



Short communication

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Gratitude and Brain: Representation and Integration

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At a conference held in 2013, the Benedictine monk David Steinndl-Rast spoke to the speakers about a new era of changes in consciousness, in which certain people would be able to experience shared happiness and build a better world. In this event, the word gratitude was used frequently. How does the central nervous system react to gratitude? What are the metabolic, neurochemical and neurophysiological changes when gratitude is offered or received? [1] In the central nervous system it is like a dynamic and "archaic" system of levers or pieces of a domino; where a simple act of gratitude causes cascades of neurotransmitters in distinct regions associated with reward and pleasure. Gratitude can be considered a typical socio-moral emotion in the maintenance of human cooperative interpersonal relationships. Researchers, through Functional Magnetic Resonance, seek answers in social interactive tasks inherent to human beings, with the cost to the benefactor and benefit to the receiver of the feeling. Alterations related to the recipient subject's neural plasticity were found in regions susceptible to reward, such as, for example, the ventral striatum; in the case of the benefactor, regions associated with mentalization (eg temporoparietal junction).

Gratitude was represented in the perigenual anterior cingulate cortex (pgACC), whose marking of triggering and signaling poten-

tials were proportional to individual gestures and effects. pgACC seems to be the main region of integration and generation of this feeling. In addition, such an area is capable of "tracking" the "levels of gratitude" when two individuals try to apply it (a receiver and another giver). More modern studies already promote results aiming at an explanation, at least, neural "mechanistic" of gratitude [2].

Few studies have analyzed the relationship between gratitude and injustice (moral violation), as well as the volatile feelings that are associated with such feelings. An interesting research, conducted through Functional Magnetic Resonance techniques, investigated participants receptive to voluntary help (gratitude group) or involuntary help (control group); beyond the process of punishing the injustice of their benefactors. The results were disappointing that the (gratitude) group was less punitive towards their benefactors compared to the control. It came to our attention that the results of self-reporting and computational modeling played a crucial role for the "trend of increased protection" on behalf of benefactors in gratitude-induced injustice. Regions associated with mentalization (temporoparietal) and reward (ventral medial prefrontal cortex) differed between groups and were related to gratitude-induced injustice. Grateful individuals are more concerned and value the chances of interacting with benefactors, refrain from actions that

disturb the building of relationships, consequently exercising less punishment on the injustice of benefactors [3].

Being grateful reduces the chances of social isolation and depression, risk factors to remain. Is there a relationship between gratitude and cognition? Some underlying neurobiological mechanism? Researchers used cross-sectional data from the Neuron to Environmental Impact through Generations (NEIGE) - 2017 study. The survey consisted of community-dwelling elderly aged ≥ 65 years ($n = 478$). Screening test by Mini-Mental State Examination (MMSE) was performed. "Levels" of gratitude were scored using the Gratitude Questionnaire. The volumes of acoustic regions associated with emotional processes and social interaction were sounded by functional magnetic resonance imaging. Linear regression models and distress models sought to associate levels of gratitude, brain volume and cognitive function. The mean gratitude score was 6.3 ($SD=0.9$) and the mean MMSE score was 27.1 ($SD=2.5$). Regression analysis showed that high levels of gratitude were associated with better cognitive function, adjusted for age, gender, education, marital status, and depression. Higher levels of gratitude were associated with larger amygdala (right) and fusiform gyrus (left) volumes. Analysis of the structural projection model showed that amygdala volumes mediated the association between gratitude and cognitive function. Memory [4].

Gratitude is one of the pillars of our little ethics, a probable gesture of recognition of our relationship with others in this uni-

verse. To be grateful is to be humble. Let's be more grateful. Being grateful promotes numerous neurochemical changes in different neurotransmitters and topographies - leading to our thinking being more harmonious with others and generous with ourselves.

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Conflict of Interest

No Conflict of interest.

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