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BRAIN LATERALIZATION OF EMOTIONAL PROCESSING OF CLINICALLY DIAGNOSED ANXIOUS AND DEPRESSED MALE PATIENTS

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ABSTRACT

Lateralization is the idea that the two halves of the brain -left and right hemispheres - execute different functions. This study employed small-N design involving 4 male patients (2 anxious) and (2 depressed with left and right hemispheres dominance). In Study1, the emotional processing was done during the PET scan which lasted for 10 minutes. In Study 2, emotional processing was conducted using the Self-Assessment Manikin (SAM). PET brain scan images revealed that both the LHDAP and RHDAP had hyper metabolism in the right sensor motor cortex while LHDDP had hyper metabolism in the left midfrontal cortex and left associative visual cortex and the RHDDP had hyper metabolism in the right primary visual cortex. On the SAM, RHDAP revealed happy emotion with the pleasant picture and felt in control with the unpleasant picture while the LHDAP revealed neither happy nor unhappy with the pleasant picture and dominated with the unpleasant picture. On the other hand both LHDDP and RHDDP revealed quite happy feelings with the pleasant picture and felt dominated with the unpleasant picture. This implied that anxious patients processed emotions in the right hemisphere regardless of valence while depressed patients processed their emotions based on their brain dominance.

Keywords: Neuroimaging, brain lateralization; emotional processing; anxiety disorder; depression

INTRODUCTION

The human brain controls all the vital functions of the body. It acts as a single entity in unison with the other parts in the system because of the connection called corpus callosum albeit divided into halves (hemispheres)–left hemisphere and the right hemisphere. The left hemisphere executes its functions separately from that for the right hemisphere. The idea that the two halves of the brain's cerebral cortex execute different functions is the brain lateralization. In emotional processing, the right-hemisphere hypothesis posits that the right hemisphere is specialized for the perception, expression, and experience of emotion, regardless of valence (Borod, Koff, & Caron, 1983; Heilman & Bowers, 1990; Ross, 1985; Tucker, 1981). Relative to this hypothesis is the finding that high-trait anxiety has been associated with increased accuracy for negative affective faces presented to the left visual field (right hemisphere) in comparison to low-trait anxious individuals (Everhart &Harrison, 2000). Likewise, depressive states were associated with relatively increased right versus left anterior activity and decreased right posterior activity (Heller, 1993). In addition, secondary mania has been associated with right anterior lesions (Gainotti, 1972).The valence hypothesis on the other hand, postulates that the right hemisphere is specialized for negative emotion and that the left hemisphere is specialized for positive emotion (Ehrlichman, 1987; Silberman & Weingartner, 1986). A variant of the valence hypothesis contends that differential specialization exists for the expression and the experience of emotion as a function of

ISSN: 2186-8476, ISSN: 2186-8468 Print
Vol. 2 No. 3 September 2013

valence, whereas perceptual processing of both positive and negative affective stimuli is a right cerebral function (Bryde, 1982; Davidson, 1984). Relatedly, this variant of the valence hypothesis indicates that the left and right anterior regions are specialized for the expression and experience of positive and negative valence, respectively, whereas the right posterior parietal, temporal, and occipital regions are dominant for the perception emotion (Borod, 1993). There are two dimensions in describing the affective experience. These are commonly referred to as “valence” and “arousal” which is called as “circumplex model” (Lang, Greenwald, Bradley, & Hamm, 1993). This model is depicted along two continuums or axes. The valence continuum ranges from negative (e.g., fear, anger) to positive (e.g., happiness, contentment) whereas the arousal axis ranges from low to high. Many emotions may be distinguished from one another using the circumplex model. For instance, anger may be described as “negative valence and “high arousal” whereas contentment may be characterized as “positive valence” and “low arousal”. This study is a pioneering work in the field of neuropsychology in the Philippines to delve into the brain dominance of the anxious and depressed male patients and how the brain structures through the use of neuroimaging method, influence the emotional processing of these patients.

METHODS

Participants

Four male patients (2 anxious and 2 depressed) referred by clinicians in mental health facilities were assessed in their brain dominance using the Luria Nebraska Neuropsychological Battery as such participants were labeled as Left Hemisphere Dominant Anxious Patient (LHDAP); Right Hemisphere Dominant Anxious Patient (RHDAP); Left Hemisphere Dominant Depressed Patient (LHDDP) and Right Hemisphere Dominant Depressed Patient (RHDDP). Informed consent was derived from the participants in conducting the study.

Materials and Procedure

Study 1 dealt with the emotional processing of the participants which was facilitated through the use of 3 affective pictures (pleasant, neutral and unpleasant) from the International Affective Picture System (IAPS. The neuroimaging method was done through the Positron Emission Tomography (PET) brain scan. The positrons are emitted from a radioactive tracer, such as radiation-tagged glucose, administered to the patient. Positron images were acquired with a Philips Gemini TF 64 PET-CT scanner at a 1-bed position for 10 minutes, 30 minutes after administration of 212.01 MBq (5.73) of [^{18}F] Fluoro-2-deoxy-D-glucose (FDG). The PET scan is non-contrast 120 kV, 50mAs CT scan of the brain was acquired with 5mm X 5mm slice thickness for attenuation correction. The participants were subjected to Positron Emission Tomography (PET) brain scan for a period of 10 minutes while viewing the fragmented affective pictures of IAPS above them. The fragmented affective pictures were arranged in such a way that on the left side was a pleasant picture, on the middle was a neutral picture and on the right side was an unpleasant picture.

Study 2 dealt with the emotional processing of the participants using the Self-Assessment Manikin (SAM) of the IAPS focusing on the emotional experience of the participants for pleasure, arousal, and dominance dimensions.

ISSN: 2186-8476, ISSN: 2186-8468 Print
Vol. 2 No. 3 September 2013

RESULTS

Study 1

The left hemisphere dominant anxious participant is a right handed person and the emotional perception through the fragmented affective pictures was from left to right with the participant's right visual field (RVF) would have an unpleasant picture and the left visual field (LVF) would have a pleasant picture. Emotional perception was measured through the glucose uptake of neurons in a particular region of the brain. Results revealed a hyper metabolism or a higher uptake of glucose of neurons at the right sensorimotor cortex (rSM) as shown in Figure 1. It can be noted that emotional perception of the participant is mostly processed at the right sensorimotor region. This is characterized by a heightened neuronal activity in the right sensorimotor region which is an area of the cortex including the precentral gyrus and the postcentral gyrus combining sensory and motor functions. The precentral gyrus is specialized for the control of fine movements such as moving finger at a time. Separate areas are responsible for different parts of the body, mostly on the contralateral side (opposite) but also with slight control of the ipsilateral side (same). The postcentral gyrus or the primary somatosensory cortex is the primary target for touch sensations and information from muscle-strectch receptors and joint receptors (Kalat, 2004). The postcentral gyrus includes four bands of cells that run parallel to the central sulcus. Separate areas along each band receive simultaneous information from different parts of the body (Nicolelis, Ghazanfar, Stambaugh, Oliveira, Laubach, Chapin, Nelson, & Kaas, 1998). Two of the bands receive mostly light-touch information, one receives deep-pressure information and one receives a combination of both (Kaas, Nelson, Sur, Lin, & Merzenich, 1979). In effect, the postcentral gyrus contains four separate representations of the body. Information about touch and body location is important not only for its own sake but also for interpreting visual and auditory information

Considering the areas of somatosensory and motor functions on Figure 2, McIntosh explains that modularity is mainly observed in sensory and motor systems, however, beyond these very receptors, modularity becomes "fuzzier" and one sees the cross connections between systems increase. He also illustrates that there is an overlapping of functional characteristics between the sensory and motor systems, where these regions are close to one another. These different neural interactions influence each other, where activity changes in one area influence other connected areas. Hence, connections between these two areas are observed for patient suffering from anxiety disorder. In anxiety disorder, there is an upward flow of signals from the limbic system to the cerebral cortex. Anxiety activates specific loci representing sensory, motor, or thinking activity in the cerebral cortex. It looks similar to that in the depressive state. When loci of unpleasant memories of the cerebral cortex are activated in the anxious state, one tends to be pessimistic. In a specific case, information processing is disturbed under the activation of anxiety locus. It is called dissociative state. Just in a case of obsessive-compulsive state, it forces the patient to repeat actions like washing hands or going to the toilet under the influence of the anxiety locus. The term used would be "anxiety locus", but these various anxiety loci act in the different fashion. These anxiety loci are considered to be different neuron groups.Anxiety disorders are characterized by numerous physical symptoms such as: excessive sweating, muscle tension, numbness and tingling, shallow breathing, fainting and rapid heart rate. The emotional symptoms of anxiety disorders occur simultaneously with the physical ones and include agitation, feelings of unreality, fearfulness, feelings of impending doom, irritability, nervousness and shyness (Prousky, 2005). Expectedly, the left hemisphere dominant anxious patient perceived the affective stimuli and was observed to have activation in the Right Sensorimotor (rSM) which explains

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Vol. 2 No. 3 September 2013

exactly the anxious state of the patient such as restlessness, muscle tension, shallow breathing, fainting and rapid heart rate. Similarly, Pissiata et al., (2002) conducted uncontrolled PET study with patients who had combat-related Post Traumatic Stress Disorder (PTSD). They were previously screened for heart-rate and emotional reactivity to the trauma-related stimuli. Increases in regional cerebral blood flow (rCBF) were seen in the right sensorimotor cortex (Brodmann Area (BA) 4,6) right somatosensory cortex (BA1,2,3) and the cerebellar vermis, and the periaqueductal grey in the midbrain. Decreased blood flow was observed in the right retroslenial cortex (BA 21, 29, 30)/ Significant increases in rCBF were also seen in the right amygdale, these increases correlated significantly with subjects' self-reports of anxiety.

The right hemisphere dominant anxious participant is a right handed and the emotional perception through the fragmented affective pictures was from left to right with the participant's right visual field (RVF) would have an unpleasant picture and the left visual field (LVF) would have a pleasant picture. Emotional perception was measured through the uptake of neurons in a particular region of the brain. Positron images shown in Figure 3 described the right Sensorimotor (rSM) cortex as the region most hypermetabolic while the left sensorimotor cortex (lSM) is the most hypometabolic region. It can be noted that neuronal activity of emotional perception is greater in the right hemisphere than the left hemisphere where the participant is lateralized. Since the participant is right hemisphere dominant, expectedly, a more active right hemisphere was observed. Similar with the Left Hemisphere Dominant Anxious Patient (LHDAP), the Right Hemisphere Dominant Anxious Patient (RHDAP) was observed to have hypermetabolized right Sensorimotor (rSM) cortex. The right sensorimotor cortex is active during emotional perception of the right hemisphere dominant anxious patient. Observations of a direct link between emotion processing and the right hemisphere were made nearly 100 years ago: Mills (1912) observed that the presence of a unilateral right-sided lesion was associated with decrease in emotional expression; Babinski (1914), Denny-Brown, Meyer, & Horenstein (1952) noted that patients with right-hemisphere lesions were often inappropriately indifferent or manic. The cumulative researches on right hemisphere led to the development of the right-hemisphere model or hypothesis. The right hemisphere hypothesis posits that the right hemisphere is specialized for the perception, expression, and experience of emotion, regardless of valence (Borod, Koff, & Caron, 1983; Heilman & Bowers, 1980; Ross, 1985; Tucker, 1981). Hence, the emotional perception of the right hemisphere dominant anxious participant is more evident in the right hemisphere regardless whether the negative valence of affective pictures were positioned in the right visual field (RVF) or in left visual field (LVF). Interestingly, the result is consistent with the study of Killgore & Yurgelun-Todd (2007) and found out that the right hemisphere was more extensively activated than the left by a masked affect task, regardless of valence or visual field of input, suggesting that affective information in general is transferred to the right hemisphere in a manner consistent with the colossal relay hypothesis of Zaidel (1983, 1985, 1986; Zaidel et al al., 1988, 1991).

The result of the positron images for both the LHDAP and RHDAP which revealed greater glucose uptake in the right Sensorimotor cortex (rSM) regardless of lateralization support a variant of the valence hypothesis which contends that differential specialization exists for the expression and the experience of emotion as a function of valence, whereas perceptual processing of both positive and negative affective stimuli is a right cerebral function (Bryden, 1982; Davidson, 1984).

The left lateralized depressed participant is a right handed and the emotional perception through the fragmented affective pictures was from left to right with the participant's right

ISSN: 2186-8476, ISSN: 2186-8468 Print
Vol. 2 No. 3 September 2013

visual field (RVF) would have an unpleasant picture and the left visual field (LVF) would have a pleasant picture. Emotional perception was measured through the uptake of neurons in a particular region of the brain.

Positron images revealed in Figure 4 for the left hemisphere dominant depressed patient that the most hypermetabolic region is the left midfrontal cortex while the left associative visual cortex is the region with the most significant hyper metabolism during the emotional perception whereas the most hypometabolic regions are the right sensorimotor (rSM) cortex and left posterior 24cingulated cortex. Hence, neuronal activity is mostly observed during the emotional perception of affective stimuli at the left midfrontal cortex and the left associative visual cortex. Considering that the participant is a left lateralized or dominant, expectedly the activation of the neuronal activity is also in the left region which showed congruency.

The principal function of the medial frontal cortex as shown on Figure 5, in particular the anterior cingulated cortex (ACC) is to monitor actions (Bush, Phan & Posner, 2000; Paus, 2001). The ACC is a part of the brain's limbic system. The findings from EEG studies of a focal area of negativity in scalp electrodes following an error response led to the idea that ACC might be the brain's error detection and correction devise. ACC is a part of a circuit involved in a form of attention that serves to regulate both cognitive and emotional processing (Bush, Phan & Posner, 2000).

Visual associative areas as shown on Figure 6, on the other hand, were relatively more active in the unpleasant/pleasant and unpleasant/neutral comparisons. Visual associative areas may be preferentially involved in the evaluation of unpleasant visual stimuli in young individuals (Morris, Friston, Buchel, Frith, Young, Calder & Doland, 1998).

Accordingly, emotion processing is composed of evaluative, experiential and expressive components. The evaluation of affect may be correct or incorrect depending on an individual's ability to identify the emotional valence carried by an event or an object and is influenced by mental illness. Patients with depression, positive life events are often considered negative or harmful because people with psychiatric disorders lose their capacity to distinguish between pleasant and unpleasant experiences and the ability to assign the appropriate emotional valence to these experiences. Patients with clinical depression show decrease perfusion in the left dorsal lateral and bilateral medial prefrontal regions. Hence, prefrontal cortex is part of the neural system engaged in detection of positive features in objects, events and mental states (Paradiso, Johnson, Andersen, O'Leary, Watkins, Ponto & Hichwa (1999). The relative increased blood flow in the frontal lobe during the neutral/unpleasant comparison is observed among patients with depression and is consistent with the hypothesis that people with psychiatric disorders lose their capacity to distinguish between pleasant and unpleasant experiences. Considering the case of the left-hemisphere depressed dominant participant, it can also be noted that the hypermetabolized areas of left midfrontal cortex and left visual associative cortex is observed during the emotional perception of affective stimuli of pleasant, neutral and unpleasant. Seemingly, the participant is unable to distinguish the appropriate emotional valence hence the activation of the midfrontal cortex and visual associative areas. Consistent with the previous findings, individuals with bipolar disorder showed greater relative frontal cortical activation in preparation for hard/win trials (Harmon-Jones, Abramson, Nusslock, Sigelman, Urosevic, Turonie, Alloy & Fearn, 2007). Moreover, trait anger was positively related to greater relative left frontal cortical activity to anger-evoking pictures but not to other types of pictures when measured by electroencephalographic (EEG) alpha power (Harmon-Jones, 2007), greater left than right frontal cortical activity is associated with approach motivation,

ISSN: 2186-8476, ISSN: 2186-8468 Print
Vol. 2 No. 3 September 2013

which can be positive (e.g., enthusiasm) or negative in valence (e.g., anger) (Harmon Jones, Gable, & Peterson, 2010).Likewise, the findings of Harmon-Jones, Abramson, Nusslock, Sigelman, Urosevic, Turonie, Alloy & Fearn (2007) on the *Effect of bipolar disorder on left frontal cortical responses to goals differing in valence and task difficulty* revealed that individuals with bipolar disorder showed greater relative frontal cortical activation in preparation for the hard/win trials particularly in response to positive challenges whereas the nonbipolar individuals showed a decrease in left frontal cortical activation from medium to hard win trial. Further, the middle pre-frontal cortex (mPFC) is a region of central importance in the process of regulation and it does this through the mechanism of integration in linking differentiated parts of the brain together into a coherent and functional whole. It functions in terms of body regulation, emotional balance, fear modulation, response flexibility, attuned communication, empathy, self-insight, morality and intuition. If one is over tired, burnt-out or "triggered" by something in the environment, he can lose his capacity for self-regulation, empathy and attunement and would act out in ways that are harmful to others and self.The left hemisphere dominant participant experiencing symptoms of depression would process emotion using the most dominant hemisphere of his brain region which is left hemisphere and this was observed with the activation of the left midfrontal cortex and left visual associative areas. Notwithstanding, this observation contradicts with the previous researches among depressed patients using EEG activities. Persons experiencing depression symptomatology characterized by a lack of positive affect [depressed mood, anhedonia, feelings of worthlessness or guilt] and approach behavior [psychomotor retardation, fatigue, and impaired social and/or occupational functioning]) have been found to exhibit a relative dearth of approach behavior and decreased left-frontal arousal as measured by EEG (Allen, Urry, Hitt, & Coan, 2004; American Psychiatric Association, 1994; Debener, et al.,2000; Heller & Nitschke, 1997; Henriques & Davidson, 1990, 1991; Robinson & Downhill, 1995; Robinson, et al.,1984, Schaffer et al., 1993).

However the finding of the present study on the neuronal activation in the left midfrontal cortex during emotional processing of the LHDDP is contrasted by the findings of the study of Esslen, Pascual-Marqui, Hell, Kochi and Lehnmann (2004) on brain areas and time course of emotional processing using low resolution brain electromagnetic tomography (LORETA) which showed that activation in brain areas of significant time segments was highest in the right frontal areas. Likewise, strong activation was found in the happy, sad and disgust conditions in extended fronto-temporal areas.

The right hemisphere dominant depressed patient (RHDDP) participant is a right handed person and the emotional perception through the fragmented affective pictures was from left to right with the participant's right visual field (RVF) would have an unpleasant picture and the left visual field (LVF) would have a pleasant picture. Emotional perception was measured through the uptake of neurons in a particular region of the brain. Positron images revealed in Figure 7 for the right hemisphere dominant depressed patient that the most hypermetabolic region is the right primary visual cortex. The primary visual cortex is also known as striate cortex or V1 and extrastriate visual cortical areas such as V2, V3, V4 and V5. The right hemisphere visual cortex receives signals from the left visual field. It is responsible for processing of processing visual information. The representation and recognition of objects are thought to be functions of the higher extrastriate cortical areas.The RHDDP participant receives the affective stimuli primarily from the left visual field and emotional perception to these affective stimuli were primarily processed in the right primary visual cortex which was observed with the hypermetabolized neuronal activity. Considering that the participant is a depressed patient, the activation of the primary visual cortex relates significantly on how the

ISSN: 2186-8476, ISSN: 2186-8468 Print
Vol. 2 No. 3 September 2013

participant processing the affective stimuli and these affective stimuli control the emotional behavior of the participant. The hyper metabolism of the right primary visual cortex as shown on Figure 8 enabled the participant to process the affective stimuli in the right hemisphere regardless of the valence of the emotions. Hence, emotional behaviors would depend on the visual information processed in the right visual cortex whether it is positive or negative emotions.

Similarly, a study of Lane and co-workers (1997), using PET method, they examined the regions of brain activity in a group of female subjects viewing pleasant, neutral and unpleasant pictures from IAPS. Results showed that large increases in activity were obtained from unpleasant pictures in extrastriate visual cortex (e.g., Brodmann's visual areas 18 and 19) relative to neutral pictures. Albeit the study did not point out the lateralization of the research participants, interestingly, hyper metabolism was observed in the visual cortex similar to the RHDDP emotional perception of the affective stimuli regardless whether the activation was for the pleasant, neutral or unpleasant picture.

The valence hypothesis postulates that the right hemisphere is specialized for negative emotion and the left hemisphere is specialized for positive emotion (Ehrlichman, 1987; Silberman 7 Weignartner, 1986). A variant of this contends that differential specialization exists for expression and the experience of emotion as a function of valence whereas perceptual processing of both positive and negative affective stimuli is a right cerebral function (Bryden, 1982; Davidson, 1984). Relatedly, this variant of valence hypothesis indicates that the left and right anterior regions are specialized for the expression and experience of positive and negative valence, respectively, whereas the right posterior parietal, temporal, and occipital regions are dominant for the perception of emotion (Borod, 1983). These previous researches support the finding of this investigation regarding the neuronal activation of the right hemisphere of the RHDDP participant during the emotional processing. In addition, a common pattern of emotion modulation was obtained for both the late posterior positive component (LPP) of the event-related potentials (ERP) from the EEG, and in the hemodynamic BOLD signal in extrastriate visual cortex. The study of Sabatinelli and others (2005) showed that the magnitude of BOLD signal in inferotemporal visual cortex covaries closely with amygdale activity. This covariation strongly supports the presence of reentrant projections from amygdale to the visual system that Amaral and others (1992) have described in nonhuman primates. This reentrant connections presumably prompts recruitment of a wider neuron pool in the posterior brain, associated with more intensive processing of motivationally relevant images (Holland& others 2000; Maunsell, 2004). The increased activation in widespread higher-order visual areas is readily able to reach the scalp, thus accounting for the LPP waveform's high sensitivity to emotional input. Similarly, the result of the PET scan for the RHDDP proved more activation in the right visual cortex which can be construed that emotional processing also took place at the primary visual cortex as reentrant connection to the amygdale the reason for its hypermetabolized neuronal activity.

Study 2

After exposure to the Positron Emission Tomography (PET) brain scan, the participants were subjected to 10 minutes of post-inquiry using the same order of affective pictures. The participants' emotional processing was assessed using the Self-Assessment Manikin (SAM).

ISSN: 2186-8476, ISSN: 2186-8468 Print
Vol. 2 No. 3 September 2013

Table 1. SAM rating of left and right hemispheres dominant anxious patients

Participant	*Picture*	*Pleasure*	*Arousal*	*Dominance*
LHDAP				
	Pleasant	5	5	5
	Neutral	5	5	3
	Unpleasant	5	3	3
LHDAP				
	Pleasant	8	6	5
	Neutral	3	1	3
	Unpleasant	1	1	9

LHAP (Left Hemisphere Anxious Patient), RHAP (Right Hemisphere Anxious Patient)
Pleasure (9 (Happy – 1 (Sad), Arousal (9 (Excited) – 1 (Frenzied)
Dominance (9 (Controlled/Dominated) – 1 (In-control/Dominant)

Table 1 shows the left hemisphere dominant anxious patient (LHDAP) assessed the pleasant affective stimulus as neither happy nor unhappy, neither excited nor frenzied and neither dominated or nor in-control. On the neutral affective picture, the LHDAP felt neither happy nor unhappy, neither excited nor frenzied and felt less in-control. Further, on the unpleasant affective picture, the LHDAP felt unhappy, frenzied and felt less in-control. Emotional processing of the LHDAP using affective stimuli elicited unbiased reactions with the pleasant and the neutral pictures however reacted accordingly to the unpleasant affective stimulus. The LHDAP reacted to the unpleasant picture as unhappy and frenzied which are correlates of negative emotion albeit felt in-control. Unpleasant picture evoked negative emotions accordingly and this is primarily controlled by the right hemisphere according to the Valence Model of brain lateralization which appeared contradictory to the lateralization of the participant. On the other hand, the right lateralized anxious patient (RHDAP) evoked happiness, neither felt excited nor frenzied and neither felt in-control or dominated with the pleasant affective picture. On the neutral affective picture, the RHDAP felt more likely unhappy, frenzied and felt less in-control. The unpleasant picture evoked feelings of unhappiness, feeling frenzied and feeling dominated or controlled for the RHDAP. The emotional processing of the RHDAP participant revealed not so consistent reaction with the pleasant affective picture such that happiness was only evoked on the pleasure dimension but not on arousal and dominance dimensions. Likewise, unbiased reactions on the neutral affective pictures were also noted. Expectedly, with the lateralization of the participant, the unpleasant picture evoked negative reactions such as sadness, frenzied and dominated. Congruent to the right hemisphere of the brain which controls the negative emotions, the RHDAP expressed negative emotions toward the unpleasant pictures. Similarly, patients experiencing panic attacks showed greater (and very high) degrees of emotional control compared with patients with anxiety disorder who had never experienced a panic attack (Baker, et al., 2004). This can be observed also with the RHDAP who felt emotionally in control when presented with the unpleasant affective stimulus. This can also be construed that RHDAP had experienced panic attacks with the anxiety-provoking situations such that the thought of it would make the RHDAP panicky.

ISSN: 2186-8476, ISSN: 2186-8468 Print
Vol. 2 No. 3 September 2013

Nonetheless, regardless of the lateralization, both the LHDAP and RHDAP evoked negative emotions with the unpleasant affective stimulus. The unpleasant stimulus for anxious patient is considered a feared stimulus and this is being processed emotionally in the brain and becomes a part of the cognitive network of the anxious patient which would then elicit avoidance response. As explained by the emotional processing theory (Foa & Kozak, 1986), fear is activated through associative networks that include information about the feared stimulus, escape or avoidance responses to the feared stimulus, and the meaning of the fear (e.g. threat or danger). Fear becomes problematic when it is intense to a degree that it gets in the way of functioning, or when it persists even when there are no clear indications of danger. In these instances, there maybe maladaptive or pathological fear structures. The theory holds that chronic avoidance (e.g., escape behavior, avoidance, dissociation) often leaves these maladaptive schemas in place, as people do not remain in a situation long enough for new learning to occur. Fear structures are cognitive networks of maladaptive thinking that become activated through fear or anxiety (Lang, 1977). For people with anxiety-related problems, there are two common maladaptive beliefs about fear stimulus: 1. That anxiety or distress will escalate to the degree it becomes unmanageable (e.g., "I can't handle this"); 2. The feared stimulus or their experience of anxiety will cause him harm (e.g., 'I will lose control" or I will go crazy"). The major problem is that people with anxiety disorders usually engage in some form of escape or avoidance behaviors when they feel anxious. As a result they do not remain in contact with their anxiety long enough to disconfirm the fear structure. Over time, people continue to engage in disruptive behaviors (e.g., escape) whenever they experience fear. An unfortunate side effect of continued avoidance behavior is that people's lives begin to constrict in order to avoid things that trigger the fear structures. Their lives become narrower and more confined [e.g., they stop leaving the house] (Thompson, 2013).Hence, anxious patients perceived the unpleasant affective picture as feared stimulus which would definitely explain how they processed their emotions as sad, frenzied and more controlled creating maladaptive neural networks.

Table 2. SAM rating of left and right hemispheres dominant depressed patients

Participant	*Picture*	*Pleasure*	*Arousal*	*Dominance*
LHDAP				
	Pleasant	7	7	6
	Neutral	9	2	2
	Unpleasant	2	2	7
LHDAP				
	Pleasant	6	4	4
	Neutral	2	4	6
	Unpleasant	1	2	8

LHDP (Left Hemisphere Depressed Patient), RHDP (Right Hemisphere Depressed Patient)
Pleasure (9 (Happy – 1 (Sad), Arousal (9 (Excited) – 1 (Frenzied)
Dominance (9 (Controlled/Dominated) – 1 (In-control/Dominant)

As shown on Table 2, the pleasant picture evoked feelings of happiness, excited but more controlled for the left lateralized depressed patient (LHDP). On the other hand, the neutral

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Vol. 2 No. 3 September 2013

affective picture evoked feelings of happiness and dominated but felt frenzied or relaxed. Albeit, the unpleasant pictures evoked sadness, frenzied but with more controlled feelings. Emotional processing of the LHDDP using affective stimuli elicited consistent emotional reaction to the pleasant picture because of feelings of happiness and excitation. Surprisingly, the neutral picture evoked feelings of happiness, relaxation and dominated. Whereas the unpleasant affective picture elicited feelings of sadness, frenzied and more controlled. In terms of the emotional experience of the LHDDP, the unpleasant picture evoked feelings of more in control. Considering that depression is the mental health problem of the participant, it can be construed that the participant is in control of his emotional symptoms in times of unpleasant events. The LHDDP reacted congruent with the pleasant affective picture and construe this with positive feelings. On the other hand, the right hemisphere dominant depressed patient (RHDDP) evoked feeling of a little happiness, neither excited nor frenzied and neither in control nor dominated on the pleasant affective picture. On the neutral affective picture, the RHDAP felt unhappy, neither excited nor frenzied and less dominated. On the other hand, the unpleasant picture evoked feelings of unhappiness, being frenzied and less dominated or felt controlled. Emotional processing for the RHDDP showed lesser emotional reactions on the pleasant and neutral affective stimulus considering the realm of pleasure, arousal or dominance. Notwithstanding, the unpleasant affective picture evoked feelings of unhappiness, frenzied and felt controlled or dominated. Unpleasant situations would make the RHDDP emotionally overwhelmed or controlled such that unpleasant events the RHDAP tends to succumb to depressive state in reacting to situations.

Table 3. PET brain scan results on the emotional processing of anxious and depressed patients and their brain lateralization

Lateralization	*Anxious Patient*	*Depressed Patient*
Left Hemisphere Dominant	Right sensorimotor cortex	Left midfrontal cortex
Right Hemisphere Dominant	Right sensorimotor cortex	Right primary visual Cortex

Table 3 presents the comparison between left and right hemispheres dominant participants in the brain regions with greater activation during the emotional processing as observed during the PET brain scan method.

Taking into account the participants' lateralization and their respective clinical problems, the LHDAP participant showed ipsilateral dominance during the emotional processing of the affective pictures. Expectedly, the brain dominance of the participant which is left hemisphere would be observed during the emotional perception however, the right sensorimotor cortex was observed to be hypermetabolized, hence, lateralization for the LHDAP participant may not be evident during the emotional processing. This has to be construed that the right hemisphere is specialized for processing all emotions regardless of valence (Borod, et al., 1998) and the perception of emotional stimuli is less consistent for lateralization (Rodway et al., 2003). Hence, for the LHDAP participant, the issue of lateralization would be inimical in the sense that whether the participant is left or right hemisphere dominant, still the right hemisphere holds for all emotional processing regardless of valence. Notwithstanding, the LHDDP participant, processed affective stimuli in the left region of his brain making his brain dominance more active with the observed hypermetabolic activity. Though Valence-Specific Hypothesis (VSH) posits that the left cerebral hemisphere specialized for processing positive emotions and the right hemisphere specialized for processing negative emotions (Ahern & Schwartz, 1979; Wedding & Stalans,

ISSN: 2186-8476, ISSN: 2186-8468 Print
Vol. 2 No. 3 September 2013

1985; Adolphs et al., 2001), there was no concrete valence of emotion being solidly measured because the affective pictures of IAPS of pleasant, neutral and unpleasant were presented on a fragmented manner making the participant able to process the affective stimuli regardless of valence though the pleasant picture was positioned on the left visual field (LVF) of the participant and the unpleasant picture was positioned on the right visual field (RVF) with the neutral picture on the middle. With regard to right hemisphere dominant participants, both the RHDAP and the RHDDP participants were observed to have hypermetabolized neuronal activities in the right region of their brain. The preponderance of the right cerebral hemisphere over the left cerebral hemisphere on the emotional perception of the participants either anxious or depressed made this consistent support to the Right-Hemisphere Hypothesis (RHH) which posits that the right hemisphere is specialized for processing all emotions regardless of affective valence (Borod, et al., 1998). Describing the participants in terms of their mental health problems, regardless of the lateralization, both left and right hemispheres anxious patient were observed having hypermetabolized right sensorimotor cortex. The tingling sensations, sensations of shortness of breath, sweating, trembling or shaking or muscle tension felt from the sensations of their body and their agitated and restlessness or being keyed up or on edge are symptoms of their anxiety which are primarily activated in the sensorimotor regions of the cortex. Lateralization may not be evident for patients suffering from anxiety disorders in the sense that symptoms are primarily activated in the same regions of the brain. This finding is similar to the result of the study of Damasio et al., (2000) by using PET scan to record activity as people recalled in detail their most emotional experiences. High levels occurred in cingulated cortex, the hypothalamus, parts of the somatosensory cortex and the midbrain. Nevertheless, there appeared to have a difference between the LHDDP and the RHDDP PET scan results whereas the LHDP was observed having hyper metabolism in the left midfrontal cortex and left associative visual cortex while the RHDP was observed having hypermetabolized primary visual cortex. It can be construed that the activation of the brain regions of the participants coincides with their respective lateralization. For the LHDDP participant with dominance in the left hemisphere, the left midfrontal and left associative visual cortices were activated during the emotional processing whereas the RHDDP participant with dominance in the right hemisphere, the right primary visual cortex was activated. However, the activation of brain regions for the LHDDP in the left midfrontal cortex and the left associative visual cortex contradicted with the previous studies that depressed individuals exhibit greater right-sided anterior activation of their brains, particularly in the prefrontal cortex and less left-sided activation and correspondingly less alpha wave activity than non-depressed individuals (Davidson, Pizzagalli, Nitschke, & Putnam, 2002).Interestingly, it can also be noted that both depressed patients regardless of their lateralization, the visual cortex is also implicated during the emotional processing. Accordingly, during emotional processing, visual information comes as reentrant projections from the amygdala to the visual system. The amygdala is involved in emotional processing of emotions such as fear, anger and pleasure.This finding is similar to the study done by Sabatinelli, Bradley, Fitzsimmons and Lang (2005) which showed that the magnitude of BOLD signal in inferotemporal visual cortex covaries closely with amygdala activity. This covariation strongly supports the presence of reentrant projections from amygdale to the visual system that Amaral, Price, Pitkanen and Carmichel (1992) have described in nonhuman primates. This reentrant connections presumably prompts recruitment of a wider neuron pool in the posterior brain, associated with more intensive processing of motivationally relevant images (Holland& others 2000; Maunsell, 2004). The increased activation in widespread higher-order visual areas is readily able to reach the scalp, thus accounting for the LPP waveform's high sensitivity to emotional input.

ISSN: 2186-8476, ISSN: 2186-8468 Print
Vol. 2 No. 3 September 2013

Table 4. SAM ratings on the emotional processing of anxious and depressed patients and their brain lateralization

Lateralization	*Pleasure*		*Arousal*		*Dominance*	
Picture	AP	DP	AP	DP	AP	DP
Left Hemisphere						
Pleasant	5	7	5	7	5	6
Neutral	5	9	5	2	3	2
Unpleasant	3	1	3	2	3	7
Right Hemisphere						
Pleasant	8	6	6	4	5	4
Neutral	3	2	1	4	3	6
Unpleasant	1	1	1	2	9	8

AP (Anxious Patient)   DP (Depressed Patient),   Pleasure (9 (Happy – 1 (Sad)
Arousal (9 (Excited) – 1 (Frenzied),   Dominance (9 (Dominated) – 1 (In Control)

Table 4 presents the comparison between the left and right hemispheres participants on the Self-Assessment Manikin (SAM) ratings during emotional processing of affective pictures. The SAM reflects emotional reactions to the affective stimuli in terms of pleasure, arousal or dominance dimensions.

Using the Self-Assessment Manikin (SAM) in processing the emotional experience of the participants and their brain dominance, it can be inferred that for both anxious and depressed patients with left cerebral hemisphere dominance the emotional experience on the pleasant affective picture seemed not so sparse and varied but a greater disparity can be observed with the rating of the depressed patient on the neutral affective picture with regard to the pleasure component. The depressed patient felt extremely happy than the anxious patient with a rating of 9. The subjectivity of the emotional experience of the depressed participant toward the neutral picture (an old man standing near the window) would evoke extreme happiness for him than the anxious person. In terms of the unpleasant affective picture, both participants showed similar emotional reactions such as feeling unhappy and frenzied. However, on the dominance component, the depressed patient evoked feeling less dominated than the anxious person who felt less in control. The depressed patient perceived that unpleasant affective stimuli controlled or influenced his life hence propensity to depressive state may be evident in the sense that individuals with depression imagines that they have no control over their own thoughts and feelings and little or no control over situations. They believe that other people and events determine how they think or feel. The depressed individuals see themselves as mainly victims of circumstances and blame other people and things outside of self for personal difficulties. If things go well (their way), they will feel good and be upbeat. However, if things go wrong, they may experience a fairly rapid decline in mental health and overall well-being. It is all because depressed individuals' self-esteem is highly dependent on outcomes, events, and other people. When there is a perception of a major loss of control over one's own life, the individual susceptible to depression assuredly becomes depressed. On the other hand, the anxious participant perceived that unpleasant events in his life may be dominant but he can withstand with these anxiety provoking situations because

ISSN: 2186-8476, ISSN: 2186-8468 Print
Vol. 2 No. 3 September 2013

feels that he has a control over these events. This could be explained that the limbic system, including the 32mygdale, of individuals with anxiety disorders, is overly responsive to stimulation or new information (abnormal bottom-up processing); at the same time, controlling functions of the cortex that would down-regulate the hyperexcitable 32mygdale are deficient (abnormal top-down processing) which is consistent with Grays behavioral inhibition system (BIS) model (Britton & Rauch, 2009); Ochsner et al., 2009). In terms of the emotional processing of the right hemispheres anxious and depressed participants, Table 4 showed that there is a disparity between the anxious and the depressed participants when presented with the pleasant picture such that both the anxious participant felt happy but the depressed felt slightly happy only on the pleasure dimension. In terms of the arousal dimension, the anxious participant felt slightly aroused but the depressed felt neither aroused nor frenzied. But in terms of dominance dimension both participants felt neither controlled nor in-control. The neutral picture also evoked different feeling between the anxious and depressed participants. The anxious felt slightly sad but the depressed felt sad in pleasure dimension. The depressed felt neither aroused nor frenzied in terms of the arousal dimension but the anxious participant felt frenzied with the neutral picture (*an old man standing nears the window*). Notwithstanding, the anxious participant felt less in-control than the depressed participant who felt that dominated. As regards the unpleasant affective picture, both anxious and depressed participants evoked feelings of sadness, frenzied and dominated. It can be construed that both anxious and depressed participants feel that unpleasant events in their life would make them unhappy, frenzied and emotionally perceived that unpleasant situations would dominate their life and would feel that they are being controlled. Taking into account the right cerebral lateralization of the anxious and depressed participants and the similarity of their emotional processing, it can be explained that regardless of the mental health problem of the respective participants, they are still dominated by their own cerebral lateralization which is the right hemisphere. As postulated, the right hemisphere is specialized for processing all emotions regardless of affective valence (Borod et al., 1998).

The two halves of the brain are believed to play different roles in emotional processing. The right-hemisphere hypothesis (RHH) suggests that the right cerebrum is dominant for processing all emotions regardless of affective valence (Borod, et al., 1998) whereas the valence specific hypothesis (VSH) posits that the left-hemisphere is specialized for processing positive affect while the right hemisphere is specialized for negative affect (Ahern & Schwartz, 1979; Wedding & Stalans, 1985; Adolphs et al., 2001).

Based on the findings of this study, adhering to the right hemisphere hypothesis, it can be construed that RHAP and RHDDP were observed to have greater neuronal activation (hypermetabolized) in the right region of the brain during emotional perception such that RHH had hypermetabolized right sensorimotor cortex and RHDDP had hypermetabolized right primary visual cortex. Hence, regardless of the valence of affective stimuli whether pleasant or unpleasant, the activation of the emotional perception of the participants was primarily controlled by the right cerebral cortex. Notwithstanding, participants with the left hemisphere dominance, the LHDAP and LHDDP participants were observed to have different brain activation during the emotional perception. LHDAP showed greater neuronal activity in the right sensorimotor cortex while the LHDDP was observed to have hyper metabolism in the areas of left midfrontal cortex and left visual associative cortex. It can be noted that for the LHDAP, cerebral lateralization may not be evident when expected; hence, the right hemisphere hypothesis would answer because of the neuronal activity. Considering that the LHDDP participant showed greater neuronal activity in the left midfrontal cortex and left visual associative cortex during emotional processing as revealed by the PET brain scan,

ISSN: 2186-8476, ISSN: 2186-8468 Print
Vol. 2 No. 3 September 2013

it can be construed that the participant processed the affective stimuli regardless of valence based on the dominance of the left hemisphere, thus lateralization may be evident for LHDDP. Albeit, this result contradicts with the findings of Johnstone, et al., (2007) that depressed patients showed distinctive patterns of activity in the ventromedial prefrontal cortex (VMPFC) and the right prefrontal cortex (PFC). These are areas that regulate the emotional output generated from the amygdale. The VMPFC is compromised in depression likely because of the inappropriate engagement of right PFC circuity in depressed individuals. In addition, Davidson (1993) and Heller and Nitschke (1997) demonstrated that depressed individuals exhibit greater right-sided anterior activations of their brains particularly in the prefrontal cortex (and less left-sided activation and correspondingly, less alpha wave activity than non-depressed individuals (Davidson, Pizzaggalli, Nitschke, Putnam, 2002). Furthermore, right-sided anterior activation was also found in patients who are no longer depressed (Gotlib, Ranganath & Rosenfield, 1998; Tomarken & Keener, 1998) suggesting this brain function might also exist before the individual becomes depressed and represent vulnerability to depression (Barlow & Durand, 2012).

CONCLUSIONS

Based on the findings of the study, albeit small in sample size, it can inferred that LHDAP and RHDAP participants reacted on the emotional processing not necessarily according to their cerebral lateralization but based on the function of the right hemisphere which primarily implicated for processing all types of emotions regardless of valence. On the other hand, LHDDP and RHDDP participants processed their emotions based on their brain dominance.

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Vol. 2 No. 3 September 2013

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Vol. 2 No. 3 September 2013

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ISSN: 2186-8476, ISSN: 2186-8468 Print
Vol. 2 No. 3 September 2013

APPENDIX-A

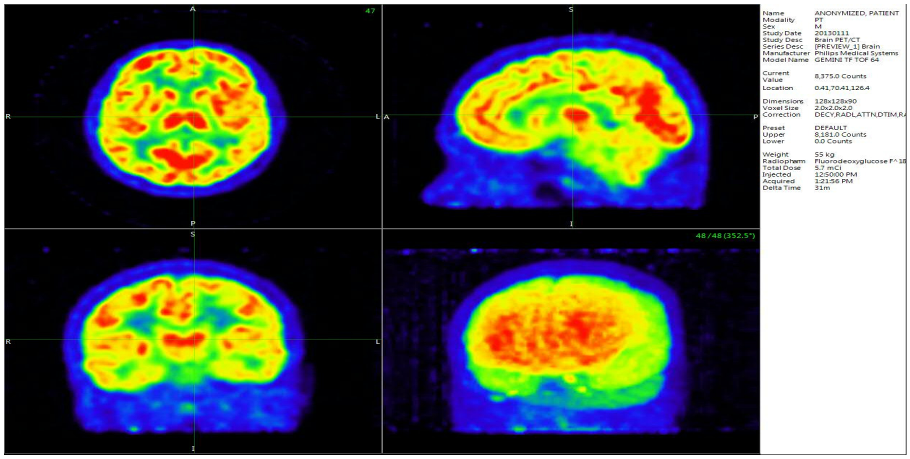

Figure 1. PET brain scan images of the Left Hemisphere Dominant Anxious Patient

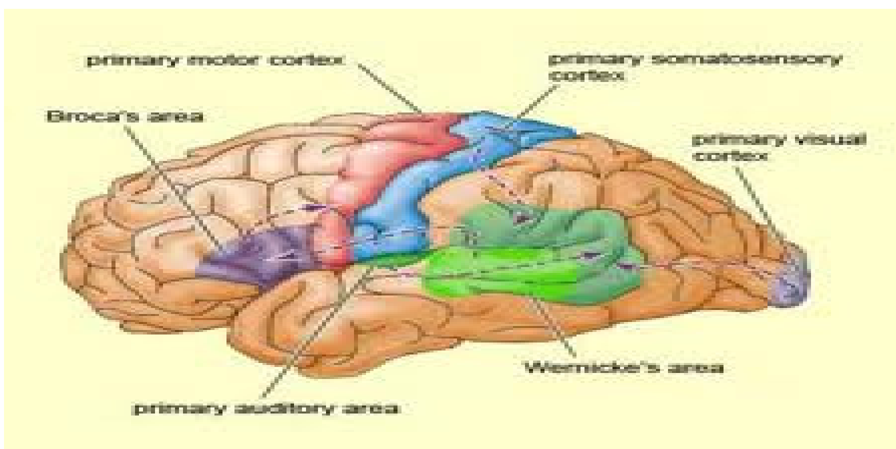

Figure 2. Brain structures of the somatosensory and motor cortices

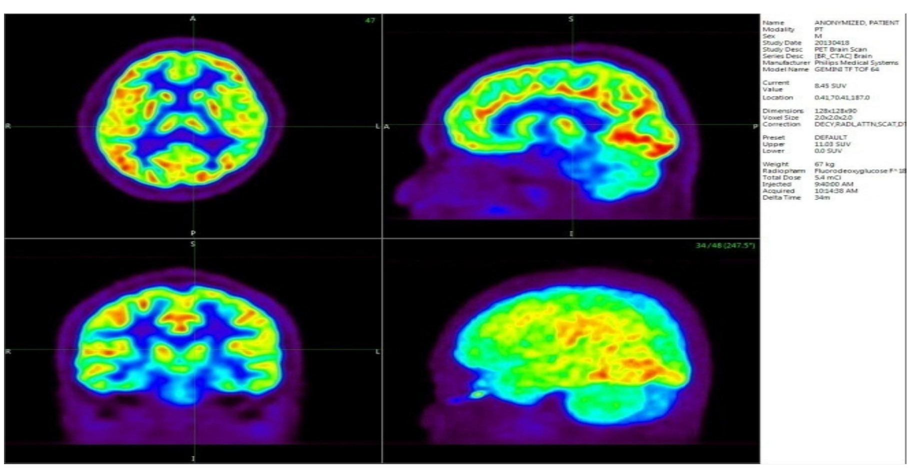

Figure 3. PET brain scan images of the Right Hemisphere Dominant Anxious Patient

ISSN: 2186-8476, ISSN: 2186-8468 Print
Vol. 2 No. 3 September 2013

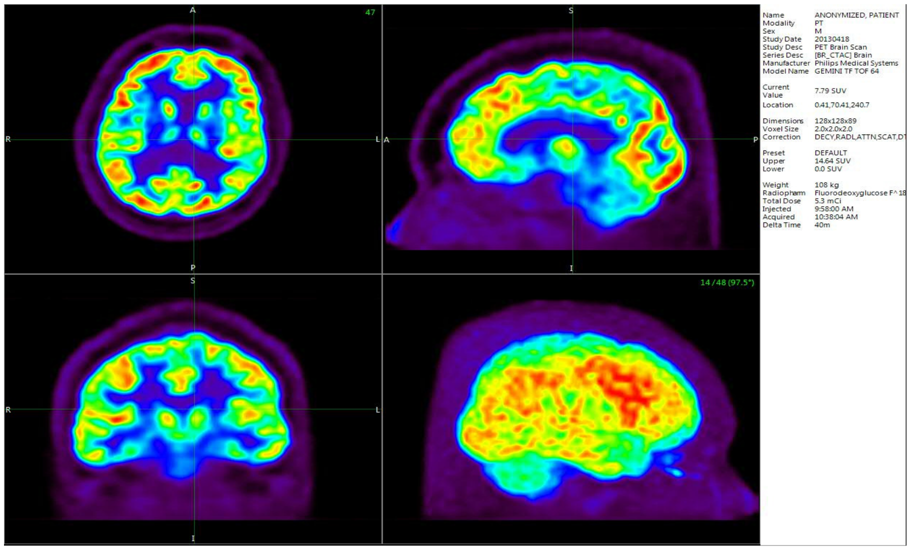

Figure 4. PET brain scan images of the Left Hemisphere Depressed Patient

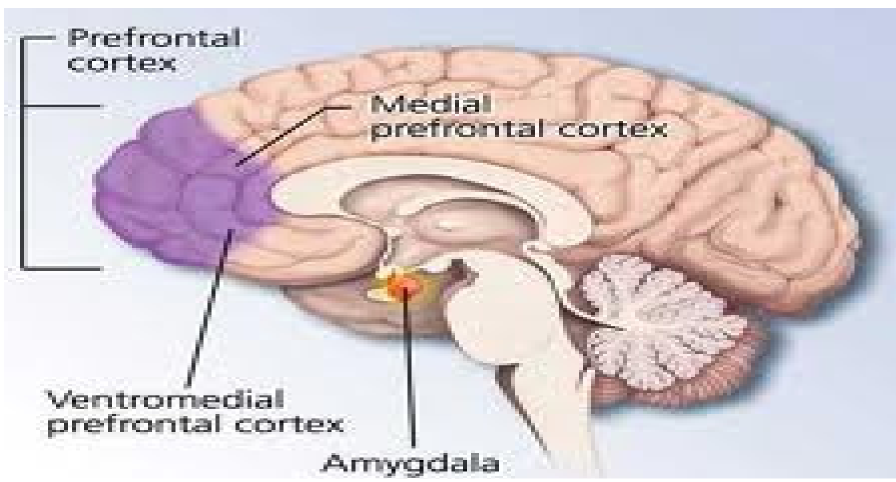

Figure 5. Brain structure showing the left midfrontal cortex

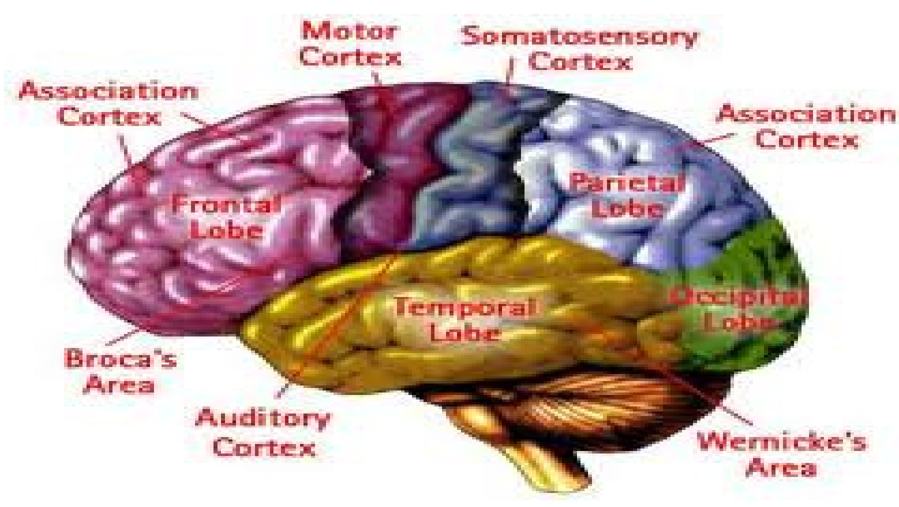

Figure 6. Brain structure showing the associative visual cortex

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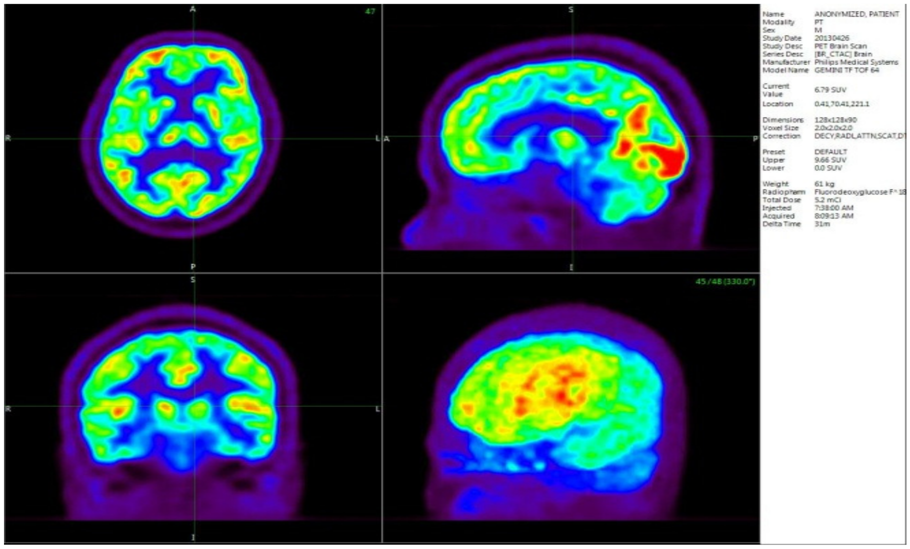

Figure 7. PET brain scan images of the Right Hemisphere Depressed Patient

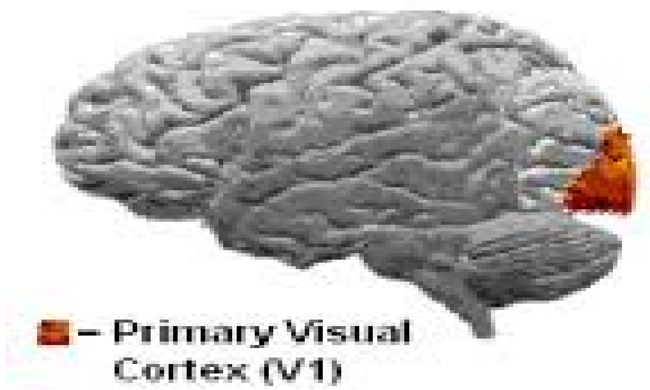

Figure 8. Brain structure showing the primary visual cortex