



NEUROPSYCHOLOGICAL CORRELATES OF PROSOCIAL BEHAVIOUR IN TYPICALLY DEVELOPING CHILDREN

Neuropsychology

A Gowtham*

Research Scholar, Department of Psychology, Bharathiar University, Coimbatore
*Corresponding Author

ABSTRACT

Prosocial behaviour is the indulgence of an individual in providing voluntary assistance to another individual in need. Empathy, altruism and perspective-taking are closely related concepts. Children and adolescents tend to exhibit varied forms of behaviour as they grow. Neuropsychology is the scientific study of the relationship between the brain and behaviour. Several regions of the brain are found to be responsible for performing prosocial behaviour even in children; some of them are the prefrontal cortex, limbic system, parietal lobe and middle temporal lobe. Psychometric testing, imaging, lesion studies and Stimulation techniques are some of the common methods of understanding the involvement of brain structures. This paper was intended to provide insight into the existing understanding of the brain structures involved by carefully reviewing the literature available and critically evaluating it. Future research directions were also provided.

KEYWORDS

Prosocial behaviour, prefrontal cortex, limbic system and empathy

1. INTRODUCTION

Prosocial behaviour involves voluntary actions that are intended to assist others. It can further be classified into three distinct types i.e. helping, sharing and comforting which are seen as reflective responses to negative states like need, distress and desire [1]. It is closely associated and shares a lot of similarities with other emotional and behavioural states such as altruism, empathy, perspective-taking, diffusion of responsibility, theory of mind etc. Empathy is more of an emotional and cognitive state whereas prosocial behaviour is purely action-oriented. Though these traits are commonly seen in adults, they tend to have a developmental path that begins at early childhood and continues till adolescence with every positive experience enhancing it further. Many factors play an important role in the development of prosocial behaviour such as physical health, family, environmental factors [2]. Very little is known about the impact of cognitive abilities or the kind of relationship they share with the helping attitude among children and adolescents.

Neuropsychology is the branch of psychology that deals with the relationship between the brain and behaviour. American Psychological Association (APA) defines Neuropsychology as "the branch of science that studies the physiological processes of the nervous system and relates them to behaviour and cognition, in terms both of their normal function and of the dysfunctional processes associated with brain damage". The field mainly focuses on the lateralization and the localization of the brain and recent advancements in the field emphasize studying neural plasticity and networking. Most of the voluntary behaviour and cognitive processes are moderated by the cerebral cortex which is essentially divided into four lobes i.e. frontal, temporal, parietal and occipital lobes.

Researchers and Scientists have tried to understand the prosocial behaviour in children by studying the neural pathways and brain regions involved in anti-social behaviour. For example, the development of social skills and behaviour depends majorly on the cognitive and developmental maturation of the brain. Do, McCormick and Telzer [3] examined the neural development patterns of prosocial behaviour from childhood to adolescence amongst the community children and found that several areas of the brain were involved in the development and sustenance of such behaviour but did not find major age differences.

2. Method of Review

The authors have used a narrative research review method to summarize the literature available on the current topic. The rationale for using this review design is because of the limited availability of resources, especially in the Indian context. Original literature in the form of articles in journals, books and short communications were the main source of data. Keywords such as prosocial behaviour, empathy, altruism, frontal lobe, neuropsychology, executive functioning, perspective taking, sharing and helping, parenting were used to search the relevant literature. Search engines such as Google Scholar, Pubmed, Science-direct and social networking sites like Researchgate were used to find the relevant data.

The inclusion criteria were mainly of studies about cognitive and Neuro-scientific aspects of prosocial behaviour (empathy, Perspective taking, helping, sharing, comforting and altruism) in typical individuals mostly children and adolescents. Studies involving clinical assessments using neuroscience techniques like lesion studies, experiments, neurophysiological methods and neuropsychological assessments, individual case series were also included in some of the variables whenever the studies available were limited.

3. Findings

i) Frontal lobe- Prefrontal cortex

The frontal lobe is located in the anterior part of the brain and occupies about 1/3 of the cerebral hemisphere (see Figure 1). It controls many functions such as memory, language expression, judgment, emotional expression and executive functions. Some of the important subdivisions of the frontal lobe are the Primary motor cortex, Prefrontal cortex, Broca's area and orbitofrontal cortex. The prefrontal cortex (PFC) plays a significant role in cognitive control functions such as attention, impulse control, memory and cognitive flexibility. Eslinger [4] found out the impact of early frontal lesions on the development of cognitive and emotional empathy, especially after the brain injury. The measures of cognitive flexibility were correlated with empathy scores concerning the different locations of the lesion. The relationship between cortical thickness and prosocial behaviour in a sample of 6- to 9-year-old typically developing children were also studied using whole-brain surface-based analyses.

Prosocial behaviour was found to be connected to a thicker cortex in a cluster that covers part of the left superior frontal and rostral middle frontal cortex [5]. Similar studies were also found in which the evidence suggests the involvement of the dorsolateral prefrontal cortex and inferior frontal gyri [6]. Evidence was also found in infancy development which shows the involvement of frontal cortical activation through EEG analysis while examining the helping and performing a task [7]. The role of the frontal lobe in the performance of prosocial behaviour among children and adolescents has been well understood with empirical evidence [4-7]. However, the functional aspects of frontal lobes i.e. executive functioning have a larger part to play in unfolding the neuropsychological aspects of prosocial behaviour.

ii) Executive functioning

Executive functioning (EF) is more of an umbrella term that is used for diverse higher-order mental functions such as attention, planning, working memory, self-regulation and initiation which are generally governed by prefrontal areas (PFC) of the frontal lobes [8]. Studies have found an association between executive functions and prosocial behaviour [9]. Traditionally, EF has been understood only from the cognitive point of view. Zelazo and Muller [10] paved the way for the affective component of EF signifying the role of emotion and motivation in determining EF. As a result, cool and hot EF emerged. Cool EF does not involve the emotional aspects. Some of them are working memory, cognitive flexibility, attention whereas hot EF includes affective components like decision making, theory of mind,

emotional regulation and empathy. This explains the close association between hot EFs and prosocial behaviour even in children. EF is more strongly related to the social outcomes at the beginning of childhood [11].

Attention

Attention is a cognitive process involving focusing on inner resources and a state of consciousness [12]. The process of attentional shifting enhances the prosocial behaviour of children while interacting with peers. A researcher had used the Children's Attentional Shifting Task (CAST) to assess the attentional shifting and latency sharing was also measured after the child experiences failure. The sample was 27 children with aggressive traits and 27 children with nonaggressive traits from first-grade boys and girls. Aggressive children were less able to moderate their behaviour especially after facing failure. Scores on CAST predicted about 31% of the variance in the latency scores [13].

Self-focus, Self-control and focused attention are more closely interlinked concepts [14, 15]. Someone who is paying more attention to himself may not be able to help others. The series of experiments conducted with the children [14] showcased the lack of an existing relationship between self-focus and helping behaviour.

Working memory

Working memory (WM) is the capacity of the brain to hold the information temporarily for reasoning, learning and storage. It has a limited capacity and has three components namely phonological loop, visual sketchpad and central executive. It is one of the Cool executive functions. An interesting study using the longitudinal study design found that prosocial behaviour may enhance the hot executive function but not the cool EF, especially WM. In turn, WM is correlated with later prosocial behaviour [16]. Emotional intelligence and executive functions especially WM were found to be good predictors of prosocial behaviour [17].

Overall, it is understood that though executive functions have a working relationship with prosocial behaviour, it is generally about the functions that are affective rather than cognitive. There is a dearth of research to understand the role of cognitive domains of EF in prosocial behaviour.

iii) Inhibitory Control

Inhibitory control is another higher-order cognitive ability that is controlled by PFC, caudate nucleus and sub-thalamic nucleus. It is the ability to suppress a prepotent response while pursuing a consciously selected goal. The underlying relationship between inhibitory control mechanisms and altruistic behaviour in children has been explored. 158 Chinese children in the age group of 3 to 11 years completed the Stroop test for inhibitory control and dictator game with an incentive for altruistic behaviour. 48 % of children wanted to share which is an essential aspect of altruism. However, no significant correlations were found between inhibitory control and altruistic sharing [18]. On a similar note [19], an earlier study also suggested the lack of significant association between the same.

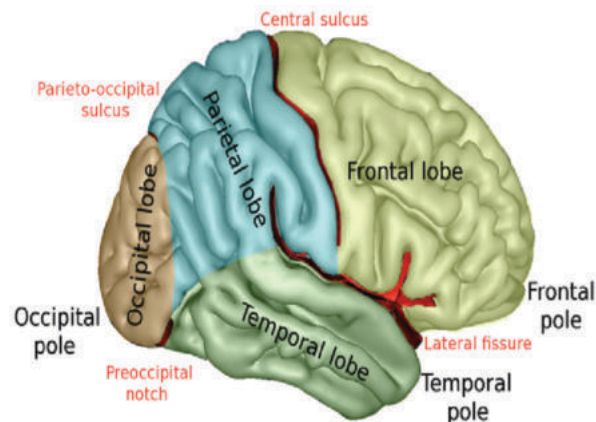


Figure 1 shows the lateral view of the divisions of the four lobes of the brain

Image licensed under Creative Common Attributions License by Sebastian023 (Free to use)

iv) Temporal lobe

The temporal lobe is located behind the ears in the temporal pole and looks after many functions such as language comprehension, memory, face and object recognition and some amount of visual perception among other functions (Fig. 1). The temporal lobe is further divided into superior, middle and inferior temporal lobes on both the right and left sides of the brain. The right Superior Temporal Sulcus (STS) was found to be linked with the congruency between action and the intention of the previous action indicating the role of the right temporal lobe in perceiving other's actions [20]. Perception of others actions is essential in performing prosocial behaviour. On the other hand, recall of scenes of helping an individual as well as imagining can also enhance the intent to help others. The medial temporal lobe and right temporoparietal junction are the regions involved in this phenomenon [21].

v) Parietal lobe

The parietal lobe is located in the upper back area of the skull. It is essential for the processing of somatosensory information received from the body (Fig. 1). It is divided into three parts namely the Post Central gyrus, inferior parietal lobule and superior parietal lobule on both right and left hemispheres. The inferior parietal lobule was found to be a contributor to prosocial behaviour in daily living [22]. fMRI studies show that the Inferior frontal gyrus and inferior parietal lobule are predictors of empathic concern and subsequent prosocial behaviour in adolescents [23].

vi) Limbic system

The limbic system is located beneath the cerebral cortex and is made up of several parts which are connected and perform important functions such as managing emotions, memory and the autonomic nervous system along with various other functions. The limbic system is more commonly associated with empathy since it deals with emotions [24]. Evidence suggests an involvement of the cingulate cortex, ventromedial prefrontal cortex and anterior insula in empathy through experimental study [22]. The Mirror neuron system which is closely associated with the limbic system is pivotal for empathy and maintaining interpersonal competence. Findings of a suggested strong evidence for amygdala and insula along with inferior frontal gyrus role in empathy [25]. As discussed in previous sections, the literature existing does not provide evidence with psychological measures of limbic system functions in understanding prosocial behaviour.

4. SUMMARY AND CONCLUSIONS

Understanding and helping others is one of the most desirable social behaviour. It helps an individual maintain good social relationship and gain a sense of satisfaction. It is crucial that these traits develop right from childhood and become part of the individual's personality trait. Hence, it is very relevant to comprehend and further postulate about the prosocial behaviour in children and adolescents. With this rationale, the review of existing literature was undertaken by the authors. Following inferences were drawn from the study.

- Prosocial behaviour is a large umbrella term that involves many affective and cognitive states such as empathy, perspective taking, helping, sharing, comforting, reflection of feelings, Theory of mind and so on. Consequently, restricting to understanding only behavioural aspects may not be sufficient to grasp the entire paradigm.
- Specific prosocial behaviour could not be correlated with specific brain regions and vice versa. Brain involves complex networking of neural circuits hence in most cases; more than one brain region is involved.
- Neuropsychological tests and tasks do not bring out the exact picture needed to understand prosocial behaviour. Studies like fMRI, imaging, lesion studies go a long way in showing the manifestations of involvement of brain structures.
- Clinical data and antisocial behavioural studies were more prevalent than the positive spectrum which was only included in the present review.
- Neuropsychological tests are time consuming and hence the sample size of most studies were well below N=50. Case reports were found to be more prevalent in the literature search.
- Other factors like parenting, schooling, peer group interactions, modeling could play a larger role in shaping the prosocial behaviour in children and adolescents which was not included in the present study.
- Lack of studies reflecting the cross-cultural aspects of

neuropsychology of prosocial behaviour. In countries like India, socio-cultural variables play a significant role.

5. Future directions

Future research could focus on collecting empirical data using mixed methods i.e. both quantitative and qualitative methods to form a holistic approach for determining the significance of cognitive components in prosocial behaviour. Efforts to include affective and environmental factors could help in better conceptualization than just cognitive aspects.

6. REFERENCES

- Dunfield KA. A construct divided: prosocial behavior as helping, sharing, and comforting subtypes. *Frontiers in Psychology*. Frontiers Media SA; 2014 Sep 2;5. Available from: <http://dx.doi.org/10.3389/fpsyg.2014.00958>
- King G, McDougall J, DeWit D, Hong S, Miller L, Offord D, Meyer K, LaPorta J. Pathways to children's academic performance and prosocial behaviour: Roles of physical health status, environmental, family, and child factors. *International Journal of Disability, Development and Education*. 2005 Dec 1;52(4):313-44.
- Do KT, McCormick EM, Telzer EH. The neural development of prosocial behaviour from childhood to adolescence. *Social Cognitive and Affective Neuroscience*. Oxford University Press (OUP); 2019 Jan 3;14(2):129-39. Available from: <http://dx.doi.org/10.1093/scan/nsy117>
- Eslinger PJ. Neurological and neuropsychological bases of empathy. *European neurology*. 1998;39(4):193-9. <https://doi.org/10.1159/00007933>
- Thijssen S, Wildeboer A, Muetzel RL, Bakermans-Kranenburg MJ, El Marrout H, Hofman A, Jaddoe VW, van der Lugt A, Verhulst FC, Tiemeier H, van IJzendoorn MH. Cortical thickness and prosocial behavior in school-age children: A population-based MRI study. *Social Neuroscience*. 2015 Nov 2;10(6):571-82.
- Dammes CK, Overbye K, Ferschmann L, Fjell AM, Walhovd KB, Blakemore SJ, Dumontheil I. Social perspective taking is associated with self-reported prosocial behavior and regional cortical thickness across adolescence. *Developmental psychology*. 2018 Sep;54(9):1745.
- Paulus M, Kühn-Popp N, Licata M, Sodian B, Meinhardt J. Neural correlates of prosocial behavior in infancy: different neurophysiological mechanisms support the emergence of helping and comforting. *Neuroimage*. 2013 Feb 1;66:522-30.
- Goldstein S, Naglieri JA. Executive functioning. *A Goldstein, Sam*. 2014.
- Riccio CA, Hewitt LL, Blake JJ. Relation of measures of executive function to aggressive behavior in children. *Applied neuropsychology*. 2011 Mar 14;18(1):1-0.
- Zelazo PD, Müller U. The balance beam in the balance: Reflections on rules, relational complexity, and developmental processes. *Journal of Experimental Child Psychology*. 2002 Apr 1;81(4):458-65.
- O'Toole SE. Cognitive predictors of aggression, prosocial behaviour and peer acceptance across early childhood: the role of cool and hot executive function and theory of mind (Doctoral dissertation, University of Greenwich).
- Cohen RA, Sparling-Cohen YA, O'Donnell BF. *The neuropsychology of attention*. New York: Plenum Press; 1993 Jan.
- Wilson BJ. The role of attentional processes in children's prosocial behavior with peers: Attention shifting and emotion. *Development and Psychopathology*. 2003 Jun;15(2):313-29.
- Gibbons FX, Wicklund RA. Self-focused attention and helping behavior. *Journal of personality and social psychology*. 1982 Sep;43(3):462.
- Kaplan S, De Young R. Toward a better understanding of prosocial behavior: The role of evolution and directed attention. *Behavioral and Brain Sciences*. 2002 Apr;25(2):263-4.
- Moriguchi Y, Shinohara I, Todo N, Meng X. Prosocial behavior is related to later executive function during early childhood: A longitudinal study. *European Journal of Developmental Psychology*. 2020 May 3;17(3):352-64.
- Espino-Díaz L, Fernández-Caminero G, Hernández-Lloret CM, González-González H, Álvarez-Castillo JL. Emotional Intelligence and Executive Functions in the Prediction of Prosocial Behavior in High School Students. *An Interdisciplinary Approach between Neuroscience and Education, Children*. 2021 Sep;8(9):759.
- Liu B, Huang Z, Xu G, Jin Y, Chen Y, Li X, Wang Q, Song S, Jing J. Altruistic sharing behavior in children: Role of theory of mind and inhibitory control. *Journal of experimental child psychology*. 2016 Jan 1;141:222-8. Available from <https://doi.org/10.1016/j.jecp.2015.09.010>
- Smith CE, Blake PR, Harris PL. Correction: I Should but I Won't: Why Young Children Endorse Norms of Fair Sharing but Do Not Follow Them. *Plos one*. 2013;8(8).
- Vander Wyk BC, Hudac CM, Carter EJ, Sobel DM, Pelphrey KA. Action understanding in the superior temporal sulcus region. *Psychological science*. 2009 Jun;20(6):771-7.
- Gaesser B, Hirschfeld-Kroen J, Wasserman EA, Horn M, Young L. A role for the medial temporal lobe subsystem in guiding prosociality: the effect of episodic processes on willingness to help others. *Social cognitive and affective neuroscience*. 2019 Apr;14(4):397-410.
- Morelli SA, Rameson LT, Lieberman MD. The neural components of empathy: predicting daily prosocial behavior. *Social cognitive and affective neuroscience*. 2014 Jan 1;9(1):39-47.
- Flournoy JC, Pfeifer JH, Moore WE, Tackman AM, Masten CL, Mazziotta JC, Iacoboni M, Dapretto M. Neural reactivity to emotional faces may mediate the relationship between childhood empathy and adolescent prosocial behavior. *Child development*. 2016 Nov;87(6):1691-702.
- Decety J, Bartal IB, Uzefovsky F, Knafo-Noam A. Empathy as a driver of prosocial behaviour: highly conserved neurobehavioural mechanisms across species. *Philosophical Transactions of the Royal Society B: Biological Sciences*. 2016 Jan 19;371(1686):20150077.
- Pfeifer JH, Iacoboni M, Mazziotta JC, Dapretto M. Mirroring others' emotions relates to empathy and interpersonal competence in children. *Neuroimage*. 2008 Feb 15;39(4):2076-85.