Viewpoint Paper

Prefrontal Cortex and Personality

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The frontal lobe is the first part of the brain to start developing and the last to stop developing in humans, according to phylogeny and ontogeny. It contains the control systems for the implementation of behaviours in relation to external and internal cues. These behaviours were previously collectively known as temporal functions and are now known as the executive functions. Apart from the executive functions, the frontal lobe is also primarily responsible for the processing of the working memory, abstract thinking, problem solving, attention and also plays an important role in the personality. An understanding of the functioning of the frontal lobe is crucial to understanding a vast majority of cognitive and non-cognitive behaviours that shape our personality.

Patients with frontal lobe lesions often do not display obvious disorders in their everyday behaviour and in fact tend to perform relatively well on most intelligence tests and memory tasks. The prefrontal cortex is contralateral and ipsilateral, thus a unilateral damage to the frontal lobe produce relatively mild deficits. Leonardo Bianchi (1922) [1], found that a bilateral damage in monkeys affected their goal driven behaviour. Although they responded and interacted with stimulus, there seemed to be a lack of understanding of the purpose of their actions. The case of Phineas Gage is a historical landmark in studying the prefrontal cortex. After a freak accident, the construction worker had a rod penetrate his skull that damaged his prefrontal cortex, bringing about a major change in his personality- displaying acts of extreme profanity, lack of planning and uncontrolled impulsivity. The difficulty to attempt to study the centralization of non-cognitive functions such as emotions and affect lies in the fact that these functions are difficult to measure quantifiably and the study of prefrontal lesions, although sheds some light on these functions, is also often times unreliable due to the irregularities of the lesion areas [1].

When studying the relation between the prefrontal cortex and the personality, it is important to understand how each of the sub regions of the prefrontal cortex play a role in various aspects of our personality: fMRI studies have shown an activation in the Orbito-prefrontal cortex in relation to extraversion- a trait associated with the ability to experience positive emotions in relation to rewards or expected rewards. Reduced volume of the medial prefrontal cortex (involved in processing, representing, and integrating social and affective information), has been found to be associated with Neuroticism. in the context of neuroimaging studies, empathy (an aspect of trait Agreeableness) has repeatedly been found to be associated with activity in the medial prefrontal cortex (mPFC).

Current neuroscientific models of personality suggest that the frontal cortex, and asymmetries in the frontal cortex, play an important role in the neurobiological foundation of broad dispositional traits. A study examined the neurological correlates of the frontal lobe and personality traits in chimpanzees [2]. They found that Chimpanzees rated as higher on Openness and Extraversion had greater bilateral grey matter volumes in the anterior cingulate cortex. Further, chimpanzee rated as higher on Dominance had larger grey volumes in the left anterior cingulate cortex and right Prefrontal Cortex (PFC). They also found that leftward versus rightward asymmetry in the frontal cortex was related to approach-avoidant temperaments in the primates. The Dominance trait and reactivity/impulsivity was associated with greater rightward asymmetries in the medial prefrontal cortex.

Animal studies serve as basis for understanding human neuropsychology as well. Animal models of chronic neuropathic pain suggest that subtle changes in the prefrontal cortex, such as altered basal dendrite length, leads to altered decision-making abilities. Researchers conducted a study using fMRI found that chronic neuropathic pain was associated with subtle anatomical changes in the medial prefrontal cortex,

anterior cingulate cortex and mediodorsal thalamus [3]. There was increased neural integrity in the medial prefrontal cortex for neuropathic pain patients, which was correlated to the personality temperament of novelty seeking.

Goal directed behaviour is primarily a function of the prefrontal cortex. The study by Bianchi, showed that when there were lesions in the prefrontal cortex, the monkeys showed difficulty in goal-oriented behaviour. This difficulty could also be the result of a deficit in the working memory. In the past, two types of studies have examined the task-oriented behaviour and working memory, these are: the delayed response tasks and the Wisconsin Card Sorting task. Goldman-Rakic (1992) used the delayed response task to study working memory in relation to the prefrontal lobe and found that those with prefrontal lobe lesions had difficulty on the task, thus affecting their working memory. Errors in this task imply that people with frontal lobe lesions tend to perseverate, that is, they tend to return to the same location. The Wisconsin Card sorting task explores the issue of perseveration. In the task involves two catches: first, the participant must explore the rules of sorting by themselves on the basis of the feedback provided by the experimenter in terms of correct or incorrect; second, the experimenter can change the rule of sorting without informing the participant. Thus, the task requires that the participant not only identify the correct rule for sorting but also should be flexible enough to discard a previously reinforced notion regarding a rule and discover a new rule to accomplish the task. Those with frontal lobe lesions perseverate [4].
This ability to be flexible to identify and implement new task goals is important in goal-oriented behaviour. In a recent study, they studied the effect of stress on 48 healthy volunteers who were challenged with a standardised stress-induction protocol (the Trier Social Stress Test) or underwent a standardised control situation [5]. Subsequently, they were exposed to a task-switching procedure with two tasks alternating in random order. Participants of the stress group displayed increased salivary activity immediately after stress exposure as well as elevations of salivary cortisol even after 10 min of discontinuing the stress condition, showing the typical stress-related activity increases in the sympathetic nervous system and the HPA axis. Stressed individuals persistently showed larger performance differences between task switches and task repetitions than control group. This effect was evident when tested 5–20 min as well as 25–40 min following treatment cessation. These results show that acute psychosocial stress can negatively affect of flexible task-goal implementation, which is essential for voluntary goal-directed behaviour.

Damage to the prefrontal cortex at an early age could also affect social and moral behaviour by creating difficulties in the comprehension of rules, impaired decision making and planning and insensitivity to the consequences of decisions. Researchers studied the long-term consequences of early prefrontal cortex lesions occurring before 16 months [6]. They studied two adults who had severely impaired social behaviour despite normal basic cognitive abilities, and showed insensitivity to future consequences of decisions, defective autonomic responses to punishment contingencies and failure to respond to behavioural interventions. What set them apart from adult-onset patients was that they even had defective social and moral reasoning, suggesting that the acquisition of complex social conventions and moral rules had been impaired. These behaviours, which were part of a syndrome caused by early prefrontal damage, were similar to psychopathic behaviour.

The ventromedial and anterior cingulate sectors of the prefrontal cortex play a role in social and affective decision making, which are affected in psychopathy. Researchers [7] found reduced gray matter volume in the lateral prefrontal cortex and orbitofrontal cortex in unsuccessful psychopaths, but not in successful psychopaths, as compared to non-psychopaths. They used cortical pattern matching to examine regional cortical thickness in a group of 27 psychopathic adult males to a group of 32 non-psychopathic males, and found that the psychopathic group had reduced cortical thickness in right lateral PFC, and to a lesser extent, in the right ventromedial prefrontal cortex and rostral anterior cingulate cortex (ACC) [8].
Scientists studied 29 patients with Borderline Personality Disorder (BPD), who showed active signs of self-harm. They studied the activation of the prefrontal cortex prior to beginning Dialectic Behaviour Therapy (DBT) and seven months after the treatment [8]. They found that those patients who had reduced their frequency of self-harm during the treatment phase, showed lower levels of neural activity in the bilateral

dorsolateral prefrontal cortex before the treatment and greater activity in the region after the treatment phase. This suggests that increased activity in the right dorsolateral prefrontal cortex is related to impulse control which is associated to reduced self-harm in BPD patients who are treated with DBT.

CONCLUSION

Based on past research and current research, it can be seen that the prefrontal cortex and its subregions play an important role in the development of the personality. The studies on patients with personality disorders tend to shed more light on the areas affecting personality, which are, the dorsolateral prefrontal cortex, the medial prefrontal cortex and the anterior cingulate cortex. The studies on healthy participants, sheds light on the impact of neural connectivity in these regions, on the everyday behaviour of an individual. These researches show how daily stress could also have an effect on the prefrontal cortex. In conclusion, the frontal cortex can be considered an important part of the brain for the development of the personality since it entails development of behaviours that shape of personality, including decision making, impulse control, goal-oriented behaviour, understanding of social constructs and rules and understanding of consequences of actions.

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