



Research Letter from ... Denmark

Praying for Dopamine

By our corresponding author, **Tahor Grundtvig**

Denmark has a history of exploring the great hereafter. From its Lutheran Protestant tradition came Soren Kierkegaard (1813-1855), the father of existentialism, who took Christianity onto another plane of consciousness. Luckily, Carlsberg beer also appeared around this time (1847) to provide solace for those fevered brows trying to deal with Kierkegaard's profound philosophical mix of "existentialism, neo-orthodoxy, postmodernism, humanism and individualism".

Clearly inspired by this tradition of ethereal enquiries into the nature of God, beer and existence, a young Danish researcher from Aarhus University's Study of Religion Department decided to track down the neurological origins of prayer using functional magnetic resonance imaging (fMRI). Uffe Schjoedt has published his findings in two recent reports: "Rewarding Prayers" (*Neurosci. Letters* 443: 165-8), and "Highly religious participants recruit areas of social cognition in personal prayer" (*Soc. Cogn. Affect. Neurosci.* 4(2): 199-207).

In "Rewarding Prayers", Schjoedt claims to have found proof that prayer is both rewarded and rewarding, at least as defined by the limits of his hypothesis: "Religious prayer is a form of frequently recurring behaviour capable of stimulating the dopaminergic reward system in practicing individuals". To demonstrate this, he persuaded 20 healthy young Christians (14 women, 6 men) from "a fraction (Inner Mission) within the Danish Christian Church" to stick their heads into an fMRI scanner and start praying intently!

A matter of training

Localised changes in brain activity are deduced in the fMRI from the detection of Blood-oxygen-level dependent (BOLD) signals. Briefly, oxygenated and deoxygenated blood have different magnetic properties – oxygenated haemoglobin is diamagnetic but becomes paramagnetic when deoxygenated. Hence, by MRI one can assess changes in BOLD contrast resulting from relative adjustments in both cerebral blood flow and oxygen consumption to different regions of the brain.

Schjoedt gave each of his participants "10 minutes of structural scanning, which habituated them to the MR environment". He then asked them to perform a range of tasks because he was "equally interested in the general effects of praying and the differences between forms of praying". They performed five tasks in a semi-randomised order, including two different prayers: "wishing to Santa Claus" and reciting a nursery rhyme. "Each of the five conditions lasted 30 seconds and was repeated six times. Tasks were performed silently as internal speech with eyes closed."

The prayers were of two different types: the Lord's Prayer was taken as a highly formalised prayer (i.e. "Our Father, who art in Heaven, Hallowed be thy name, etc.") and compared to improvised Personal Praying activity (e.g. be with everybody in

a difficult situation. Forgive all the things I have done wrong. Amen."). As for "wishing to Santa Claus", Schjoedt made sure in a questionnaire prior to the experiment that, as much as his participants definitely did believe in God's existence, they most certainly did not believe in Santa Claus! Meanwhile, "reciting a well-known rhyme of our choice" controlled for "effects of formalisation" and in the fifth task, "a linguistic, non-semantic base line" was introduced by getting his Christians to count backwards from 100.

Now, given the number of axial imaging slices and all the computer processing required to get a reasonably localised differential BOLD signal, it helps if, instead of looking at the whole human brain in action, you limit your analysis to just the bits that interest you. In this case, Schjoedt explains, "Based on our prior hypothesis, we made a Region of Interest analysis of the caudate nucleus bilaterally." Naturally, restricting the zone of analysis has its advantages since it allows him to announce that his "regional analysis revealed a significant main effect of religious praying in the right caudate". He says that plots relative to control showed comparable activations for both religious conditions but later admits that "in a related study, we found no significant caudate activation of self-reported religious persons, who did not pray regularly". However, this merely "suggests that a regular practice of prayer may be key to a cognitive effect of religious prayer". Which explains the importance of verifying that the 20 carefully selected subjects for his study all regularly practised the Lord's Prayer – 4.75 times a week – and personal prayer – 19.75 times weekly; their neuronal prayer pathways, clearly well-developed through frequent prior training, were easier to spot!

In his sweeping conclusion, Schjoedt says, "The activation of the caudate nucleus supports the hypothesis that religious prayer is capable of stimulating the dopaminergic system of the dorsal striatum in practising individuals." However, before we forget that Schjoedt is from the Department for the Study of Religion, he then nuances his findings with the following philosophical distinction, "We note that the present study cannot disambiguate between an effect of praying in actually changing outcomes" (for which he cites the bible – Matthew chap. 7, verse 7: 'Ask and it shall be given you; seek, and ye shall find; knock, and it shall be opened') "and an effect mainly in the reward system of the practitioners" (for which, of all sources, he refers to Karl Marx and his 1843 observation that "Religion is the opium of the people.")!

It's hard to know what Kierkegaard would have made of the finding that people use their brains when thinking about the meaning of life, the nature of God and religion but didn't he say, "The function of prayer is not to influence God, but rather to change the nature of the one who prays." Is the fMRI actually revealing anything very different? No wonder Carlsberg's rather more prosaic beer has been such a success in Denmark!

