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The Ghost World of Liberals and Conservatives - September 2011

The Colin Firth Experiment

The neuroanatomy of political disposition

by Charles Brack

How did this academy award winner become a co-author on a paper in the new field of neuropolitics?

The deck is stacked against the fledgling science of neuropolitics, forever drawing the ire of most of the political spectrum. No one wants to believe that their political and religious beliefs are more about the way the brain works, and less about their ability to reason. Much less. In the face of such inhospitality, the field attracts quite an interesting and diverse cast of characters, one of which just won the Academy Award for his portrayal of King George in the movie, The King's Speech.

How an elite actor became mixed up in the world of neuropolitics is an interesting story. Colin Firth was the

son of a historian and leftest political activist. Following in his father's footsteps, Firth was drawn to liberal political activism early in his life. Exactly when Firth began his musings on the brain and political behavior is anybody's guess, but the strange alliance between the Liberal Democrat Nick Clegg and the Conservative Party in England did not sit very well with him.

Firth, as a bit of a joke, then commissioned a study on the brain, and declared:

> "I took this on as a fairly frivolous exercise: I just decided to find out what was biologically wrong with people who don't agree with me and see what scientists had to say about it and they actually came up with something".

Firth engaged the University College London Institute of Cognitive Neuroscience, and alumni Ryota Kanai and Geraint Rees. The result was a 2011 paper entitled: *Political Orientations Are Correlated with Brain Structure in Young Adults*. Of course, the "Young Adults" in this study were 90 students at the very same University College of London (55 females, 35 males), with an average age of 23.5 years. The problem with using students for subjects in political studies is that it is very hard to find ones that are very conservative.

Regardless, this study focused on neuroanatomy, which was a rather unusual tactic compared to the tradition of neuropolitical studies, which were based on physiology. This anatomical approach is due to the fact that Colin Firth put his money where his mouth was. Without Firth's financial backing, Kanai most likely would have continued the neurophysiological tradition, since neuroanatomical studies tend to be less convincing in their relationship to behavior. Indeed, Kanai tries to bridge this issue, and cites studies that correlate variations in anatomy to variations in physiology.

Further, the Firth experiment only deals with gray matter. The reason for the exclusion of white matter is not elucidated, and Kanai simply states: "We speculate that the association of gray matter volume of the amygdala and anterior cingulate cortex (ACC) with political attitudes that we observed may reflect emotional and cognitive traits of individuals that influence their inclination to certain political orientations". To date, Kanai has not responded to our question of the missing white matter, even though he cites a study linking repetitive training to white-matter architecture.

Regardless, the Firth experiment highlights variations in gray matter volume in four regions of the brain that correlate with political affiliation. Two of those regions, the anterior cingulate and amygdala, were described by Kanai as "regions of interest", or ROI. This categorization schema by Kanai appears to support two different approaches to correlating anatomy with political orientation.

Firstly, Kanai's "regions of interest" approach gave statistical precedence to the anterior cingulate and amygdala, which was based on Kanai's presumption that these two regions "had prior hypotheses" for being relevant to political disposition. Kanai's rationale might need some further explanation, in that there were indeed more than two regions associated with activation to politically relevant stimuli, such as the dorsolateral prefrontal cortex (Richeson, 2003) (Grafman, 2006) (Knoch,2006), (Kaplan, 2007), fusiform gyri and ventromedial prefrontal cortex (Grafman, 2006), caudate and nucleus accumbens (Harbaugh, 2007), orbital frontal cortex (Westen, 2006), and insula (implied by Wicker (2003), and Inbar (2009)).

However, Kanai might have "backed" into these regions of interest, since they returned a positive result. Of these other potential candidates, the insula is one of the more likely suspects, given the elevation in "disgust sensitivity" as noted by Inbar (2009), which is strongest in individuals with a high bias against gay marriage and abortion.

Kanai did note a strong correlation between gray matter volume of the left insula and conservatism (R =

0.42) in his whole-brain correlation analysis. However, Kanai's own statistics beg the question of some sort of experimental error inadvertently introduced into his analysis.

The role of the Anterior Cingulate Cortex in political disposition

Let's first discuss the findings with regards to Kanai's "regions of interest", which were the amygdala and anterior cingulate cortex. The anterior cingulate (ACC) has been noted to be activated many times in experiments associated with political disposition, including Grafman (2006), Kaplan (2007), Richeson (2003), Westen (2006), and Amodio (2007).

Of the various experiments implicating a role of the ACC, Kanai singles out Amodio's 2007 paper. To briefly review, Amodio tested the reaction times of conservatives and liberals as they were deliberately conditioned for a "Go" response to the letter "M" displayed on a computer screen, while intermittently requiring a "NoGo" response to an alternating "W". The liberals were elevated in registering "conflict" related neural activity, that is, the liberals were more responsive to the novel "NoGo" condition.

Further, this elevation correlated with the strength of liberalism. Curiously, Amodio did not report the laterality data, and based on our correspondence, was unaware of any hemispheric asymmetries in his own data. Kanai does not report it either. The missing laterality data from the Amodio experiment could be filled by Braver et al. (2001), as that experiment confirmed that "inhibition (i.e. No-go responses) identified an almost wholly right-lateralized network".

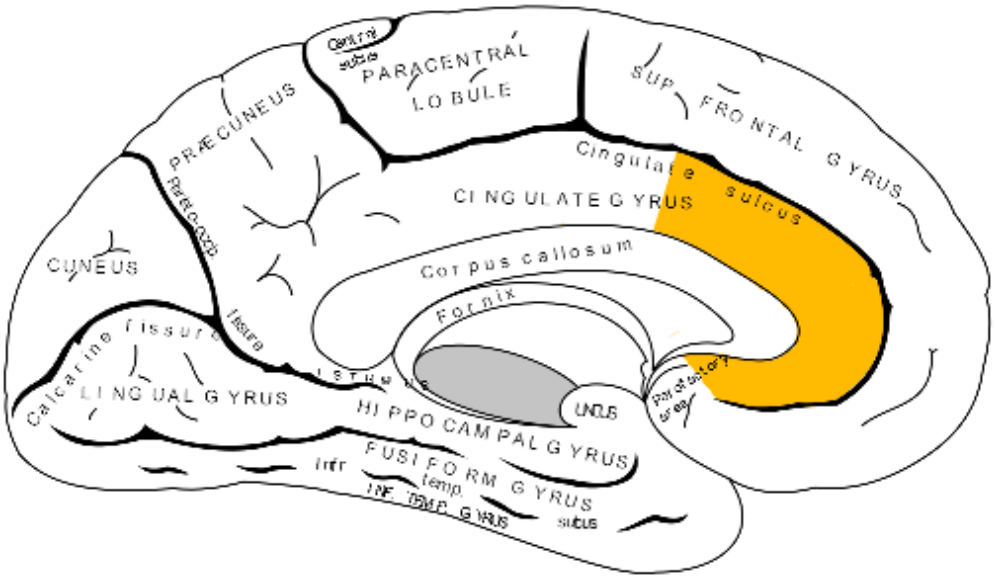
Also note that Kern et al. (2004) describes an exclusively right-sided network associated with response conflict and behavioral modulation: "the greatest adjustments in behavior following conflict were associated with increased activity in the dorsolateral PFC [right middle frontal gyrus, Brodmann areas (BAs) 9 and 8; Fig. 2C]. There was a second PFC region, in the right superior frontal gyrus (BAs 9 and 10), that was also more active on trials with the greatest post-conflict behavioral adjustments."

Further, Menon et al. (2001) noted that response inhibition is a predominately right hemispheric phenomenon, especially for the anterior cingulate cortex. In the same study, Menon also noted that response execution more prominently engages the left hemisphere. The predominance of the right hemisphere in response inhibition is noted by a meta-analysis of studies by Simmonds et al. (2008).

So the liberals were exhibiting a more rapid response to conflict than the conservatives, and further, this elevated response appears to be more likely organized by the right hemisphere. But this raises the question: why is the anterior cingulate cortex showing up so consistently in neurophysiological studies of political disposition?

Let's look at the location of the ACC, which just happens to surround the frontal corpus callosum, the major communication relay between the right and left cerebral hemispheres. This location may be hinting at a strategic function the ACC has in integrating the activities associated with the communication between the two hemispheres, in that the ACC provides the least transcallosal distance between neurons of any cortical area in the brain. Given this, we can certainly entertain the proposal that the ACC is the most directly connected cortical region with the opposite hemisphere via the corpus callosum.

To bolster this point of view, Alien hand syndrome, or the inability to control the random grasping of objects, can be caused by lesions in the anterior cingulate in the hemisphere contralateral to the alien hand (Hashimoto, 1998). This indicates that the ACC also facilitates the contralateral inhibition of motor responses.



Why is this region (in yellow) so active in neuropolitical experiments?

Interestingly, the ACC is one of the few regions in the brain where spindle neurons have been found. In humans, spindle neurons have been detected in the ACC and the fronto-insular cortex (spindle neurons are 30% more numerous in the fronto-insular cortex in the right hemisphere).

In 2008, Fajardo et al. detected spindle neurons in the dorsolateral prefrontal cortex in humans. Interestingly, like the ACC, the dorsolateral prefrontal cortex is also very active in human political disposition, and in particular, liberal political disposition (see Barack's Brain). Note that the coactivation of the ACC and dorsolateral PFC is robust across a wide range of cognitive tasks.

The role of spindle neurons is still the subject of much debate, however, their function has been linked to rapid decision making, also referred to as "intuition" (Allman, 2005). Further, Allman (2009) proposed that this arose in larger brains to permit fast information processing along "highly specific projections and that evolved in relation to emerging social behaviors".

The subgenual region of the ACC is an autonomic control center (e.g., blood pressure), and works to improve physiological responsiveness to emotionally salient stimuli. The social orientation of the ACC's spindle neurons may ultimately be adapted from their role in improving parental investment in offspring. Spindle neurons are activated by stimuli involving offspring emotional states, such as crying, which may have provided considerable evolutionary pressure for their increasing presence in the brain.

The highest density of dopamine innervation in the primate cerebral cortex is found in the ACC. The ACC is the main target area of the mesocortical dopamine system, which originates in the ventral tegmental area. In the human cortex, the highest density of dopamine fibers is found in the paralimbic ACC. A similar distribution is observed in the case of serotonin fibers, but at a much lower overall density.

Further, noradrenaline input from the locus coeruleus preferentially targets deep layers of the ACC, providing a complementary source of modulation of neural activity (Paus, 2001). Therefore, the ACC is a center of activity of the brain's monoamine transmitter systems, which have been proposed by Brack (2004) to be of particular relevance in human political cognition.

The role of the ACC in response conflict and "cognitive flexibility" seems to be politically relevant. Response conflict occurs when competing signals from different areas of the brain need to be resolved in the planning

of behavior. This is seen in Stroop testing (e.g,. this Youtube video). The midcingulate cortex, just immediately posterior to the ACC, connects reciprocally to the motor cortex and facilitates rapid changes in behavior, which correlates with cognitive flexibility.

The role of the ACC in "cognitive flexibility" is best seen in Stroop testing. Damage to the ACC seems to generally decrease reaction time in response selection, and both the aforementioned Amodio experiment and the Firth experiment implicate a greater role of the ACC in liberal political disposition.

However, the ACC is most likely not critical to political disposition. This viewpoint comes from the fact that religious disposition is not changed by removal of ACC. Given the fact that religious and political disposition are closely linked, this is an indicator of a relatively subordinate role of the ACC in political disposition. However, this remains to be seen.

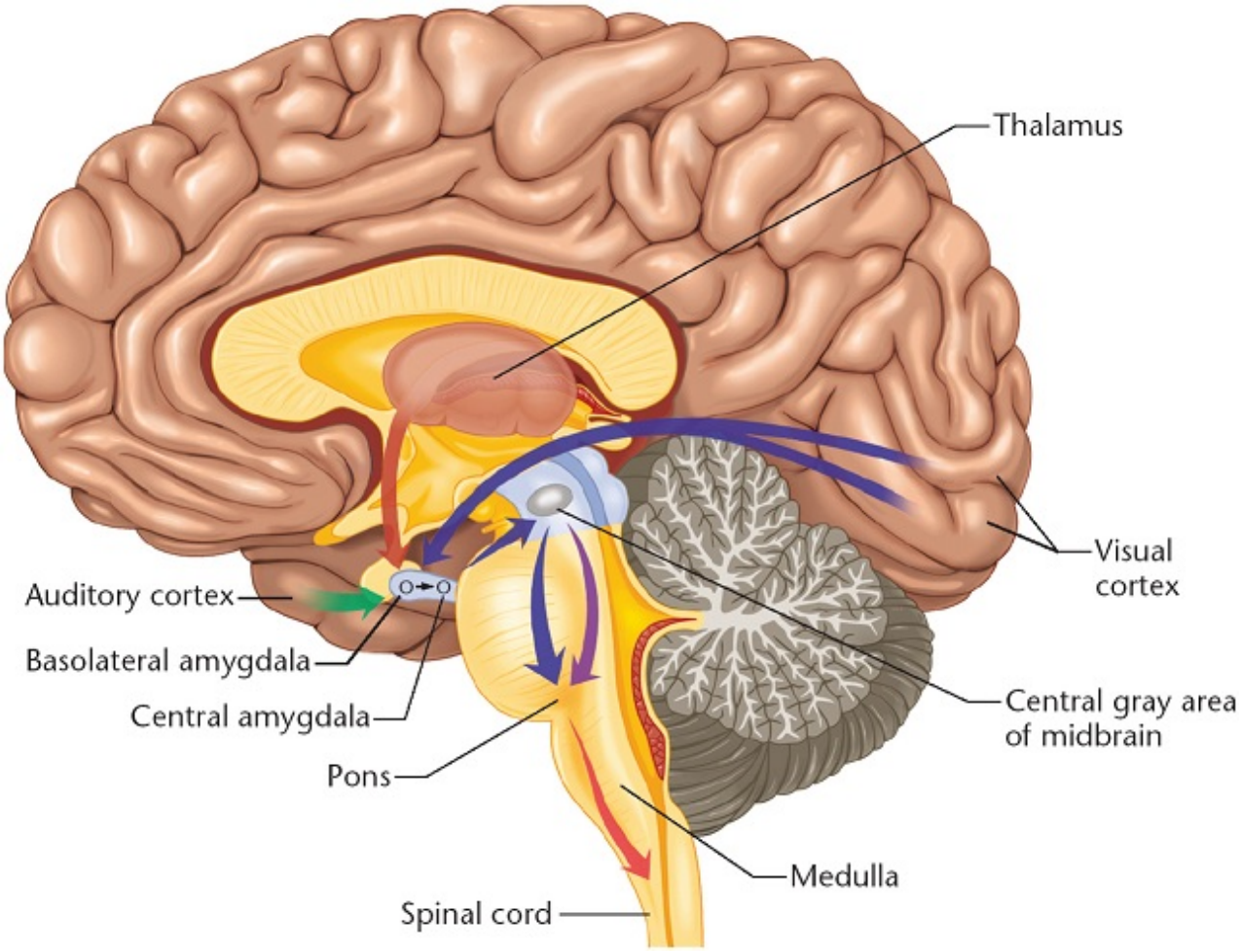
In our correspondence with Kanai, there appears to be little variation in the relative gray matter volumes in the right and left ACCs with political disposition, although total gray matter volume is enhanced in liberals. In private correspondence, Kanai indicated that the left ACC seemed to be relatively more enhanced in liberals than in the right, however, Kanai never officially reported laterality variations of the ACC.

Kanai et al. erroneously indicates a negative correlation of -2.71 (t=2.63) between ACC gray matter volume and his 5-point political scale (very liberal = 1, liberal = 2, moderate = 3, conservative = 4, and very conservative = 5). The correct correlation is -0.27, which was confirmed by Kanai in our correspondence. Further, Kanai did a follow up study on 28 additional subjects, and replicated the direction of the correlation -0.49 (t=2.87) of the ACC with liberalism.

However, this might imply some sort of experimental error in the initial and/or follow up studies, as these two correlation coefficients are statistically too far apart, given the t values. This issue also shows up in the other regions Kanai highlights as being correlated with political disposition.

The role of the Right Amygdala in political disposition

Remarkably, the amygdala has not been much of a player in the neurophysiological studies of religious and political disposition. Given its crucial role in emotional processing, it would seem to be at the forefront of political disposition. However, there are relatively few references to amygdalar activation in neuropolitical studies.



The basolateral amygdala has been linked to conditioned fear and disgust learning, while the central amygdala has been linked to conditioned fear learning. The Firth experiment did not differentiate gray matter volume between these regions

In 2004, Marco Iacoboni reported (in the layman's press) that the liberals had elevated amydalar responses to the viewing of a political commercial about nuclear war. In 2006, Grafman reported that activity in the left amygdala was correlated with the degree of affiliation towards one's political party and valence of one's beliefs. Also in 2006, Westen detected a rapidly habituating activation of the left amygdala when the subjects were exposed to "emotionally threatening information" about their preferred candidate.

So why this lack of reporting of amygdalar activation in the neuropolitical press? This is possibly due to the competition the amygdala engages with higher cortical regions. However, when it comes to neurophysiological studies on racism, the amygdala is firmly established as a key player. This should spill over into political disposition, given the correlation between racism and political disposition.

Hart et al. (2000) selected an equal number of blacks and whites, repeatedly showing them pictures of white and black faces while performing fMRI. They noted: "across all subjects, we observed significantly greater...BOLD signal in the amygdala to outgroup vs ingroup faces, but only during later stimulus presentations". In other words, when it came to the pictures of the other race, the subjects were still exhibiting bilateral amygdala activity after repeated presentations, while the same-race pictures were having no effect.

With the results from Hart, the amygdala had taken center stage in the study of neuroracism. The

amygdala-racism connection would gather steam with Phelps et al. (2000). There are several important findings from this experiment, which gave some subtle clues that regions in the brain were indeed competing with each other when it came to racial cognition.

Phelps found this out with the combination of three tests: the Implicit Association Test, Modern Racism Scale, and the Startle Eyeblink test. White subjects were found to be impaired in their reaction times in matching black faces with "good" words, although they reported pro-black racial beliefs on the Modern Racism Scale.

While the subjects were undoubtedly steering their responses to socially-acceptable racial attitudes, it is indeed the "steering" neural networks that were counteracting the amygdala's tendency towards facilitating racial bias. Further, Phelps found that activation in the left amygdala and right amygdala (all the way to the insular cortex) were correlated with a negative bias towards black faces on the Implicit Association Test.

However, the only region that was activated in both the Implicit Association and Startle Eyeblink tests was the left-superior amygdala. (Phelps employed a 2 second exposure to the pictures of sequentially alternating whites and blacks). Phelps noted: "the region in the amygdala most strongly correlated with negative evaluation [of black faces] was the left-superior amygdala".

Phelps did a similar experiment, this time using well-known famous black and white faces. The implicit association test results revealed a smaller gap between the famous white and black faces, with whites still being favored. In the Startle Eyeblink test, the famous white faces actually drew a higher startle response than the famous black faces. Further, there were no distinctive differences in the activation patterns of the amygdala to the famous white and black faces. The amygdala was being neutralized.

But by what? Richeson et al. (2003) performed an fMRI investigation of the impact of interracial contact on executive function, and uncovered a critical findings with regards to racial prejudice: it is inhibited by right hemispheric neural networks such as the dorsal lateral prefrontal cortex and anterior cingulate. Richeson's findings of a right-hemispheric network that inhibits racial prejudice shows the push-pull mechanism of the amygdala and the dorsolateral prefrontal cortex, especially on the right side.

In a related experiment, Cunningham et al. (2004) would clarify some of the confusion regarding the amygdala's role in racial prejudice. As opposed to the 2 second exposure period of black faces in the Phelp's experiment, Cunningham used two different exposure periods: an subconscious exposure of 30 milliseconds; and, a conscious exposure of 525 milliseconds.

During the subconscious exposure, which was not long enough for most of the subjects to even be aware of the black and white face photos, Cunningham found the right amygdala to be activated in the black minus white condition, which was in contrast to Phelp's finding that "the region in the amygdala most strongly correlated with negative evaluation [of black faces] was the left-superior amygdala". Perhaps Cunningham's rapid and subconscious presentation of the photos exposed the right amygdala's greater role in perceptual monitoring, along with implicating it in racial bias. Longer presentations of racial stimuli favor activation in the left amygdala, at least according to Phelps.

But with the 525 millisecond presentation, the amygdala's racial responsiveness was inhibited, meaning it didn't take very long for another area in the brain to assume control. And that region was located predominately in the right hemisphere, confirming the work of Richeson. Cunningham noted: "the regions Richeson et al. identified as underlying the control of prejudice were nearly identical to the regions identified in this study as being associated with modulation of automatic evaluations".

Thus, a right hemispheric network associated with the dorsal lateral prefrontal cortex (DLPFC) and anterior

cingulate (ACC) were dampening the reaction of the amygdala to race.

And this brings us to one of the key findings in the Firth experiment: conservatives had an enhanced right and left amygdala gray matter volumes, with a more statistically significant correlation with the right amygdala (0.23, t = -2.22) than with the left (0.15, t = -1.43).

Given the greater correlation with the right amygdala, this is possibly contrary evidence to the hemisphericity theory of political orientation (see Conservative Left Brain, Liberal Right Brain). But perhaps this elevation in the Conservative right amygdala is reducing the influence of the liberalistic right dorsolateral prefrontal cortex. Let's see how this might work.

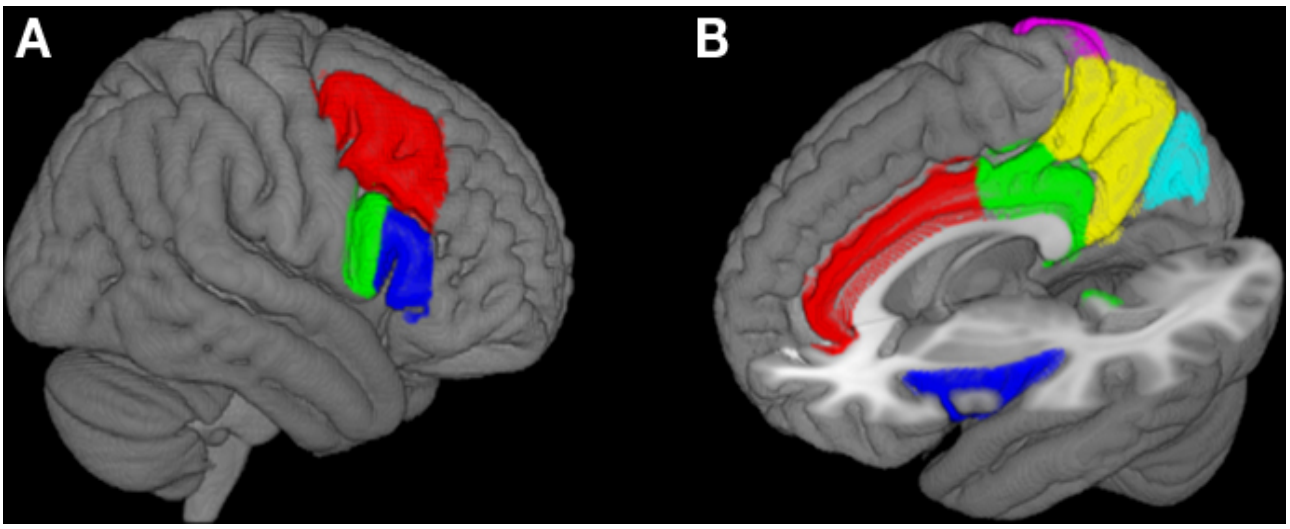
Of all the regions in the brain linked to liberalism, the right dorsolateral prefrontal cortex is, so far, the most obvious. The DLPFC has been implicated in a variety of key liberal attributes: inhibition of racist tendencies (Richeson, 2003); aversion to dominance (Grafman, 2006); and, aversion to inequality (Knoch, 2006). It is also closely linked to the anterior cingulate cortex, another hot spot of liberalism.

Interestingly, the right DLPFC has recently been the target of high frequency repetitive Transcranial Magnetic Stimulation (rTMS) by Vanderhasselt et al. (2011). Activation of the right DLPFC decreased, and activation increased in the right amygdala, along with "an attentional bias towards threatening information". Vanderhasselt noted: "the effects of a single placebo-controlled rTMS session of the right DLPFC is consistent with the effects of a disrupted prefrontal-amygdala circuitry".

Thus, the current neurophysiological evidence implicates a generally inhibitory relationship between the right DLPFC and right amygdala. This certainly counters the hemisphericity theory of political orientation. But before we give up on the hemisphericity theory, Kanai notes two other regions that support it.

The role of the Left Insula in political disposition

The lowest statistically significant correlation of conservatism noted by Kanai was with the right amygdala. The highest correlation (using Kanai's whole-brain analysis method) was with the left insula (0.42, t=4.32). Why the insula never made it to the cherry-picked sanctum of Kanai's "regions of interest" is certainly curious, especially in light of the Haidt (2007) and Inbar (2009) papers on the sensation of disgust and political conservatism.



The left insula (B, in blue) is close to another politically hot region, the anterior cingulate cortex (B, in red)

Interestingly, Inbar identified a positive correlation between "disgust sensitivity" and political conservatism. Further, those with higher ratings of disgust sensitivity were especially prone towards anti-abortionism and anti-gay marriage, both issues involving reproductive output. Amusingly, they were also prone towards a favorable opinion of tax cuts.

Contrary to Kanai's neuroanatomical findings with conservatism and the left insula, the neurophysiological evidence from Harbaugh (2007) regarding taxation and the brain indicates bilateral activation of the insula, highlighting the difficulties in the extrapolation of neuroanatomical findings to behavior (or neurophysiological findings, for that matter).

But what does disgust have to do with the insula, and in particular, the left insula? This brings us to Wicker's 2003 paper, *Both of us disgusted in My insula: The common neural basis of seeing and feeling disgust*, which is particularly relevant to the Firth Experiment. First with the amygdala, which Wicker found to be activated by both pleasant and disgusting stimuli, bilaterally.

Kanai's presumption that the amygdala-fear relationship is ignoring the possibility that disgust is also facilitated by the amygdala, and should also be considered as another possible explanation for the conservative-amygdalar link. (Interestingly, there is some evidence that the left insula is activated during the experience of impending threat).

One of the key results of Wicker was that while the insula were activated to pleasant and unpleasant stimuli bilaterally, the left insula was more specialized for disgust, which makes Kanai's results much more compelling in light of the relationship between enhanced disgust sensitivity and conservatism.

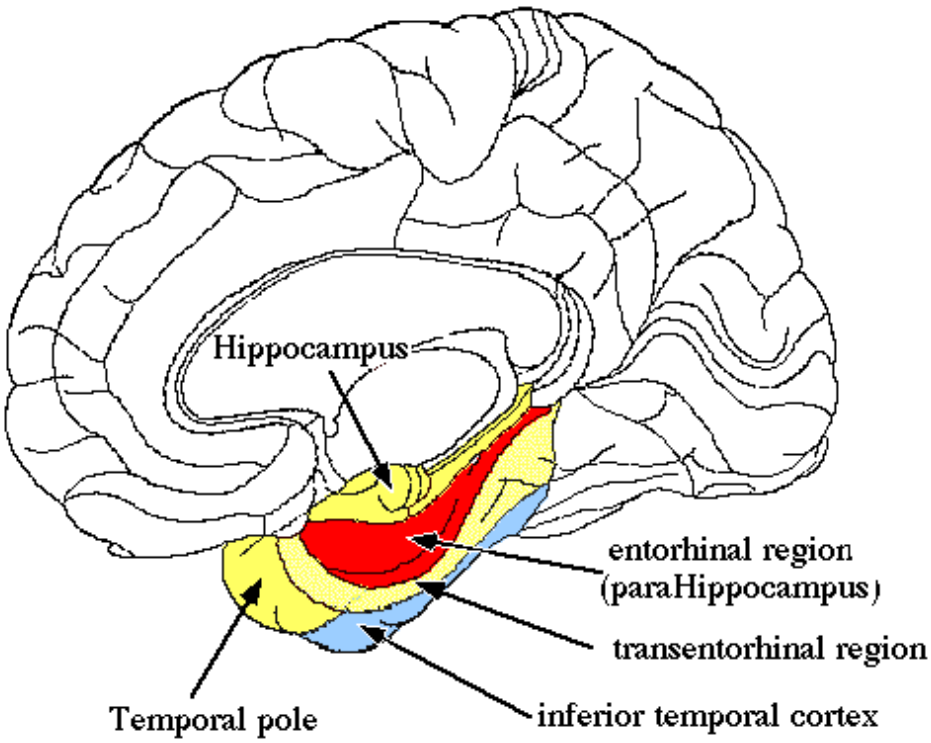
Also interesting was the participation of the anterior cingulate cortex in the sensation of disgust, thus making a slightly more complicated interpretation of Kanai's results along the lines of the conservatism-disgust link. The elevation of activity of the ACC to disgust is another neurophysiological finding out of congruence with Kanai's neuroanatomical link to liberalism.

The role of the Right Entorhinal Cortex in political disposition

There were a number of mistakes in Kanai's paper, one of which was previously discussed regarding the correlation coefficient associated with the ACC. Another mistake involves the reporting of the correlation coefficient of conservatism with the right entorhinal cortex.

Kanai first reports a negative correlation ($r = -0.368$, $t = 3.70$) between conservatism and gray matter volume in the right entorhinal cortex in his initial sample of 90 subjects. In his subsequent sample of 28 subjects, Kanai then reports a positive correlation of ($r = 0.606$, $t = -3.89$). So which is it, a negative or positive correlation?

We queried Kanai about this issue, and indeed, Kanai confirmed: "the last $R = 0.606$ should have been negative", indicating a strong negative correlation between conservatism and the gray matter volume of the right entorhinal cortex. In other words, the greater the propensity towards conservatism, the smaller the gray matter volume in the right entorhinal cortex.



The right entorhinal cortex (in red) tends to be depleted in conservatives

So what are the potential interpretations of a depletion of right entorhinal gray matter volume in conservatives? The entorhinal cortex is one of the more elusive regions of the brain as to how it might relate to political disposition. Studies of reduced right entorhinal gray matter volume implicate a role in memory loss and problems in episodic memory encoding, particularly visuospatial encoding.

This result might imply a greater disruption in memory encoding and retrieval in the right hemisphere of conservatives. Further, the entorhinal cortex seems to be conveying polysensory information to the hippocampus. This obviously raises the question: are the sensory worlds of conservatives and liberals the same? Perhaps not, but the results from the Firth Experiment are rather exciting, especially since they may implicate a slightly different sensory picture in the respective brains of liberals and conservatives.

Discussion

In comparison to neurophysiological studies, neuroanatomical studies indeed suffer in their ability to make inferences on neural function. Further, the Firth Experiment was a gray matter volume experiment, and did not incorporate white matter volume, which indeed may be politically relevant. The Firth Experiment was also low resolution, and did not report on the various substructures which are critical to making more appropriate functional inferences, such as resolving the contribution of fear versus disgust in both the amygdala and the insula.

But overall, the results support a dichotomy of political orientation of the left and right hemispheres. Three of the structures highlighted by Kanai implicate a right hemispheric orientation of liberalism: the ACC (via the Amodio experiment and the fact that response inhibition is mainly associated with the right hemisphere); the left insula (related to disgust, which is elevated in conservatives); and, the right entorhinal cortex (depleted in conservatives).

The fourth structure, the right amygdala, was elevated in conservatives, and counters the theory that the

right hemisphere is more conducive to liberal political dispositions. However, we propose that the activation of the right amygdala can actually work to decrease the influence of the right prefrontal cortex in political disposition. As we have previously proposed, the right prefrontal cortex is one of the liberal hot-spots in the brain.

Thus, political orientation seems not only to follow a left-right dichotomy of cerebral function, but also a dorsal-ventral dichotomy, although we believe that dorsal-ventral variations are generally weaker in political influence than left-right variations. This proposal may even vary by gender.

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