


Examining the function of neurobiology in Christian spiritual experiences and practice

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Before one can adequately deal with a biblical and neurobiological examination of spiritual experiences, one would need to define what they are. Here, one could offer that a spiritual experience could be an encounter with something or someone that is other than a material experience. It is a supernatural experience that transcends the natural, yet impacts the natural, by affecting our mental and physical senses and how we practise our spirituality. It is an experience that leaves us with a new and perhaps intense sense of otherness. One could further propose that as spiritual experiences are by nature 'experiences', they are inherently subjective, and can therefore be classified as personal encounters. In other words, we have unique spiritual experiences in our encounters with God. This article offers several such examples and shows the significance of looking inwardly to answer the important question of why we are (or not) transforming spiritually and mentally.

Contribution: The article's challenge is to not only show that science and theology are not in conflict, but also how the intersection and emerging field of neurobiology (natural science) and theology can help better understand how spiritual experiences manifest, and that naturally we are seemingly wired for these experiences.

Keywords: God; Brain; Neurobiology; Spiritual experiences; Spiritual transformation.

Introduction

The purpose of this article is to explore briefly what research is currently available on the role of neurobiological correlates in God-generated spiritual experiences and practices. Believers often assume that God works independently of their natural faculties, such as the mind, brain and nervous system, when they are experiencing anything spiritual. The motivation here is to challenge this and show that one cannot approach a study of spiritual experiences without recognising that the mind, brain and nervous system are also central to their manifestation; they are interdependent. For instance, and although they do have their critics, research now shows how neurobiological correlates are involved in various spiritual experiences and practices, such as prayer, meditation, worship, *glossolalia* [ecstatic tongues] and prophecy. On this, scholars such as Evans (2004), Jeeves and Brown (2009) and Clarke (2015), have shown through their various empirical studies how important it is to understand that neurological mechanisms are relevant in not only causing thoughts and feelings to rise, but also in spiritual experiences. In studying these experiences, scholars such as Newberg and Waldman (2010:69, 76), Verghese (2008:233, 237), Giovannoli (2001) and D'Aquili and Newberg (1999) have employed neuroimaging devices such as functional magnetic resonance imaging (fMRI), single photon emission computed tomography (SPECT), and positron emission tomography (PET) to peer into the brain and record their findings. As stated by Pretorius (2016),¹ '[s]tudies such as these have assisted in clarifying the neurobiological mechanisms associated with spiritual practices and experiences'. It is now also accepted that spiritual experiences can encourage spiritual transformation (see Ironson, Kemer & Ironson 2006:241, 260). Through spiritual experiences, the brain's reward circuits are activated, which help to rewire the brain (neuroplasticity) and cause spiritual transformation.

Theoretical framework

As stated before, this article explores whether spiritual experiences are a result of neurobiological correlates or supernatural intervention by God, or both. In this sense, and according to the view of Pretorius (2018:152), when studying the reality of spiritual experiences, there is a metaphysical side to it, specifically *first principles* of phenomena which, according to this framework, is God and

1. Note that some information in this article was used in three previous papers published by the author: see Pretorius (2016, 2017, 2018).

Note: Special Collection entitled Theology and Nature, sub-edited by Johan Buitendag (UP).

his work in creation, notably in revealing more of himself within scripture and the sphere of spiritual experiences.

The study is also qualitative in nature and takes an interdisciplinary approach in unpacking how science and theology dialogue and specifically how God, mind and brain intersect around spiritual experiences. In this sense, the dialogue model of Barbour (2000:23) is the desired pattern, as natural science and theology are not only conversational partners but also complement each other in various ways.

Conversely, although science may observe the chemical process of a spiritual event, according to Pretorius (2018:152), it is limited in observing a person's thoughts, meaning the inner workings of their *mind*, and does not observe how the Holy Spirit (first principle cause) merging within the neural networks of the brain can generate spiritual events. This study will attempt to show how, although in a fairly limited way, neuroscience is able to observe secondary causes that reveal the emergence of spiritual experiences. Apart from this, the point of departure is to show the benefit of dialogue between neuroscience and theology to better understand the inner and outward workings of spiritual experiences.

Neural correlates of spiritual experiences

To begin, the recently expanding field of neurotheology,² which specifically investigates the relationship between neurobiology and spiritual experiences, has uncovered a causal link showing that neurobiology contributes to spiritual experiences. This is proposed in the work of Cole (1998:210–219) who reasons that '[t]he physical process of the mind/brain is *the vehicle* for expression of Christian experiences', while Moll (2014:17) maintains that '... research is quickly accumulating (that) our bodies, down to our cells and DNA, are designed for spiritual experiences' (cf. Newberg & Waldman 2010:4). Furthermore, Newberg and Waldman (2010:4) rightly reason that the brain is a complex system 'uniquely constructed to perceive and generate spiritual realities'. Their statement is based on hundreds of clinical trials conducted, including several neuroimaging studies as emphasised by McNamara (2009:xi). These trials show that the amygdala and anterior temporal cortex including large portions of the prefrontal lobes are regularly associated with manifestation of religious experiences.

However, the most striking finding noted in these studies is that there exists no single specific neural correlate in spiritual experiences. Rather, these various studies show what appears to be a form of networking between different parts of the brain, especially the frontal and parietal lobes, the thalamus, basal ganglia and limbic system (see Arumugam 2015; Newberg 2014).

2. Neurotheology is a broad discipline that, depending upon the researcher, may explore a variety of topics related to religion and how it is experienced or understood by the human brain. As a hybrid of neuroscience and theology, neurotheology has emerged as a distinct discipline with the intention of understanding the biological components of the human brain, seemingly wired for spiritual experiences, a sort of innate awareness of infinite possibility beyond human finitude (see Ashbrook & Albright 1997:8; Moll 2014; Newberg & Waldman 2010; Sayadmansour 2013:52).

Interestingly, these and other similar studies are unclear whether a change in regional brain activity triggered the spiritual experience or simply responded to the experience. This is an important observation, as some scholars (especially those cited in footnote 2) posit that God is the origin of the activity, and the various brain areas simply respond to God's involvement.³ However, and it must be noted that, there are arguments against any sort of first cause phenomenon, such as God's involvement, when it comes to spiritual experiences. Some scholars, as presented by Shukla, Acharya and Rajput (2013:1486–1490), argue that spiritual experiences are ultimately caused by neural correlates alone, such as the temporal lobe, which can cause episodic time distortion, sensations of altered space, 'flying or floating, [including a] feeling of the presence of sacred or malefic ghosts or apparitions which include voices and heavenly visual experiences'.

Yet, and as suggested, although God transcends the natural, he is also immanent in creation and thus impacts the natural by affecting specifically one's mental and physical senses through the indwelling presence of his Holy Spirit in believers (see Ezk 36:27; Jn 16:13; Rm 8:9; 8:111; Cor 3:16). Furthermore, scripture encourages believers in Ephesians 5:18 to be continually filled with the Holy Spirit since he is the source of spiritual power. Here, Anders (1998:106) in dealing with the Charismatic and Pentecostal ideas concerning this verse writes that these groups tend to believe that it is referring to a supernatural experience that leads to one being able to speak in tongues, including other high-profile manifestation not mentioned in this verse. Conversely, MacArthur (2015) argues against the idea, and proposes that Charismatics often use this as a proof text for spiritual experiences. Nevertheless, and as will be shown, the Holy Spirit is strongly considered to be the source of religious experiences.

Internal and external experiences

Often, believers think of their spiritual lives as something external, according to Moll (2014:21) – a collection of things we practice, such as attending church, prayer, Bible study and worship, for instance. However, Moll (2014) reasons that our relationship with God, although external, is also profoundly connected to what is happening within our bodies. In this sense, what we do outwardly and how we practise our spirituality connects to what is happening biologically and spiritually in us. There is, as proposed, a causal link which contrasts with the argument by Newberg et al. (2001:113, 122) that all experiences, moods and perceptions are neurologically grounded, leaving no room for a supernatural cause. In all fairness, they are not alone. Today, numerous neuroscientists believe that religiosity and spiritual experiences involve genes related to the brain's dopamine and serotonin neurotransmitters. For example, McNamara (2009:63) suspects that religiosity links to dopamine activity in the prefrontal lobes, while Giordano and Engebretson (2006:187, 196) propose that it begins in the networks of the brainstems

3. The author 'is aware and sensitive to the reality that spiritual experiences do happen within a broad range of religions. However, this study specifically concerns itself with interpreting and sketching out spiritual experiences and practices within an evangelical framework'.

reticular system. This then brings into play the midbrain dopaminergic pathways releasing dopamine in networks of the forebrain, thus creating a spiritual or – as they put it – a mystical experience. As offered by Hagerty (2009:Ch 6), '[m]ost scientists have zeroed in on serotonin and the serotonin system as the main triggers of transcendent experience'.

Criticism of 'God-inspired' spiritual experiences

It is widely stated and argued, as revealed by Dein and Cook (2015:9–113) '...that mental health professionals have a long tradition of pathologising religious experience, since there are similarities between mystical and psychotic states of mind'. Others further argue, as proposed by Wulff (1997:49), that various role-players may also be present in the occurrence of a spiritual or mystical experience, such as depriving oneself of food by extreme fasting, depriving oneself of sleep, submitting one's body to certain discomforts or control of breathing and meditation (see Newberg 2014; Pretorius 2008:157). It is also well documented that spiritual experiences can similarly be manifested by ingesting hallucinogenic drugs, such as psilocybin and lysergic acid diethylamide (LSD) as identified by Griffiths et al. (2019), Barrett and Griffiths (2018:393–430) and Newberg (2014).

However, it goes deeper than this, especially as the data collected by test instruments such as fMRIs come with their own challenges, for example, one must consider the validity and reliability of the tests. Here, the work of Middleton (2020) is particularly important, as he proposes that in quantitative research, one must consider the validity of the methods and measurements used. He (Middleton 2020) recommends the importance of looking at four vital areas:

- Construct validity – the test must measure the intoned concept.
- Content validity – the test must fully represent what it is intended to measure.
- Face validity – the content of the test must suit its aim.
- Criterion validity – if a different test is done on the same thing, will the results correspond?

When assessing the reliability of instruments, one is referring to how consistent the measure is. Here, psychologists and psychometrists consider three types of consistency (cf. Evans et al. 2011; Holmbeck & Devine 2009):

- over time (test–retest reliability)
- across items (internal consistency)
- across different researchers (inter-rater reliability).

If the reliability and validity of tests are suspected, it could negatively impact the results sought in valid spiritual experiences.

Here, Newberg (2014) takes this further by offering that numerous attempts have developed 'self-reporting scales which measure the subjective nature of certain religious or spiritual element'. However, he cautions that these measures are questionable. In their book, *Measures of Religiosity*, Hill

and Hood (1999) offer a rigorous review of numerous scales and questionnaires that assess everything from 'feelings of religious commitment, to mystical experiences, to the direct apprehension of God'. During their assessment of these various scales used, they were found wanting.

As surprising as these may be, and without denying the role they may play, the following, as argued by Pretorius (2008), cannot be proven through psychological scales: (1) that the spiritual experience is merely a creation of the mind, with no spiritual relevance, or (2) that the spiritual experience is not supernatural as a result of the involvement of natural means. D'Aquili and Newberg (1999:146) clarify this as follows: '[i]f you were to dismiss spiritual experience as "mere" neurological activities, you would also have to distrust all of your own brain's perceptions of the material world'.

Furthermore, and as rightly proposed by Judge (2010:1), we must take caution in the idea that we are 'nothing but a pack of neurons', and thereby reduce conscious (and spiritual experiences) to mere mechanistic terms which leave no place for divine intervention. In addition, Jeeves and Brown (2009:99) also caution '...that one cannot and should not reduce religion (or religious experiences) to a primary form of cognitive activity only'.

The effect of prayer and meditation on the brain

Meditation or focused prayer is regarded as the one practice that has the most effect on our brains as suggested by Moll (2014:27). A study conducted at Harvard University using fMRI scans of people meditating showed, according to Newberg and Waldman (2006:181), an increase of activity in the limbic system, prefrontal cortex and a control of the autonomic nervous system (cf. Lazar et al. 2000:255, 259). Newberg and Waldman (2006:182) further proposed that '[a] strong emotional response (which is created by the amygdala and other parts of the limbic system) enhance [*sic*] the realness of an event'. To this, I would add focused prayer and meditation. Expressly, and corresponding with the research conducted by Newberg and Waldman (2006:182, 183), the thalamus specifically makes the spiritual experience (an experience of God) feel real during prayer and meditation. The hippocampus then records it, which helps embed the experience into long-term emotional memory. Newberg and Waldman (2006) further maintained that if one has an intense (spiritual) experience, and it is sustained for more than half an hour, it can permanently change neural circuits involving especially emotion and memory. In the author's view, this is a form of spiritual transformation which shows that committing to prayer and meditation can change the brain. In this sense, the process of neuroplasticity plays an important role in spiritual transformation.

However, it must be stated that there are critics of neuroplasticity as a working model in psychoanalysis therapy, and therefore the author concedes that the critique would also relate to the idea that neuroplasticity is then

irrelevant to spiritual formation (see Carmeli & Blass 2013; Park & Gérard 2013). However, and as will be explored, the empirical evidence leans towards the positive contribution that neuroplasticity makes to spiritual formation. Conversely, there is a second way that spiritual experiences and spiritual transformation happen, and it has to do with our words. As identified by Newberg and Waldman (2012:3) '[a] single word has the power to influence the expression of genes that regulate physical and emotional stress'. They further proposed that when words and phrases are repeated at a barely perceivable volume, it can create subtle changes in mood (Newberg and Waldman 2012:33) (cf. Wenberger, Kelner & McClelland 1997:599, 605). They further maintained that even holding (meditating on) a positively charged word in one's mind stimulates frontal lobe activity, which is a part of the brain involved in spiritual experiences. This relates well to God's instruction in Joshua 1:8 and Psalm 1:2 for God's people to meditate on his Word day and night.

The effect of music and worship on the brain

As previously stated, the human brain is programmed to believe and seek God. This inevitably leads people not only to seek God but also to worship him. As stated by Moll (2014:127), worship can lead us into experiences of God, whether sublime or intense, that can shape us emotionally and bring about spiritual transformation. Here, the science of neuroplasticity in worship is evident, because by shaping our emotions our brains are rewired, leading us into more Christ-like behaviour by spiritual formation. The unique multisensory experience of worship, especially in the more Charismatic and Pentecostal churches, seemingly affects numerous sections of the brain, such as the hippocampus for memory, the amygdala for emotional reaction to music and the cerebellum that can cause foot-tapping and dancing, as music influences the autonomic nervous system. For an in-depth study of this, see Pretorius (2017).

Additionally, music engages the brain at almost every level as proposed by Leeds (2010:111). There has also been extensive research undertaken by Chanda and Levitin (2013:179, 193) and Raglio et al. (2015:68, 78), which found that 'music engages various areas of the brain, especially those involved in cognition, motivation, emotion and neuromotor functions'. On this, Moll (2014:135) makes a pertinent statement: '...experientially, richer worship changes us more powerfully'. In this sense, the richer the experience, the more powerfully it impacts the brain, and changes one's behaviour. As presented so far, the brain has the extraordinary ability to form and reorganise synaptic connections, especially in response to musical experiences. Here, one can recognise its similarity to the affect that prayer and meditation have on the brain. To complement this, Wimberly (1997) stresses:

Whether physical, psychological, relational or spiritual [*it is a*] mysterious process that happens. It is given by God who created us and who seeks to help us arrive at healing and wholeness [*and, of course, spiritual formation*]. (p. 104)

Here, Moll (2014:131) rightly proposes that '[n]eurologically speaking, church worshippers' brains release oxytocin that cause [*sic*] us to feel good about being with other people'. He goes on to say that as the brain's reward system releases oxytocin, it biologically explains why many people feel the need to worship corporately, at least once a week. Oxytocin, as presented by Uvnas-Moberg and Petersson (2005:57, 80), can induce anti-stress-like effects, such as reducing blood pressure and cortisol levels. Because oxytocin is also released during social interaction, worshipping corporately allows one to feel the support, warmth and empathy of those they are worshipping with, and bonding takes place. We connect with fellow believers in ways that are not only social but also mental and spiritual. Furthermore, worship can lead us into experiences with God that can intensely shape our emotions (see Moll 2014:127). Here, and as previously proposed, the author believes that the indwelling presence of the Holy Spirit achieves this by supernaturally increasing or decreasing certain chemicals in our brains to trigger a change in our reality, causing a subtle yet powerful spiritual experience leading to spiritual transformation.

The effect of glossolalia [tongues] on the brain

Unlike worship, *glossolalia* produces a slightly different pattern of brain activity. For instance, Newberg et al. (2006:67, 71) have shown, using SPECT imaging, that blood flows to the brain when singing and speaking [or praying] in tongues are different. For instance, there is an increased activity in the parietal lobe, and decreased activity in the prefrontal cortex, which is related to executive functioning. This shows that *glossolalia* seems to involve a relinquishing of control whilst experiencing a bonding with God. But, like worship, praying in tongues also links to the amygdala (the emotional area of the brain) and stimulates a chemical reaction within the body, which in turn produces an emotional and physical response. In this context, changes in brain structure propose a complex brain activity during the practice.

Furthermore, a study conducted by Francis and Robbins in 2003, involving almost a thousand clergy members of a British evangelical group, found that 80% of those who practised *glossolalia* [tongues] were emotionally more stable and less neurotic (cf. Newberg et al. 2006:67, 71). Therefore, the effect of tongues on the brain and its benefit for health should not be underestimated.

The neurobiology of prophecy and visions

According to Shantz (2009:113), ecstatic experiences usually precede a prophecy or vision. These types of experiences are generally prevalent in evangelical churches, and specifically those with a strong Charismatic and Pentecostal focus on preaching and worshipping. One only needs to attend these churches to realise that usually it is a cascade of music, lighting, shouting and dancing that can affect the sensory

processing of the brain. It can cause a surge of various neurotransmitters such as dopamine, serotonin and oxytocin, creating joy and an intense sense of union with God and sharing of self with fellow believers. In such cases, they believe that they can better sense the presence of the Holy Spirit, leading them to believe that they have received a word or vision from God which they need to share with others. As further proposed by Shantz (113), these ecstatic experiences can also cause an alteration of language processing, which the author of the present article believes can also result in a prophetic word in tongues (*glossolalia*).

Spiritual formation and neuroplasticity

For many decades, it was believed that the brain became fixed at childhood, and that nothing could alter it. A person's ways and habits were permanent. However, in the past two decades it has been shown, through the advancement of brain technology which maps the brain (such as fMRI and other similar technologies) that the brain is not fixed. Rather, it has the remarkable capacity, regardless of one's age, to be rewired, changing behaviour. Thus, training can alter the brain. This means that throughout one's life, the brain has the capacity for creating new connections and neurons 'in response to experience' as proposed by Lazar et al. (2005:1893, 1897) and Siegel (2010:5). This, as previously acknowledged, is known as neuroplasticity, first offered by Donald Hebb in his 1949 book *The Organization of Behavior*, in which he postulated that when neurons fire together, they wire together. This is often referred to as Hebb's rule.

Since then, researchers have proved the truth of his findings. Each time we repeat a thought or action, neural firing takes place, strengthening connections between sets of brain cells or neurons which over time lead to automatic and thus habitual behaviour. As argued by Begley (2008):

The power of neuroplasticity to transform the emotional brain opens new worlds of possibility. We are not stuck with the brain we were born with but have the capacity to willfully direct which functions will flower and which will wither, which moral capacities emerge, and which do not, which emotions flourish and which are stilled. (p. 240)

Just a cursory look at what research is available in this area immediately reveals that biblical scholars and psychologists alike are beginning to understand the important intersection of spiritual formation and brain research. Scholars in both fields are openly optimistic and hopeful about neuroplasticity and its benefits for understanding its important role in spiritual formation.

As presented, neuroscience has shown through neural imaging studies the brain's capacity to change itself. But the Bible is also clear that lasting change which glorifies God can only be achieved by the inward work and direction of the Holy Spirit. For example, in Philippians 2:13, 'for it is God who works *in you* both to will and to work for His good pleasure'. As further proposed by Willard (2002:109),

spiritual transformation 'is achieved by the ministry of the Spirit [amid] necessary and well-directed efforts'. Here, believers can either accept the inward work of the Holy Spirit in their lives to bring about change or reject this work.

One of the most commonly used verses on change is found in Romans 12 (NIV):

Do not conform to the pattern of this world, but be transformed by the renewing of your mind. Then you will be able to test and approve what God's will is – his good, pleasing and perfect will. (v. 2)

In this verse, Paul the Apostle offers up two ideas. Firstly, that currently our minds (νοῦς) conform (συσχηματίζω) to worldly patterns and that these patterns control our lives. Secondly, he proposes that our minds can change, that is, to transform (μεταμορφώω). As proposed by Thayer (1995), μεταμορφώω is to conform one's self (i.e. one's mind and character) to another's pattern (fashion one's self according to). It is also a renewing (ἀνακαινώσις). Here, Thayer (1995) proposes that ἀνακαινώσις, in this sense, is a renovation and a complete change for the better. It is a renovation in which man as well as God (Holy Spirit) takes part. Further, and in the view of Forlines and Picirilli (1987:321), Paul the Apostle is using νοῦς to refer to mind, heart and will. They go on to say that νοῦς also comprises the faculties of perceiving and understanding, and those of feeling, judging and determining. In other words, Paul is referring to one's basic inner nature and personality that must change if one is to be successful as a believer. In referring to the theoretical framework, while the mind and body are metaphysically distinct, they causally interact and affect each other, especially on behaviour. This means that as one changes inwardly, it translates to changed outward behaviour.

Paul encourages believers to transform *progressively* by changing their thinking patterns and the way they judge and determine worldly issues, which would eventually lead to a new and better way of life. Theologically, we can refer this to the process of sanctification (ἁγιασμός) or a gradual separation of believers from the world, and a progressive transformation (as a noun, it also refers to an inward modification and restructuring) to become more Christ like (cf. 2 Cor 3:18 and Col 3:10). Paul is referring to an inward transformation that leads to good outward practice and habits.

Conclusion

Throughout this article, it was revealed that neurobiological correlates are involved in various spiritual experiences and practices such as prayer, meditation, worship, *glossolalia* [ecstatic tongues] and prophecy, despite many of the criticisms about them. It was further proposed that believers often suppose that God works independently of their natural faculties, such as the mind, brain and nervous system, when experiencing anything spiritual. Yet, and as shown, empirical evidence considers that God works with the neurobiology of our bodies and thus we cannot approach a study of spiritual experiences without recognising that the mind, brain and

nervous system are also central to their manifestation. It was also proposed that when believers are involved in various spiritual experiences, their brains are literally rewired, which can lead to more Christ-like behaviour and spiritual formation.

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M.P. is the sole author of this research article.

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