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Neurophysiological Benefits of Worship

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Abstract

Believers are called to worship, first Thessalonians 5: 16-17 (King James) instructs believers "Rejoice evermore. Pray without ceasing." Believers understand the positive ramifications of worship, although few could elucidate the exact mechanisms at work in the brain. It is only in the recent decades that advances in imaging technology as well as an overall increase in neuroscience knowledge, have allowed us to peer into the workings of the real-time brain. The ever-expanding concept of neuroplasticity has opened and expanded knowledge related to the neurophysiological benefits of worship. Understanding the physical and mental health implications of these benefits validate Paul in Romans 12:2 (King James) 'And be not conformed to this world: but be ye transformed by the renewing of your mind, that ye may prove what is that good, and acceptable, and perfect, will of God." Neuroscience now confirms the same robust benefits are available to all believers.

Key Words: Neurophysiology, Dopamine, Worship, Prayer, Cingulate

Neurophysiological Benefits of Worship

Believers are called to worship, first Thessalonians 5: 16-17 (King James) instructs believers "Rejoice evermore. Pray without ceasing." Hebrews 13:15 (King James) extorts believers to "offer a sacrifice of praise to God continually." In John the Revelator's vision of heaven, he describes four living creatures, each one with six wings full of eyes and day and night they do not cease to say "Holy, Holy, Holy, is the Lord God the Almighty, Who was and Who is and Who is to come." Revelation 4:8 (King James). In fact, the word "worship" is found 8629 times in the Bible and 8600 of those have some reference to prayer (https://www.biblegateway.com/resources/dictionary-of-bible-themes/8629-worship-times). Worship seems to be an integral part of the Christian experience. In Romans 12:1-2 (King James), Paul admonishes believers to offer their bodies as "living sacrifices and states that this is your "true and proper worship." Believers have known through experience that worship is helpful in maintaining equilibrium between the many stresses in life. Believers understand the positive ramifications of worship, although few could elucidate the exact mechanisms at work in the brain. It is only in the recent decades that advances in imaging technology as well as an overall increase in neuroscience knowledge, have allowed us to peer into the workings of the real-time brain. The ever-expanding concept of neuroplasticity has opened our eyes to the neurophysiological benefits of worship in the brain (Pittenger & Duman, 2008).

Definitions and Presuppositions

For the purpose of this study "Worship" will be defined as "Reverent honor and homage paid to God" or "to render religious reverence and homage" (Oxford Dictionary Website, n.d.). Worship is assumed to be the necessary consequence of a believer who has faith as defined in Hebrews 11:6 (King James) "he who comes to God must believe that He is". ."For the purposes of this study, "God" will be defined as the traditional Judeo-Christian God of the Holy Bible. this author also admits the bias of Protestant Judeo-Christian tradition, specifically traditional Seventh-day Adventist beliefs. A believer will be defined as one who has believed that Jesus Christ, God, came to earth and died the substitutionary death John 3:16 (King James) for a sinner, one who transgresses God's Law, found in Exodus 20 (King James) and rose again Romans 10:9-10 (King James) and will come again Hebrews 9:28 (King James). Worship is assumed to be defined as based on Scripture 2 Timothy 3:16-17, 1 John 2:3-4 (King James), Christ centered John 4:23-24, John 14:6 and characterized by the fruits of the spirit Galatians 5:22-23 (King James) and be a daily activity. Though the specifics of worship are subject to much debate and deliberation, they will not be addressed in this paper.

Background and Clinical Significance

"Then Job arose, and rent his mantle, and shaved his head; and he fell to the ground and worshipped. And he said: "Naked I came from my mother's womb, and naked shall I return there. The Lord gave, and the Lord has taken away; Blessed be the name of the Lord." Job 1:20,21(King James). Job 1:1-19 tells the tale of Job, a man from the land of Uz. The story begins with a description of the riches Job had amassed, including his children. He is labeled as "the greatest of all the men of the east" Job 1:3 (King James). Unbeknown to Job, God has called him to the attention of Satan and pointed him out as "a perfect and upright man" Job 1:8 (King James). Job is described as rising early in the morning to worship God by offering burnt offerings for his children in case they had sinned. Job 1:5 gives insight into the habits of Job's worship, by stating he did this "continually." Satan is given permission to test Job and in one day he destroys all his flocks and kills all his children. As Job learns about one disaster after another his reaction seems antithetical to the reality he has been presented with. He reacts as expected by shaving his head and renting his mantle, a culturally appropriate grief response, but follows not with curses but with worship. Later in the story we find that Satan is given permission to attack Job's person, yet Job remains faithful, as shown in his response to his wife's suggestion to "curse God and die" Job 2:9 (King James). His answer once again reveals an unflinching devotion to God as he answer's his wife's suggestion "What? Shall we receive good at the hand of God, and shall we not receive evil?" Job 2:10 (King James).

The story of Job and his response to tragedy hallmarks a believer's response to both physical and psychological stress and provides an example for the modern believer to follow. How can the modern believer cultivate the same response to the overwhelming stressors in today's world? Is there any insight in Job's story as to the mechanisms or tactics which can best serve the believer in cultivating this amazing response to stressors? The recent increase in neuroscience knowledge and advanced imaging techniques allows for a glimpse into the neurophysiological mechanisms which make Job's response to not only possible but an expected response. Using

current studies into biochemical and neurophysiologic responses to stress, as well as neuroimaging techniques, it is possible to trace the root of Job's response back to one specific habit, that of continual worship. Worship is the mechanism which prompted Job's response and can still have the same robust effects on the modern believer's brain and lead to the same significant response to stressors in today's world.

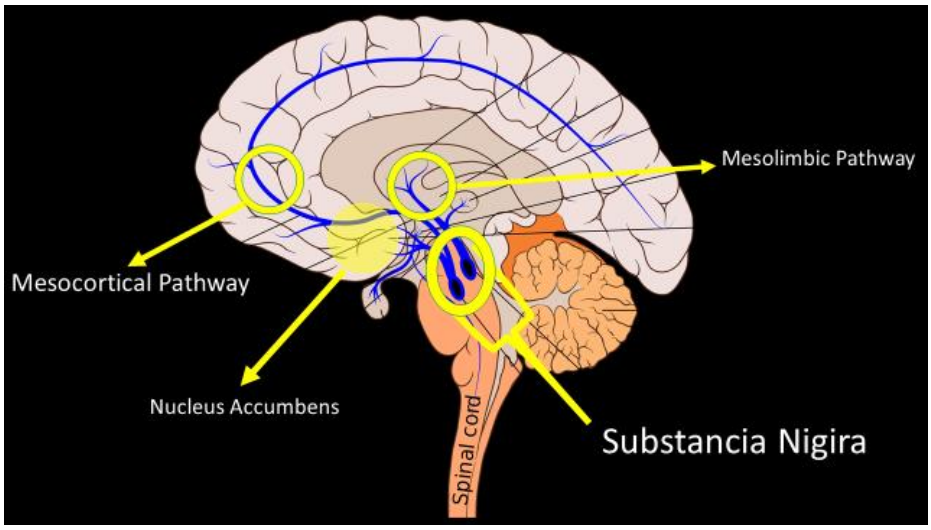
Dopamine

Dopamine is an important neurotransmitter in the central nervous system and has been shown to be highly active in important executive functions such as motor control, cognition, memory creation and reward-directed behavior. Dopamine is also the chemical precursor of Norepinephrine and Epinephrine, important in the fight or flight response (Schultz, 2007). Dopamine has four major pathways by which it affects the brain which are the mesocortical, the mesolimbic, the tuberoinfundibular and the nigrostriatal pathways. Dopamenergic neurons are mainly located in the substancia nigra where they play an important role in motor control and learning new motor skills. The nigrostriatal pathways are primarily involved in movement and are the areas that are affected by the motor pathology seen in Parkinson's Disease in the substantia nigra.(De Tassigny, Pascual, & Lopez-Barneo, 2015). The tuberoinfundibular pathway governs the release of hormones such as prolactin from the anterior pituitary gland as well as playing a role in the menstrual cycle in women. (Vallone, Picetti, & Borrelli, 2000). For the purposes of this paper the dopaminergic neurons in the ventral tegmental area will be the focus of study.

The second-largest location of dopaminergic neurons is the ventral tegmental area (VTA) which contains projections which extend forward into the frontal lobe known as the mesocortical tract or to the nucleus accumbens and limbic system by way of the mesolimbic tract. Important components of the limbic system are the Amygdala, the Hippocampus, and the Cingulate Gyrus/Cortex.

The Limbic System

The amygdala are two almond shaped nuclei deep in the medial temporal lobe associated with threat evaluation, memory creation, and emotional response (Balleine & Killcross, 2006). The amygdala is responsible forconditioning and the associated physiological response associated with fear, increased heart rate, blood pressure, and respiratory rate. This is achieved by stimulation of the hypothalamus with its connection to the pituitary hormones. The subsequent release of epinephrine and norepinephrine and their actions on the adrenergic receptors located throughout the arterial vascular system as well as the heart and lungs results in



widespread vasoconstriction, increased heart rate and strength of contraction. There are subsequent activations of clotting cascade making the organism more likely to clot, as well as a release of glucose into the bloodstream to allow for fighting or flight. Long-term effects of a chronic fight or flight reaction is one of the mechanisms thought to be responsible for the increase in cardiovascular risk, stroke, diabetes mellitus and a host of other pathology (Curtis & O'Keefe Jr, 2002). The amygdala hyper activation and subsequent volume increase has been implicated in posttraumatic stress disorder, anxiety disorders, and depression (Drevets, 2003). This mechanism is thought to be

implicated in chronic stress-related disorders and dysfunction in the human body and is the mechanism that is affected with lifestyle modifications and changes (Darviri et al, 2015).

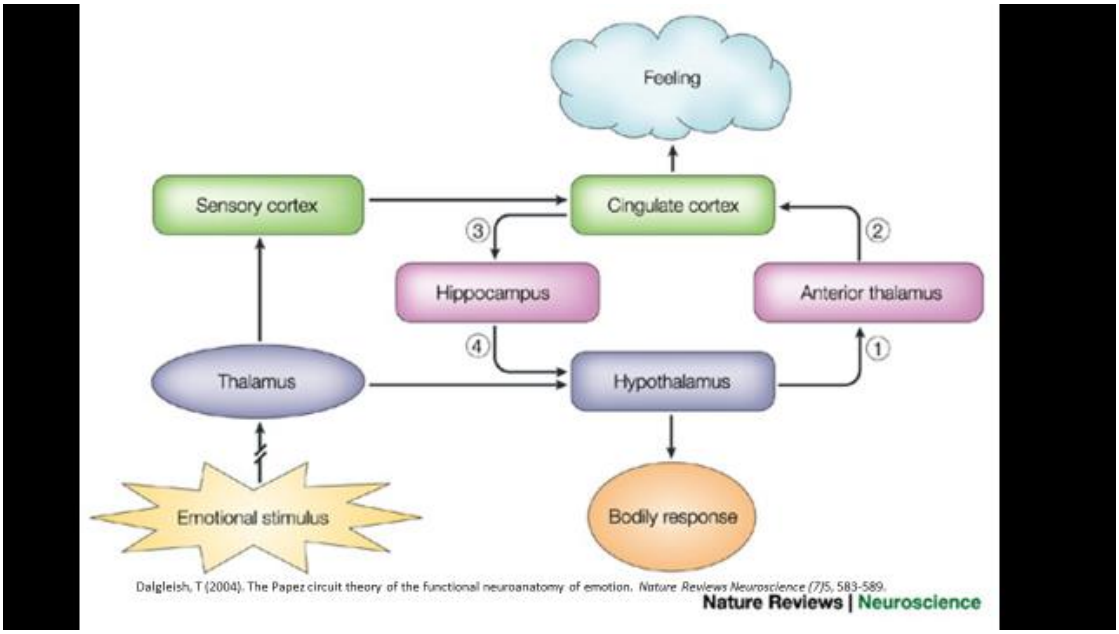
The Hippocampus is important in the consolidation of information from short-term to long-term, spatial memory which aids in orientation, navigation, and long-term potentiation (LTP) involved in behavioral learning. Memories are created not only by experiential contact, but by any exposure of senses to stimuli. These experiences are subsequently categorized and saved into memory. All memories have a physiological response whether positive or negative (Zola-morgan, Squire, Clower, & Alvarez-royo, 1991). It is an all or none response, meaning there will be a physiologic consequence or there will be none. Therefore, the amygdala and hippocampus will evoke a physiological response prior to the brain interpreting the memory. If the amygdala is hyper-sensitized to react, it will default to the fight or flight response for all stimuli and will rely on the executive functions of the cingulate cortex to override if the fight or flight response is not appropriate (Arnsten, 2009).

The cingulate cortex has been found to be highly active in emotional situations and it is the primary location for analysis and interpretation of emotions. Its importance lies in the Circuit of Papez, which is the mechanism by which we create a feeling associated with a specific stimulus and direct the body's response to the stimulus via the hypothalamus and make or reinforce memories associated with the feeling in the hippocampus (Bush, Luu, & Posner, 2000). The anterior cingulate cortex has been associated with empathy and forgiveness, specifically while observing someone who is experiencing pain or trauma. The ability to forgive involves a complex series of interactions between the cingulate and the hippocampus which in turn requires a rewriting per se of memory (Farrow et al. 2001). The anterior cingulate gyrus also serves an important function in self-regulation regarding emotional response, and goal directed action. It has been implicated in altruistic behavior and the negation of self or the initiation of behavior that may cause harm to the organism overriding the amygdala's fear response (Posner, Rothbart, Sheese, & Tang, 2007).

The Frontal Lobe

The frontal lobe makes up two-thirds of the human brain and functions in motor control, language, executive level functions such as attention, memory, mood, affect, personality and moral reasoning. The frontal lobe is equipped with a high-level filtering mechanism that enhances goal-directed activations and inhibits irrelevant activations (Duncan & Owen, 2000). It assumes top-down processing control when behavior is guided by internal states or intentions rather than external stimuli. Resulting in response rather than reaction to environmental and internal stimuli (Dennis, 1991). The frontal lobe is also charged with maintaining attention and modulating intention in response to stimulus and organismal need (Miyake et al.1999).

Attention is more accurately defined as the frontal lobe understanding the importance of a given situation and conscientiously deciding to focus the energy and focus of the organism to the stimuli it seeks to attend too.



This requires silencing the myriad of other stimuli which is constantly barraging the organism and quieting the somatosensory cortex and amygdala (Miyake, 1999). This quieting is an intentional act that requires complex inhibition of several important areas of the brain and includes the amygdala's fear center, the portion of the amygdala that responds to dopamine for memory creation remains intact. Quieting of the hypothalamic fight or flight response, while allowing the hippocampus to remain engaged for recall and new memory formation as the cingulate gyrus assigns feelings to the memory created (Duncan & Owen, 2000)

Intention requires several distinct components which must be formulated prior to initiating an action. There are five separate variables which must be addressed as the frontal lobe gathers the information necessary to initiate an action to accomplish a specific goal. The first variable is a cognizance of time, time to accomplish task, time to attain goal, energy requirements for the allotted goal and time. These must be calculated prior to intentionality (Tse, Intrillgator, Rivest, & Cavanagh, 2004). The frontal lobe relies on nuclei in the temporal and parietal lobes for inputs on the time requirements and energy calculations. It also relies on the hippocampus for reference to past experiences with similar goals and requirements (Rao, Mayer, & Harrington, 2001). The frontal lobe then examines the problems and time constraints and determines the cause and effect of each action that is required before attaining the goal. The cingulate cortex adds an empathic parameter which calculates each actions potential for engagement of other individuals and returns to the frontal lobes to calculate the ethical and moral consequences of each action and the goal. Finally, if meaning can be extrapolated, the frontal lobe again relies on the hippocampus for a memory reference and the cingulate for an emotional input the series of actions and goal will entail. Once all the variables have been calculated the frontal lobe decides whether the goal and actions required to obtain the goal are worthwhile and if so initiates the action (Rudd, Vohs, & Aaker, 2012). These steps have been drawn out in detail for purposes of examination but all of this occurs in only milliseconds. Complex evaluations and discernment are the hallmarks of frontal lobe executive functions. When contrasted with the amygdala-hippocampus reactionary initiation of the fight or flight response, the frontal lobe's well informed decision-making process seems even more eloquent.

Worship's Effects on the Brain

Worship and prayer have a well-documented positive effect on both the person who engages in the prayer and worship, and the person who is the subject of prayer (Galton 2012). The most exciting finding related to prayer was found by Andrew Newberg a radiologist who first began to study the effects of prayer on the individual using a functional magnetic resonance imaging (fMRI). fMRI was a relatively new form of advanced imaging technology which is able to show detail unprecedented in prior imaging techniques, using the properties of the highly-oxygenated blood in the brain and is able to capture minute metabolic changes and extrapolate a detailed image of not only the physical location studied but also the metabolic characteristics of the same location (Logothetis, Pauls, Augath, Trinth, & Oelterman, 2001).

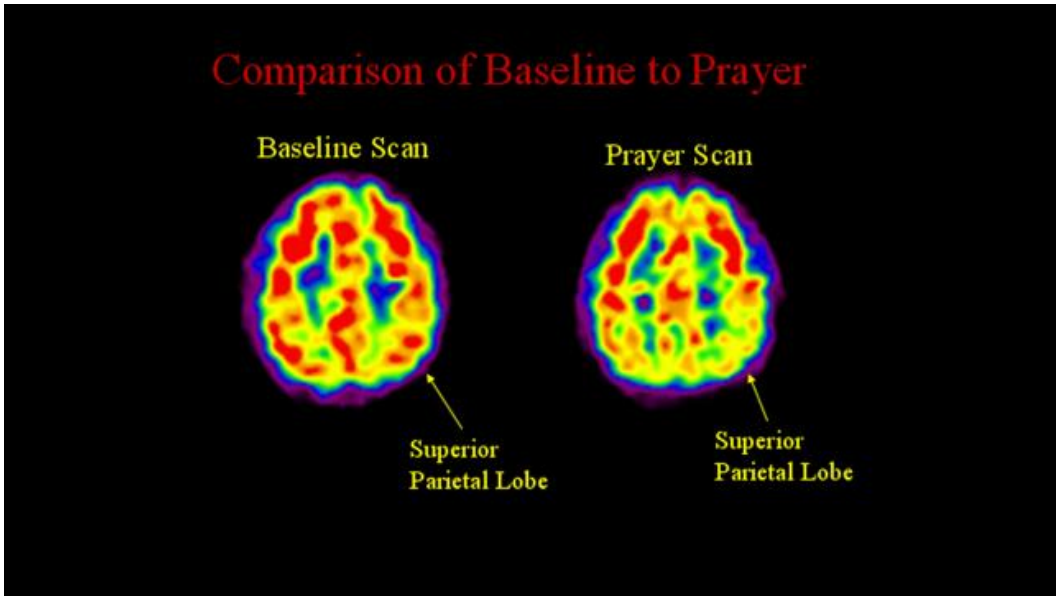
Using a simple study design, he recruited patients from different faith traditions and directed them to spend twelve minutes a day in active prayer, a conversation with God and control group who did nothing. After obtaining a baseline fMRI, a repeat fMRI scan was obtained and differences in volume and metabolic activity were evaluated. The startling finding shattered the previously believed myth that the brain would not grow in adulthood. A statistically significant increase in the volume of the cingulate cortex was observed and launched Newberg's career into the field of neurotheology (Newberg et al., 2003).

Newberg's findings were startling and demonstrated actual quantifiable changes in brain volume and metabolism in two very distinct structures. The first structure was the cingulate cortex which increased demonstrably in volume and metabolic activity. The second was another unexpected finding the down regulation of the amygdala's fear response and subsequent decrease in the activation of the hypothalamus fight or flight mechanisms (Newberg, 2003). Since this hallmark findings the images collected have brought understanding of the physiological benefits of prayer which have been studied in the past. The main neurophysiologic benefits of

worship and prayer can be summarized by t Newburg's findings pertaining to the cingulate cortex and the amygdala.

Worship and the Cingulate

An increase in the volume of the cingulate cortex or gyrus results in an increase in not only the capability, but also implementation of empathetic thinking and feeling. In essence, as the cingulate grows in volume and metabolic activity you transform into a nicer, more forgiving and trustful person (Kuchan, 2007). Jesus' direction in



Matthew 5:44 (King James) to "Love your enemies, bless them that curse you, do good to them that hate you, and pray for them which despitefully use you, and persecute you" becomes a more attainable goal if the person spends time in daily worship and prayer. John 13:34-35 (King James) states the believer should "love one another; as I have loved you" and adds a demonstrable example of a follower of Jesus "By this shall all men know that ye are my disciples, if ye have love one to another." When Christ describes the scene at the end of the world He describes the actions of those He has come to save, Matthew 25:35 (King James) "For I was hungered, and ye gave me meat: I was thirsty, and ye gave me drink: I was a stranger, and ye took me in:" these actions would be the direct result of a larger more active cingulate. The interesting component to this story is that this behavior has become so common place for the believer he is incredulous and they question Jesus by asking, "then shall the righteous answer him, saying, Lord, when saw we thee hungered, and fed thee? or thirsty, and gave thee drink?" Matthew 25:37 (King James). Which can only mean this empathy and love has become so ubiquitous in the life of the believer the frontal lobe does not have to intention to act in this specific way. It has become the most prime directive overriding the self-preservation and self-awareness which is the default of the amygdala (Schjoedt, Stødkilde-Jørgensen, Geertz, & Roepstorff, 2009).

Worship and the Amygdala

Worship's effects on the amygdala have also been well studied and demonstrates a wide range of effects as a result of the hypoactivation or down-regulation to the fight or flight mechanism (Boelens, Reeves, Replogle, & Koenig, 2010). This hypoactivation extends to the hypothalamus and the initiation of the fight or flight response. The result is a significant decrease in the deleterious effects of chronic fight or flight activation and the decrease in heartrate, blood pressure, blood glucose levels and serum markers of inflammation (Anderson & Nunnelley, 2016). This hypoactivation also has measurable psychic effects, measurable decreases in depression, anxiety, chronic pain and even posttraumatic stress have been identified and can be traced back to one daily action, worship (Simão, Caldeira, & Campos de Carvalho, 2016). These finding have been so robust, that incorporating prayer as part of the treatment plan for pathologies ranging from anxiety/depressive disorders, hypertension, diabetes mellitus, and disorders of chronic inflammation has been encouraged (Anderson & Nunnelley, 2016). This effect is most completely captured by 1 John 4:18 (King James) "There is no fear in love; but perfect love casteth out fear."

The hypoactivation of the amygdala results in a downregulation of the mesolimbic pathway for dopamine use and results in the mesocortical, and its subsequent activation of the frontal lobe and the eloquent process of attention and intention, as the default pathway for stimuli interpretation (Peterson, Zhang, Hu, Chao, & Li, 2017). The result of this pathway becoming the default increases self-control, discipline and reactionary responses. Each stimulus is no longer interpreted from a self-preservation model, but relies on the cognizance of time, evaluation of cause and effect, empathy, moral/ethical evaluation and derives meaning from the actions of the individual (Van Elk & Aleman, 2016).

Conclusion

The story of Job and his ability to worship in response to horrific stressors, seems much more plausible when one examines his response in the light of the aforementioned mechanisms. As he received the stimuli, it travelled through the mesocortical pathway to the frontal lobe for interpretation, bypassing the mesolimbic pathway which may have lead him to a reactionary response. Instead Job's response is appropriate for grief, in his cultural context, and he defaults to doing as was his custom. He worshipped. Long before Christ spoke the words of John 16:33 (King James) "These things I have spoken unto you, that in me ye might have peace. In the world ye shall have tribulation: but be of good cheer; I have overcome the world." Recalling the stories of the Bible, of Daniel, Daniel 6:10 (King James), the early Christian church in Acts 2:46-47 (King James), and the group of believers in Berea from Acts 17:11(King James) who "searched the scriptures daily" one can begin to understand the admonishment of Paul in Romans 12:2 (King James) 'And be not conformed to this world: but be ye transformed by the renewing of your mind, that ye may prove what is that good, and acceptable, and perfect, will of God." These same robust results as described above are available to all believers who are willing to spend as little as twelve minutes a day in prayer and worship.

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