# A classical approach towards understanding altruism in humans and animals along with reviewing theories emphasizing genetic, neural, social and endocrinal basis of altruistic behavior.

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**Abstract**
The aim of this paper is to investigate and review the research literature in the field of psychological and ethological sciences based upon altruistic behaviour emphasizing its molecular, neuro-endocrionological aspects responsible for its execution in humans and animals. The regions of the brains involved were thoroughly studied about. Also, I am going to review the research based upon various social experiments and molecular biology studies of responses and change in genetic makeup of an altruistic individual as to bring out what brought back such changes and hence sets apart the giving nature. In this paper, I also examined how altruistic behavior helps during uncomfortable situations referring to behavioral and neural evidence that by acting altruistically, painful feelings can be relieved in human performers. The positive altruism has also been referred along with an overview of positive psychology, which is the scientific study of well-being and optimal human functioning. The results and findings of this paper will shed light on the psychological and biological mechanisms underlying human pro-social behavior and provide practical insights into pain management as well.

Keywords: Altruism, Ethology, Positive altruism, Psychology, genes, sacrifice, gene mapping, cortex, NaCC, ACC, COMT.

## INTRODUCTION

In psychological research, altruism is conceptualized as a motivational state that a person possesses with the goal of increasing the welfare of another person. [1] Altruism is a social and interpersonal construct related to various types of pro-social behavior. While its definition varies depending on the discipline, altruism is often defined as an action that is done with the intention of helping another. In essence, biologists and evolutionary scientists often focus on the benefit of a particular behavior while psychologists are interested in understanding the motivation behind the behavior. From a biological or evolutionary perspective, altruism is a behavior that decreases the fitness or genetic contribution of one individual while increasing the fitness of another. [2] Altruism and related constructs such as cooperation and reciprocity are mostly viewed as uniquely human traits. [3] Other species have also shown some aspects of these constructs; for example, elephants will give support to other elephants who are too weak to stand or who are emotionally distressed [4]; monkeys will refuse food when they learn that by taking the food, a shock will be delivered to another monkey [5]; Dolphins have been reported to help other dolphins who have been caught in nets. [6] Previous behavioral research suggests that humans willingly interact with strangers in ways that are beneficial to others, even when it is not in their own best interest. [7] Fehr and Fischbacher suggest that if two strangers are allowed to engage in repeated anonymous monetary exchanges in the laboratory, there exists a high probability that altruistic behavior will spontaneously emerge. [3] Humans have been reported to continue to engage in altruistic behaviors even in situations when there will be no future interaction. [8] Some studies have proven that altruistic behaviour observed by children and infants develop further and show up in adulthood as well, for example, in humans, there is

evidence that infants exhibit altruistic behavior beginning at a young age. Infants as young as 14–18 months of age assist others in obtaining out-of-reach objects and help to open cabinets for others. Infants engage in these behaviors without reward or encouragement from an adult and expectedly without knowledge of concepts such as reciprocation and reputation as suggested by Warneken and Tomasello. [9]
Research suggests that individuals engaged in altruistic behaviors also benefit; there are several studies which show the physical and psychological benefits of altruistic behaviour. Hunter and Linn demonstrated that when compared to those who did not volunteer; older adults who volunteered regularly showed greater satisfaction in life and exhibited reduced rates of depression and anxiety. [10] Volunteerism is positively correlated with self-reported happiness, health, and well-being. [11] Volunteerism is positively correlated with self-reported happiness, health, and well-being. [10] In a study of adults over 55 years of age, individuals were 63% less likely to die if they had volunteered for multiple groups in a given time point. Even after controlling for health status prior to the study, volunteering was associated with a significant reduction (44%) in mortality. [12] Moen et al showed that mothers who belonged to a volunteer group were less likely to experience a major illness. [13] Hence, these studies and theories show that the act of giving to others without benefiting from it or the act of kindness add up to the well- being of the giver.

**Altruistic studies and social experiments performed in the past:**

A study by Otake et al asked participants to count the number of acts of kindness they performed for one week. The experimental data were compared with a control condition that did not partake in the "counting kindness" task. Results indicated that counting acts of kindness significantly increased self-reported levels of happiness. Together, these studies suggest that altruistic behaviors not only benefit others but also have profound positive effects on the current and future physical and psychological well-being of the person performing the behavior.[14]
In a study completed by Fehr et al, participants played a public goods game (PGG) with two conditions. One condition allowed another person to punish those who did not play fairly while the other condition did not allow punishment. Specifically, at the end of each round, each participant could pay to allocate a punishment, ranging from 1 to 10 points, to the member being punished. Each point would cost the participant 1 monetary unit but would cost the punished participant 3 monetary units. The researchers found that in situations where altruistic punishment is a possibility, cooperation is more likely, but when altruistic punishment is not allowed, the rate of cooperation is greatly reduced. [7]
There is evidence that during in-group situations, rewarding and punishing others based on social norms results in cooperation, These effects of punishing can translate to future encounters where previously punished individuals increase cooperation with new partners. [7]
The Altruistic Personality Scale [15] measures altruistic tendencies by gauging the frequency that a person engages in pro-social behaviors. Altruistic behavior in the workplace, which involves actions by an organization's employees who are meant to help others but are not formally rewarded, [16], has been studied using the Citizenship Behavior Scale and the Helping Behavior Scale. [17]
Another way to measure altruism is through the Big Five Model of Personality. Specifically, the altruism facet within the global trait of Agreeableness on the NEO Personality Inventory is often used to assess altruistic tendencies. Additionally, economic and neuro-economic studies tend to utilize behavioral measures of altruism because they are readily available, easy to use, and have been shown to be reliable for measuring altruism. [18]
Evolutionary theorists such as Sober and Wilson have argued that we should revise Neo-Darwininian evolutionary theory. They argue that human altruism evolved through group selection in which groups of altruists were naturally selected because they had a comparative advantage over other groups. [19]
Neuroimaging studies reveal that altruistic behavior activates brain regions that are associated with cognitive and emotional empathy and reward processing [36]; [37]. Engaging in altruistic behavior stimulates the feel good hormones of the brain: dopamine, oxytocin and serotonin. [38]
The evolution of altruistic cooperative behavior—in which an organism's action reduces its fitness and increases the fitness of another organism (e.g. by sharing food) only makes sense when it is directed at

genetically related organisms or when one can expect the favor to be returned. The first kind of altruism is referred to as 'kin altruism' and was elucidated by Fisher [20] Haldane [21] and Hamilton [22] who understood that the altruistic organism was in fact increasing its evolutionary success since it was helping genetically related organisms. The second kind of altruism is known as 'reciprocal altruism' and was elucidated by Trivers [23] who understood that the altruistic organism was in fact behaving in an 'enlightened' self-interested way since it could expect the favor to be returned in the future. [24] Hence, Robert Trivers [23] elucidated the concept of reciprocal altruism and showed that it is 'enlightened self-interest'.

Humans often behave altruistically towards strangers with no chance of reciprocation. Many people donate blood and funds for the benefit of people they will never meet and often do so anonymously. In experimental settings, people often cooperate with strangers in one-shot prisoner's dilemma's (in which 'defecting' always yields a higher individual payoff) and offer something rather than nothing in dictator games to strangers (when they could have kept everything for themselves) [25], [26]; [27]; [28]; [29]. Many people are also willing to incur costs to punish those who have harmed the group or others. This too is altruistic behavior. [28] The interaction between cultural and genetic evolutionary processes is referred to as 'gene-culture co-evolution' by Boyd and Richerson. [30]

Reasoning about morality can lead to behavior and moral norms that are far-removed from the behavior for which our moral psychology evolved. Peter Singer [31] refers to this as "escalator of reason." Altruism towards strangers with no chance of reciprocation in the absence of any social expectation or potential reputation gain—such as anonymous charity donations, anonymous (and unadvertised) blood donations, cooperating in anonymous single shot prisoner dilemma's with strangers and anonymous fair offerings in dictator games—is an instance of such behavior. These moral actions are not merely the output of hardwired psychological dispositions (which explains why many people do not engage in these altruistic acts). They often involve moral reasoning. Interestingly in this regard, a study has brought to light that altruistic behavior correlates with level of education. [32] The authors of the study surmise that people who benefited from a higher level of education might be better at internalizing pro-social norms. I would add that people who benefited from a higher level of education might also be better trained in reasoning about moral issues and reflecting on their moral behavior.

Reasoning processes—which are content-free—will not lead to moral behavior by themselves. They must latch onto 'moral' and 'altruistic' psychological dispositions such as a sense of fairness [33] and empathy.

Fisher [20] and Haldane [21] were the first to formalize this process of 'kin selection'. It explains most instances of altruistic animal behavior, including its most extreme manifestations such as the sacrificing behavior of eusocial insects likes bees and ants for the hives and colonies (of genetically related organisms) they belong to. Later, Hamilton [22] developed and formalized the concept of 'inclusive fitness'.

**Psychological V/s Biological Altruism:**

Psychological altruism is solely concerned with motives. It refers to the desire to benefit another. Biological (or evolutionary) altruism, on the other hand, is solely concerned with acts. It refers to acts that increase the fitness (the chances of survival and reproduction) of the recipient and decrease the fitness of the actor. The desire to share a candy bar is a matter of psychological altruism, while the act of sharing food qualifies as biological altruism [19]; [34]; [35].

**Positive altruism:** [39]

Positive altruism is a positive intervention because it strengthens both hedonic and eudaimonic well-being; it cultivates positive emotions, behaviors, and thoughts; and it can build strengths (e.g. kindness, love, teamwork) and well-being over time. The link between altruism behavior, positive emotions, and increased human functioning supports this. [39]

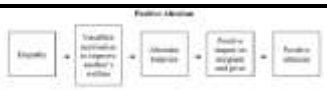

Fig 1.1.The screen grab from Anna S. Irani; Positive Altruism: Helping that Benefits Both the Recipient and Giver; 2018.

**Altruism in the brain:**

According to Filkowski MM, [40] Key structures that may be involved during altruistic decision making and subsequent altruistic behavior include regions within the mentalizing network such as the medial prefrontal cortex (mPFC) and temporoparietal junction (TPJ), reward regions including the ventral tegmental area (VTA), striatum, specifically the nucleus accumbens (NaCC), and anterior cingulate cortex (ACC), and regions of the emotional salience network including the dorsolateral prefrontal cortex (DLPFC), insula, and amygdale. [40]

(Refer to Fig.1.2.)

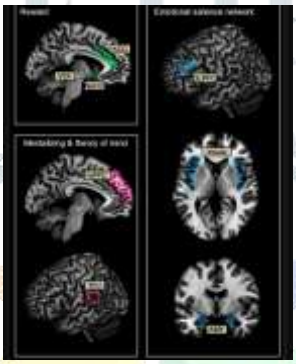

Fig.1.2. The screen grab from Filkowski MM et al 2016; Altruistic behavior: mapping responses in the brain.

Description of Fig.1.2. Schematic representation of brain networks associated with reward (green), mentalizing and theory of mind (pink), and emotional salience (blue) thought to be involved in altruistic behavior.

Abbreviations: AMY, amygdala; ACC, anterior cingulate cortex; DLPFC, dorsolateral prefrontal cortex; mPFC, medial prefrontal cortex; NaCC, nucleus accumbens; TPJ, temporoparietal junction; VTA, ventral tegmental area. [40]

According to an article submitted on “Altruistic behavior: mapping responses in the brain.” Brain regions within the mentalizing/theory of mind (ToM) network may be involved in altruism behavior. The mPFC is involved in reputation processing, [41] mentalizing, and in self-referential processing, specifically, determining boundaries between the self and others.[42] The mPFC is also associated with emotion processing[43][44] and ToM. [45];[46] The combination of evaluation of others versus the self, ToM, and reputation processing makes the mPFC an important candidate in altruistic behavior and decision making. Also part of the mentalizing network, the TPJ is involved in ToM[47]; [48] and perspective taking.[49]; [50] Together, activation in these regions is likely if individuals are actively engaged in thinking about not only the emotions and feelings of others but also about their own thoughts, feelings, and desired outcomes.

Brain regions those are associated with altruistic behavior: [51]; [52]
VTA. (Core reward processing region associated with pleasure.)
Striatum. ( " )
NaCC. (Associated with pleasure; Reputation processing.[53])
ACC. (Associated with reward processing, the pain and conflict monitoring [54] and emotional perception. [55]; [56]; anticipation of potential rewards. [57]; [58])

Anticipation of potential rewards, whether from external sources (eg, a better reputation) or internal sources (eg, the "warm glow" effect), may facilitate altruistic decisions. [36]

Regions involved in cognitive control and emotion processing: (involved in altruistic behaviour)
DLPFC. (Effortful regulation of attention and categorization of emotional stimuli.) [59];[60]
Amygdala. (Role in attention.) [61]
Insula. (Negative stimuli, in addition to interoceptive states.) [62]; [63]
Hippocampus.

**Genetic basis for altruism:**

It has been acknowledged repeatedly and widely that there exist individual differences in altruistic behaviour. The question arises if altruism represents a trait with a strong genetic impact or if it is a learned behaviour influenced by upbringing, education and other environmental factors like, e.g. religiosity. [64] Findings from twin studies yield mean heritability estimates of about 0.50 for pro-social behaviors like empathy, cooperativeness and altruism indicating that nature and nurture have an equal impact on pro-social behaviour. These behavioral genetic studies mostly rely on self-report data: a twin study by Rushton et al. (1986) of 563 pairs of monozygous (MZ) and dizygous (DZ) twins, using an altruism and an emotional empathy scale, reported that 50% of the variance in altruism and empathy was due to genes and the other 50% to environmental factors. [64] However, not all studies in the literature are supportive for the claim that pro-social behaviour is highly heritable. Krueger et al. (2001) reported no genetic effect at all for altruism in a study on 170 pairs of MZ and 106 pairs of DZ males, although Krueger applied only a slightly modified version of the Self-Report-Altruism Scale used in the study by Rushton et al. (1986). Furthermore, Bouchard and Loehlin (2001) failed to find any evidence of genetic influence on self-assessed altruism. However in sum, the balance of evidence suggests a genetic effect on pro-social behaviors, especially on altruism. There is the prominent role of oxytocin and vasopressin for pro-social behaviors like attachment and pair bonding (Ebstein et al., 2010; Insel, 2010). First genetic association studies have successfully linked polymorphisms of the oxytocin receptor gene (OXTR) and the vasopressin 1a receptor gene (AVPR1A) to pro-social behaviors (Prichard et al., 2007; Israel et al., 2008, 2009; Lerer et al., 2008; Meyer-Lindenberg et al., 2008; Levin et al., 2009). However, the proportion of variance explained by these gene loci is rather low indicating the involvement of additional genetic variants in the expression of pro-social behaviour. The COMT Val158Met polymorphism is an interesting candidate polymorphism because this gene locus has turned out to be functional. Catechol-O-methyltransferase is an enzyme which plays a crucial role in the

metabolism of catecholamines by inactivating them in the synaptic cleft, mostly in the prefrontal cortex. A single nucleotide polymorphism (SNP), a G→A transition in codon 158 of the COMT gene located at the q11 band of human chromosome 22 (rs4680), results in 3- to 4-fold reduction in COMT enzyme activity by coding for the synthesis of the amino acid methionine (MET) instead of valine (VAL). Carriers of the Val/Val genotype have highest, carriers of the Met/Met genotype lowest and heterozygotes (Val/Met genotype) have intermediate levels of COMT activity (Lachman et al., 1996). The aim of the present study was to extend current knowledge of the molecular genetic basis of pro-social behaviors by investigating the potential role of the COMT Val158Met polymorphism for altruism. This was done in an experimental approach by studying human donation behaviour under conditions of high ecological validity. [64]

**Recent Studies and Experiments to study genetic basis of altruism:**

In the study, published in the journal Social Cognitive and Affective Neuroscience, German researchers took a saliva sample from 101 men and women, using the sample to extract DNA from the participants' cells. The researchers were focusing on the three variations of a gene called the COMT gene, which influences how certain neurotransmitters are activated in the brain. [65] After providing the saliva sample, the participants had to try to memorize a set of numbers and repeat them as accurately as possible; they received five Euros for completing this memory test. After the test, they could try to increase their reward by gambling with it. Finally, the participants were shown images that were taken from an ad for a charity: a picture of a little girl—named Lina, from Peru—and a bracelet she had knitted. The experimenters left the room and told the participants they could anonymously donate to the charity some or all of the money they'd earned, though the experimenters were actually able to keep track of how much money each person gave. (After the study ended, all money the participants chose to donate was in fact given to the charity.) [65] [64]
Results: The researchers discovered that people with either of two of the variations of the COMT gene (called the Val/Val and Val/Met variations) donated twice as much money to the charity as people with the other variation (called Met/Met), regardless of their gender. In fact, more than 20 percent of the people with the altruistic variations donated all of their money. In the general population, the number of people with the altruistic variations of the COMT gene varies by ethnicity. Among Caucasians, the ethnicity of all the participants in this particular study, roughly 75 percent carry one of the two altruistic variations: 25 percent carry the val/val, 50 percent carry the Val/met, and 25 percent carry the met/met variant. [65] [64]
Another study of altruism and sociality in humans have reported strong effects of oxytocin and vasopressin allelic variation, and experimental oxytocin administration, on a variety of altruistic social phenotypes [66] [67] These considerations suggest that genes affecting altruism in humans may be represented as the set of functional genetic variants that modulate oxytocin–vasopressin–dopaminergic neural and neuro-endocrine systems including AVPR1A, COMT, DRD4, DRD5, GABRB2 and OXTR. [68]

Examples of candidate genes underlying altruism in insects and humans: [68]

**Queen–worker caste differences:**

Uncharacterized loci- heritable variation for queen versus worker caste differentiation in various species of ants and bees[69][70]
Worker - allelic segregation at potentially just one X-linked locus affects royal versus worker caste differentiation in multiple species of subterranean termites[71]
Neofem2- expression of Neofem2 in dry wood termite queens is required for reproductive suppression of workers[72]

**Worker–worker interactions :**

OvA1–OvA4- quantitative trait loci that influence worker sterility and selfish reproduction in the European honeybee.[73]
Sting-1quantitative trait locus that influences selfless colony defence in Africanized worker honeybees.[74][75]
Thelytoky- allelic segregation at this locus influences development into queen-like versus altruistic worker castes in the Cape honeybee.[76]

**Human social groups:**

AVPR1a RS3 microsatellite repeat - amounts of money allocated to others in dictator game, and self-report measures of altruism.[77] [78]
COMT rs4680psychological-genetic test of altruistic donations to poor, anonymous children.[79]
DRD4, DRD5, IGF2 polymorphisms- self-report measures of selflessness, empathy and altruism.[80] [81]
GABRB2 rs187269- self-report measures of altruism; gene is subject to imprinting.[82]
OXTR SNPS, rs1042778, rs2254298- amounts of money allocated to others in dictator game.[81][83]

## RESULT AND DISCUSSION

The purpose of this research paper was to just classically approach the scientific, genetic, chemical, social and environmental basis for altruistic behavior. The results have been explained and discussed theoretically throughout the paper suggests the role of various parts of brain involved in executing altruistic behavior in animals as well as humans. The thorough review of past studies on altruistic behavior have shown NaCC, ACC, VTA and striatum are brain regions involved in showing altruism along with DLPFC, amygdala, insula and hippocampus are regions associated with cognitive and emotion processing. The altruistic research done by Ebstein and Insel shown the prominent role of oxytocin and vasopressin for pro-social behaviors like attachment and pair bonding. According to Prichard, First genetic association studies have successfully linked polymorphisms of the oxytocin receptor gene (OXTR) and the vasopressin 1a receptor gene (AVPR1A) to pro-social behaviors.
The group of researchers studying the genetic basis of altruism through a social experiment based upon donating nature discovered that people with either of two of the variations of the COMT gene (called the Val/Val and Val/Met variations) donated twice as much money to the charity as people with the other variation (called Met/Met), regardless of their gender. In fact, more than 20 percent of the people with the altruistic variations donated all of their money. In the general population, the number of people with the altruistic variations of the COMT gene varies by ethnicity. Among Caucasians, the ethnicity of all the participants in this particular study, roughly 75 percent carry one of the two altruistic variations: 25 percent carry the val/val, 50 percent carry the Val/met, and 25 percent carry the met/met variant. Also, the genes affecting altruism in humans may be represented as the set of functional genetic variants that modulate oxytocin–vasopressin–dopaminergic neural and neuro-endocrine systems including AVPR1A, COMT, DRD4, DRD5, GABRB2 and OXTR.

## CONCLUSION

Human altruism is exceptionally executed in the animal kingdom. The widespread (biological) altruism directed at non-kin, with no chance of reciprocation, has not been observed in any other species. There had been deep debates, criticized theories and the clash of viewpoints among researchers since the Darwinian times in regard to altruistic explanations. The human altruistic behavior is a ground for future potential research since there is a lot of confusion and doubt. In many cases, it is not always clear what exactly ‘group selection’ refers to and hence different scholars use it in different ways.

Evolved psychological dispositions, however, do not explain many instances of actual human altruistic behavior. Therefore, the actual aim of this paper was to complete extant scientific explanations of human altruism that have focused broadly on the molecular, neurological and chemical aspects of the human and animal altruistic behavior. In this paper, I also provided an overview of positive psychology, which is the scientific study of well-being and optimal human functioning. This paper explores altruism, which is behavior motivated by the unselfish goal of helping others. While some helping behavior can be motivated selfishly, other behavior can be altruistic. Positive altruism occurs when altruistic behavior increases the welfare of both the recipient and the giver. Research suggests that the source of altruism is empathy, which is an other-focused emotional response that is elicited by and congruent with the perceived welfare of another person.

This review also highlights the role of a network of brain regions associated with the tendency to make altruistic decisions. An open question for future research is how this evidence can translate to the benefit of actual people. For example, if a person realizes that their brain is well suited to be altruistic; would this serve as an additional motivation to behave altruistically? So, to infer this review, Altruism is defined as selfless concern for the welfare of others. However, there is a great debate in the literature if true altruism really exists (Fehr and Fischbacher, 2003). Pure altruism is giving without regard to reward or the benefits of recognition and need. People who doubt the existence of pure altruism argue that helping others is intrinsically rewarding for altruistic persons and therefore they are exercising their personal interest to benefit their own selves rather than others. In other words, helping others makes them feel good.

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