

# The Neuroscience of Spirituality

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In the last decade, a number of studies have shown the success of spiritual medicine. These studies come from a wide number of fields and deal with many aspects of religious and spiritual practice. A recent study by Koenig et al (1999), looking at a population of nearly four thousand 65 year-old people over a six-year period, was able to show that those who go to church at least once a week are more likely to be alive after six years. Another study has shown the effect of church attendance on the immune system. Again, over 65 year olds who went to church at least once a week had lower levels of interleukin 6. Interleukin 6 is a cytokine involved with the inflammatory process and lower levels of this immune protein suggest an up-regulation of the immune system.

Koenig et al. (2001a) in their *Handbook of Religion and Health* show in tabular form the different factors involved in susceptibility to disease and the importance of having a religious or spiritual belief. Many of these factors can be influenced by the behaviours which flow from an active religious faith, for example the limitation of self damaging behaviours such as smoking, drugs and alcohol, the social support network involved in religious belief and attendance at church and church services. A strong faith, positive relationships and positive thinking up-regulate the immune system, reducing the risk of cancer, improving general health and protecting the cardiovascular system. The field is now so large that it is not possible to review the whole area. I will, however, look in detail at some studies relating to immune system functioning and cardiovascular parameters.

Azari et al. (2001) looked at blood flow changes during religious practice. They studied a group of six subjects who had had a spontaneous religious conversion and compared them with subjects who had had no such experience. There were three conditions in the study. The first was reading a psalm, which induced strong religious feelings; secondly, a nursery rhyme, which induced happiness, and thirdly, reading from the telephone directory. A PET scan measuring blood flow was taken in these three conditions and the results show that there were a number of changes specific to the experience of religious feelings. The religious condition showed significantly increased flow in the pre-SMA (supplementary motor area), in the DLPC (right dorsolateral prefrontal cortex) and in the right pre-cuneus. They suggest that activity in the pre-SMA supports the preplanning of motor acts, particularly those that are involved in religious schema.

The pre-cuneus, they argue, is linked to visual working memory, and the DLPC with memory retrieval. They also suggest that the DLPC could be involved in the monitoring of thought. It is difficult to argue that these changes are specifically related to the experiencing of religious feelings. However, it is clear that there is a difference between the religious and the control group. But as only six subjects were involved, replication of this study is needed to confirm its findings.

A single case study has been carried out by Puri et al. (2001) in a patient with schizophrenia suffering from religious delusions. They measured cerebral blood flow by PET examination and repeated this when the subject was improved. They argued that the effects of the drugs he had been given are known and that they could not affect the results of PET scan examination. They showed that there was an increase in left frontal blood flow at the time of the religious delusions, and also some increase in left anterior temporal flow. They argued that these two areas might be involved with religious beliefs. The increase in left temporal blood flow during the religious delusional state is congruent with much of the epilepsy literature. The authors suggest that changes in the DLPC may be related to attention.

A large number of studies have looked at meditation. Because many different types of meditation have been used it is difficult to compare these studies. Of equal importance is the lack of a comprehensive description of the meditation practice. Some studies use highly experienced meditators who may have spent over 40 years in meditation practice, while others used meditators of only two or three years' experience. The number of meditation studies is now so large that for this short review I will look in detail at only four of the more recent ones, which have been selected because they use different, sophisticated methods of analysis.

There is now general agreement in the literature concerning the main changes that occur in meditation. The process of meditation initiates the relaxation response with a decrease in cortisol and a decrease in blood pressure. There is also some reduction in the galvanic skin response. Changes in the EEG have also been described, and these are seen to affect the EEG in between the meditation sessions in subjects who had practised meditation over a number of years.

Newberg et al. (2001) published a SPECT scan study in a group of eight meditators. They mention that they were doing a form of mantra meditation, but did not describe the exact practice. They compared the meditators with nine control subjects, whose scans were part of the control group in another project. Perfusion in the left frontal lobe was enhanced during the meditation sessions, and the authors suggest that this related to a cognitive attentional component. There was hypo-perfusion of the superior parietal lobule, and they argued that this related to attentional processing and altered sense of space. They also noted an increase in thalamic activity and pointed out that there was thalamic asymmetry in the baseline of the meditators, which was different from the controls. The authors argue that these baseline changes are due to a long-term effect of the meditation practice. They also report that the changes they have seen in the frontal and parietal cortices during the meditation session are closely related to the positive mental states that are described during meditation

A number of studies have looked at the EEG changes during meditation. The most frequently described changes in the previous literature are an increase in frontal theta activity, an increase in temporal theta activity, an increase in central beta spindling and an increase in generalised coherence. (Coherence is the frequency correlation coefficient, and thus an increase in coherence suggests an increase in similarity in the frequency domain between different brain areas). All these changes correlate with a level of consciousness that lies between sleeping and waking. The newer EEG studies, because of the more sophisticated analysis, have added further information to the above picture. A study by Aftanas and Golocheikine (2001) has examined the EEG during Sahaja yoga meditation. The authors measured the EEG during this practice in 11 short-term meditators with half a year's experience and 16 long-term meditators with three to seven years of experience. They mention three phases, the incoming phase, the thoughtless phase when feelings of bliss arise (the deepest stage of meditation which may last for about an hour), and finally the outcome phase. They were particularly interested in the correlation of the electrical activity with feelings of bliss and the difference between long and short-term meditators. Comparing the short and long-term meditators before meditation, they found that the long-term meditators showed an increase in generalised theta activity before the meditation session. During the meditation session, the long-term meditators showed a high coherence in the left frontal lobe with many different brain areas. This was not seen in the short-term meditation group. They also noticed a positive correlation between frontal theta power and feelings of bliss, and a negative correlation between the appearance of thoughts and frontal theta activity. This study again confirms the EEG changes in long-term meditators and suggests that both the reduction in thoughts and an increase in feelings of bliss, are related to frontal theta activity.

Finally I would like to mention an interesting PET scan study, which to my knowledge is the first study to examine dopamine levels during meditation using the radioactive dopamine ligand C-Ralopride. The meditation in this study, Nidra Yoga meditation, involves giving up personal goals and loss of executive control, while attending to internal sensations and withdrawing from action. This study found that there was an increase in dopamine during the meditation sessions, particularly prominent in the ventral striatum. The subjective accounts correlated with a decrease in readiness for action and an increase in visual imagery. They also noted that there was an increase in EEG power in the theta band, which correlated with the increase in dopamine. This paper confirms the widespread effects of meditation, and suggests that subcortical structures such as the thalamus are significantly involved. This change in dopamine levels in those structures that are related to movement is of particular interest, as there are many subjective reports of an improvement in movement after meditation sessions.

The more recent imaging studies show a further indication of the specific brain areas and the electrical changes that are involved in meditation. The attention mechanisms of the DLPC are prominent as are parietal lobe changes which relate to the body image in space. Feelings of bliss and emotional changes certainly correlate with frontal theta activity, some of which will be arising from the anterior cingulate gyrus. Frontal theta also links in with specific attentional frontal lobe mechanisms. The studies relating to changes in dopamine are interesting, as dopamine is also involved in the reward system. It would be interesting to speculate that some of the dopamine changes may be related to the positive affect that flows from meditation sessions. Finally, the relationship of changes in dopamine levels to motor activity is also important and interesting.

Meditation has been used a number of years in clinical practice and has been found to be generally helpful in those clinical conditions where high arousal and anxiety are part of the pathology. A study by Sudsuang et al. (1991) looked at Dhammakaya Buddhist meditation. The authors found that consistent meditation was related to a decrease in blood pressure, pulse rate, and serum cortisol. These effects were not maintained if the meditation was intermittent. Kabat Zinn (1992) looked at general anxiety or panic disorders in his Massachusetts clinic. He gave an eight-week programme of weekly two-hour sessions. These comprised a two-hour structured class on relaxation and stress reduction each week and in the sixth week a 7½-hour silent meditation retreat. He found that 20 of the 22 people involved in the study were significantly improved at the end of the course, and 18 of the 22 remained improved at a three-year follow up. This study shows the importance of the linking of meditation to group therapy, and indicates the significant results that may be obtained.

A single blind trial of TM meditation in 111 African-Americans aged between 55 and 85 looked at changes in blood pressure, the index group having a mean blood pressure of 179/104 (Schneider et al. 1995) These meditators were paired with a group given progressive muscular relaxation and a group who had lifestyle education. After three months, those carrying out the TM practice showed both a significant reduction in systolic and diastolic pressure. However, although this method was effective, the mean changes were only 10 millimetres Hg systolic and just over 6 mmHg for the diastolic, which still leaves the population in the high-risk category. Clearly further longer term studies are still required. Some subjects have now practised TM since the time of the Beatles in the '60s and it should be possible to look at the ultra long-term studies of a group of meditators to see if meditating over a number of years really does increase life expectancy.

In summary, the findings for both the imaging and the clinical studies show that attentional techniques can alter cortical function that underpins the many physiological effects that have been found. These changes do lead to an

enhancement of quality of life and raise the question of whether it may be time for these methods to be taught and made available on a wider basis.

### **The immune system**

Changes in immune system function have been correlated with many factors amongst which are social support, cognitive styles of behaviour and thought content. It is thought that these effects are mediated in part through the DLPC and the VMPFC (ventromedial prefrontal cortex). Pathways from these areas then link up with the amygdala and limbic structures and also go straight to the hypothalamus. Here there are a number of systems, which are triggered by corticotrophic releasing hormone (CRH) in different ways. On release, this hormone enters the pituitary portal system and then targets the release of ACTH and thus cortisol from the adrenals. Another effect is via the hypothalamus and so via tracts to the locus coeruleus and out through the brain stem to the glands innervated by the sympathetic system. A further set of tracts carries parasympathetic stimulation to the periphery. All these systems are part of the immune system and affect the bone marrow, thymus, spleen, lymph nodes etc. Equally important are a number of receptor sites in the amygdala and hippocampus which are sensitive to cortisol and which reduce the levels of CRH and so ACTH. Some cells in the immune system also signal to the brain via the inflammatory proteins, the cytokines. There is thus a dense network of communication between the hypothalamus, the higher centres and the immune system.

With such a dense and widely linked network, it is no surprise to find that what we think, our emotions and our relationships all interact with the immune system. A large number of studies have now been carried out looking at the effects of mental and spiritual state on the immune system. I shall choose several to highlight the significance of negative and positive thinking. Kielcolt et al. (1993) looked at 90 newly wed couples and rated a 30-minute discussion between them. If hostile behaviour was displayed between a couple there was a significant decrease in non-killer cell activity, a weaker blastogenic response to two mytogens, weaker proliferative response of monoclonal antibodies to the T3 receptor, a large increase in T lymphocytes and helper T lymphocytes, and higher antibody titres to latent Epstein Barr virus, all of which indicate a down-regulated immune system. There was also a prolonged increase in blood pressure in this group. This study shows the effect of anger on immune system functioning and blood pressure.

A number of studies have looked at the development of cancer and correlated its onset with psychosocial stress. The study by Prigerson et al. (1997) looked at 150 subjects after their spouses had died. The subjects who showed high traumatic grief scores had an increased probability ( $p=0.0001$ ) of developing a new cancer between the sixth and 15<sup>th</sup> months. All cases in the group that developed cancer had high dramatic grief scores. A six-year follow up study by Emerson et al. (1996) looked at 2400 middle-aged Finnish men over a period of six years. 174 died, 87 from heart disease and 40 from cancer. Those with moderate to high levels of hopelessness as scored on a rating scale were two to three times more likely to die of cancer and heart disease than those with low levels of hopelessness. The groups were matched for blood pressure, cholesterol, smoking, drinking, social class, education and prior depression and social isolation.

Uchino et al. (1996) reviewed 81 studies, monitoring the effect of social support. His review showed improved immune functioning with higher support. There were also improved and more stable cardiovascular systems and an overall reduction in cortisol levels. An interesting study was carried out by Koenig et al. (1997) who measured the serum levels of interleukin 6 in subjects over 65 years of age. This cytokine is related to inflammation and is a measure of immune system functioning. It is not found in the serum until the age of 65, and then it is a measure of down-regulation of the immune system. Lower interleukin 6 levels were found in those who

went to church once a week or more, suggesting the significance of religious practice or belief. High levels of interleukin six have been associated with cancer, myocardial infarction, hypertension, Alzheimer's disease, osteoporosis and rheumatoid arthritis.

Finally, the power of compassion and positive thinking was shown by McClelland (1998). He studied a group of students, 70 of whom watched a film of Mother Teresa healing and 62, the controls, viewed a film, the triumph of the Axis in World War II. The measure was salivary IgA, an immunoglobulin. The results of the study showed that there was a significant increase ( $p=0.025$ ) in salivary IgA in those who had watched the film of Mother Teresa healing with compassion compared to the control group. The authors suggested an up-regulation of the immune system. A second study measured the effects of the visualisation of Mother Teresa healing. This also produced an increase in immunoglobulin, and an up-regulation of the immune system. The study has been used to point out that positive thinking and feelings of compassion can lead to positive changes for the thinker.

In summary, these studies show the close correlation between religious and spiritual practice and positive changes in a number of stress related hormonal systems. Social, religious and spiritual beliefs, when practiced, can lead to an upgrading of the immune system. A positive rather than a negative attitude may contribute to a healthier life with the possibility of an extended life span.

### **Intercessory prayer**

Finally I would like to look at intercessory prayer. In the last few years there have been a number of high quality double-blind randomised control trials. Not all of these have been positive although the majority have. Townsend et al. (2002) have reviewed a number of prayer studies and concluded that prayer is effective but that more studies need to be done. I shall mention two important studies; the first by Byrd (1988) from a coronary care unit, because it took the previous prayer data seriously and blazed a trail with a good double-blind randomised control trial, and the second by Cha et al. because of its clever design and the important inferences which must be drawn from it. Byrd had two matched groups of patients. When patients entered the CCU they were asked if they wanted to take part in a prayer study. Those who said yes were randomised to the active ( $n=192$ ) or the control group ( $n=201$ ). The names of the active group were sent to a prayer group who were instructed to pray for them. Those praying prayed that those named would get better more quickly have fewer complications etc. The results showed a significant effect of prayer. There was a five-fold reduction in the use of antibiotics, a three-fold reduction in the occurrence of pulmonary oedema, fewer subjects required intubation and fewer subjects died (but not significantly fewer) than in the control group. This paper became the model for a number of further studies.

Cha et al. (2001) from the department of obstetrics and gynaecology at Columbia Hospital New York carried out a prospective double-blind randomised control trial on the effects of intercessory prayer on in vitro fertilization and embryo transfer in a group of patients in Seoul, South Korea. Patients in the Seoul clinic were randomly allocated to control or prayed for groups ( $n=219$ ). The names of the active patients were sent to a prayer group. There were three praying groups, one in Australia, one in the USA and one in Canada. The study continued over four months. Two important points about this study should be noted, firstly that nobody in the clinic in Seoul, patients or staff, knew that the study was taking place. Secondly, those praying were widely separated from their subjects and so action at a distance would have to be postulated. The results were striking. The prayed for group showed higher implantation rates of 16.3% against 8% for the control ( $p=0.0005$ ) and higher pregnancy rates of 50% against 26% ( $p=0.0013$ ). The high significances again suggest that prayer is effective. The design of this study rules out leakage of information about the trial to the Seoul clinic. It also confirms action at a distance, which would suggest that some kind of intention to heal on the part of those praying

crosses space to influence the target group. This study is thus a parapsychological study on healing and suggests the possibility of direct effects of mind beyond the brain.

### Summary

This paper argues for an important role for spiritual medicine. The first section points to a very important role for the beliefs, relationships and thinking styles of our patients. It is very important to find out what patients believe and that they understand the protective value of faith, a committed belief and social structure such as that given by a church group. How the patient deals with stress and bereavement is important, since prolonged feelings of hopelessness may increase the chances of cancer or heart disease. Meditation has been known to be important for a number of years. The latest imaging studies suggest that the location for the correlates of the mechanism of attention and the correlates of the mental state of bliss are seen in the frontal lobe. There is important information about the correlates of body image as a reduction in blood flow in the parietal region.

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