does not appear to generalize to conflict-driven self-control processes [6].

Algoe and Way [7] examined the role of oxytocin in fostering close social bonds, particularly through social interactions involving expressed gratitude in romantic relationships. They hypothesized that these interactions would be linked to variation in the CD38 gene, which influences oxytocin secretion. Their research found that a polymorphism (rs6449182) affecting CD38 expression was significantly associated with global relationship satisfaction, perceived partner responsiveness, and positive emotions, especially love, following lab-based interactions. This polymorphism was also linked to observed expressions of gratitude toward a romantic partner in the lab and the frequency of gratitude expressions in daily life. Additionally, a separate polymorphism in CD38 (rs3796863), previously associated with plasma oxytocin levels and social engagement, was related to perceived responsiveness from the benefactor after expressing gratitude. The combined effects of these two polymorphisms were associated with various gratitude-related behaviors and feelings, suggesting that the oxytocin system plays a key role in strengthening the emotional bonds that form meaningful relationships [7]. Hazlett et al. [8] investigated whether gratitude activates a neural 'caregiving system' (e.g., ventral striatum (VS), septal area (SA)) that may downregulate threat responses (e.g., amygdala) and potentially reduce cellular inflammatory responses linked to health. They found no significant differences between the gratitude and control intervention groups in neural responses (VS, SA, or amygdala) to the gratitude or threat tasks. However, across the entire sample, participants who showed larger increases in self-reported support-giving from pre- to post-intervention also exhibited greater reductions in amygdala reactivity following the gratitude task (compared to the control task). Additionally, those with larger reductions in amygdala reactivity showed greater reductions in the stimulated production of TNF-α and IL-6. Importantly, gratitude-related reductions in amygdala reactivity mediated the relationship between increases in support-giving and decreases in TNF-α production [8]. Gallagher et al. [9] explored the pathways linking gratitude to cardiovascular reactivity (CVR) in response to acute stress, with a focus on whether social support mediates this relationship. In their study, 178 healthy adults completed measures of trait gratitude and perceived social support, and participated in a standardized mental arithmetic and speech stress protocol. Their CVR (systolic and diastolic blood pressure [SBP, DBP], heart rate [HR], cardiac output [CO], and total peripheral resistance [TPR]) were monitored throughout the experiment. Results showed that gratitude was positively associated with SBP, DBP, and TPR reactivity, with higher gratitude linked to greater CVR. Social support was also positively associated with TPR during the math task. The association between gratitude and TPR was mediated by social support, but this effect was observed only in response to the math task, not the speech task. These findings suggest that CVR may be a potential mechanism explaining the link between gratitude and physical health [9]. Ginty, et al. [10] examined the relationship between gratitude, a specific type of positive affect, and physiological responses to acute psychological stress. In this study, 324 healthy participants (59.9% female, 67.0% Caucasian, 17.9% Hispanic) were assessed for both state and trait gratitude. State gratitude was measured at the start of the laboratory session using the Gratitude Adjective Checklist-Three Items, while trait gratitude was assessed with the Gratitude Questionnaire-Six Items. Participants' blood pressure and heart rate responses to an acute mental arithmetic task were recorded. After adjusting for baseline cardiovascular activity, body mass index, sex, depressive symptoms, task performance, and state positive affect, state gratitude was found to be associated with lower systolic blood pressure reactivity. However, no associations were found between trait gratitude and cardiovascular variables. These results support previous research indicating that state gratitude, rather than trait gratitude, is linked to cardiovascular stress reactivity, suggesting that higher levels of state gratitude before a stressful event may offer a protective effect [10]. Leavy, et al. [11] explored the relationship between trait gratitude and the risk of acute myocardial infarction, focusing on the potential role of gratitude in regulating cardiovascular responses to stress, which may reduce the incidence of cardiovascular diseases. Despite the growing body of literature on gratitude's effects, no prior research had specifically examined its influence on acute myocardial infarction. Using logistic parallel mediation models, the study found that trait gratitude was significantly associated with a reduced risk of acute myocardial infarction, mediated by increased heart rate reactivity ($\beta = -0.098$, 95% CI [-0.331, -0.010]). However, neither systolic nor diastolic blood pressure reactivity mediated this relationship [11].

Discussion and Future Perspectives

This review explores the evolving understanding of gratitude's impact on well-being, emphasizing its role in neural, physiological, and social processes. Gratitude activates specific brain regions associated with moral cognition, empathy, and reward systems, suggesting a distinct neural signature. Studies have shown that gratitude interventions, such as journaling, can enhance neural sensitivity to gratitude, potentially leading to long-term benefits. Additionally, gratitude promotes altruism and strengthens social bonds, with evidence pointing to improved interpersonal relationships and increased support-giving. However, not all studies find consistent effects, with some, like Saunders et al. [6], failing to show significant links between gratitude and self-control, and Hazlett et al. [8] finding no direct impact on threat-related neural responses.

In terms of physical health, gratitude appears to have a protective effect against stress, particularly cardiovascular diseases. State gratitude has been linked to reduced cardiovascular reactivity to acute stress, suggesting that it may buffer against stress-related health issues. However, the precise mechanisms through which gratitude influences these responses remain unclear. Future research should explore the long-term effects of gratitude practices, examine its influence across diverse cultural contexts, and integrate findings from neuroscience, psychology, and physiology to develop a more comprehensive understanding of its benefits. This could ultimately lead to interventions that harness gratitude to improve mental and physical health outcomes.

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