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Hemisphericity (Right, Left and Integrated) as a Predictor of Reaction Time

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Abstract

The study aimed to explore the predictable correlation between hemisphericity (right, left and integrated) and reaction time. Two instruments were utilized—the reaction time machine and the hemisphericity scale. Instruments' validity and reliability were insured. Fifty-four students were randomly assigned to participate in the study; their age mean was 21.4 years. Results proved that was significant differences were found between left hemisphere and both the right hemisphere and the integrated brain in favor of the left hemisphere; a correlation was found between hearing reaction time and both the left hemisphere and the integrated brain. A statistical effect was found on the left hemisphere, the integrated brain on hearing reaction time.

Keywords: left hemisphere, right hemisphere, the integrated brain, reaction time.

Introduction

Psychologists and experts picture the human awareness of a certain event with a composite equation; existence of a sensing device + conductive organ + certain centers in the brain. Stimuli we deal with and affected by on a daily basis are acquired by the senses in the form of electrical currents. The sense organ receives the stimulus and the nervous system sends a message to the brain, in its turn, the brain interprets these signals or information in light of its previous expertise to understand it and for the perception to occur. (Breus, 2006)

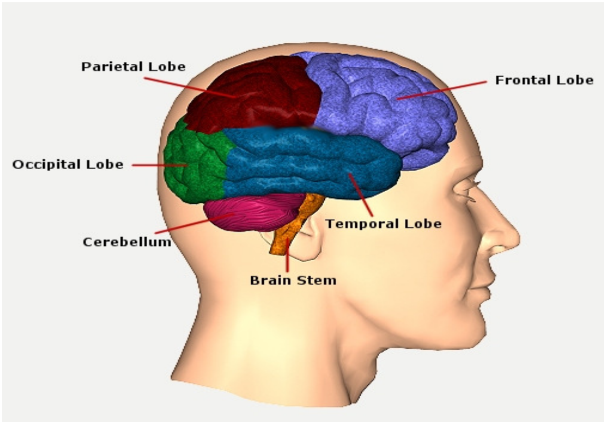
The nervous system is considered anatomically the general communication network that links different parts of the body together by a series of nerves reaching from internal and external body parts and different parts of the brain. Functionally the nervous system controls body parts and monitors functionality of the organs and combines between them to achieve integration and unity. The system is a group of centers connected together that receives surface or deep sensory stimuli from the body parts and produces motor stimuli for muscles (voluntary and non-voluntary) as well as the endocrine and ductus glands (Al-Waqfi, 1996)

The brain is comprised from four main parts, each of which has a certain function, but all harmonize together. The four parts according to Kolb &Wishaw (1990); Eysenck&Groome (2015) are:

First.Cerebral hemispheres. There are two anatomically important fissures of the brain; they are topographically used as markers to divide each hemisphere into lobes. The first is Rolandic Fissure or

the Central Sulcus and the second is Sylvian Fissure or the Lateral Sulcus. Each hemisphere consists of four lobes as illustrated in figure 1 and they are; frontal, parietal, temporal and occipital lobes (Robert & Lehr, 2010).

Figure 1: Brain Functions and Map



A The frontal lobe consists of: the PrecentralGyrus, frontal Central Sulcus and Motor Cortex responsible of muscles voluntary movements in the opposite part of the body.

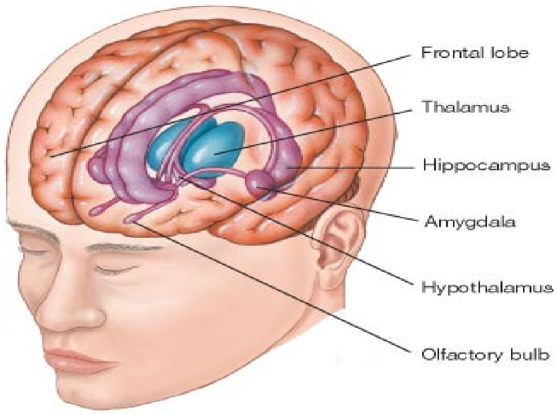
B The parietal lobe consists of: the PostcentralGyrus which consists together with Central Sulcus of the Sensory Cortex that is responsible of sense in the opposite part of the body. Damage of this region leads to losing the sense in the opposite part of the body which are represented oppositely as in the motor cortex.

C The Temporal lobe consists of: the Superior Temporal Gyrus which has hearing regions, SupramarginalGyrus and Marginal Gyrus and both contain the memory of read and written words, damaging this region means having Dyslexia.

D The Occiptal lobe is located in the back of the head and consists of the vision center, damaging this region leads the blindness.

Second. The Limbic System. This is a region located in the middle of the brain and comprises 20% of its volume, it includes several parts; Hippocampus, Thalamus, Hypothalamus and Amygdala as Jensen (1998) mentioned. These regions are illustrated in figure 2 according to (Richard, 2000).

Figure 2: The limbic system



The two hemispheres are very similar, anatomically they are both linked together by connecting fibers, the largest of these fibers is known as Corpus callosum in addition to a set of fibers linking the symmetrical lobes and the different lobes of each hemisphere comprising a regular circuit of

connections that integrate brain functions in general (Holder, 1992; Kolb &Whishaw, 1990; Glick, 2011). Touching and spatial skills are connected with the left hemisphere, few skills depend a set of plans in both hemispheres (Jensen, 2002).

In addition to the functional differences between the two hemispheres, the left is responsible for logical thinking, analyzing, decision making based on logic and recognizing the body parts (Spinelli&Mecacci, 1990; Peng, 2005). The left hemisphere analyze information linearly, starts processing parts and gather them logically to reach a conclusion (Scaddan, 2008; Aaron, 1996; Kathleen &Eliassen, 1998). The right hemisphere controls the non-verbal functions and is responsible for emotional, intuitional, creative and imaginative functions and has a visuospatial major role in the surroundings, it runs information, pictures, music, color perception and space and vacuum perception (Bear, Connors &Paradiso, 2015).

Some functions depend on one hemisphere not the other; this hemisphere is called the dominant hemisphere for such a certain function (Gabbard, 1997; Scaddan, 2008; Kathleen &Eliassen 1998; Springer & Deutsch, 1999). Therefore, the hemispheres activity is the activity of using the left or right hemisphere, each hemisphere is responsible of certain functions despite the similarity in many evolutionary characters but there are clear differences between them attributed to the individual differences in development to the environment and heredity factors or maturity and expertise.

Reaction time is defined as the fast reaction from the body as a result of a sudden incentive such as putting a hand in hot water or tearing. It is also defined as the interval between incentive emergence and reaction start, this is called response latency that is the time the individual takes before giving a proper response to a certain incentive. the length of reaction time is influenced by several factors such as the intense, familiarity, sensitivity of the organ, age, gender, psychological and mental condition and lack of incentives or its abundance in natural or experimental situations (Fishman, 1990; Kayree, 1995).

From experimental studies it was proved that preparation period that precede emergence of the incentive should be 2-8 seconds, if it is less the reaction time becomes longer because in this case the time is not enough for the individual to have attention and motivation, and if it is more the reaction time becomes longer because the preparation loses its effectiveness gradually and the individual starts relaxing (Rose, 2011).

The incentive type is a factor affecting reaction time, audio reaction time is shorter than sensory which in turn is shorter than visual. It was also proved that incentive intensity; power and appropriateness expedite the reaction time in most times.

Reaction time speed has psychological determinants controlled by the abilities of the psychological processes correlated with the nervous subsystem including the time required to stimulate the nerves receiving incentives and the speed of conducting the impulses and contraction of the muscles etc. psychologists estimate the duration between 50-60 ml/s, these estimates mean the minimum reaction time does not exceed 100-150 ml/s (Excitability of nerves future stimuli and conduction velocity of nerve impulses and muscle contraction, etc., which are estimated to have a physiological scientists time between (60-80) ml/ s, in addition to the time it takes the central nervous system in processing sensory input, which is estimated at about (50-60) ml/ s, and these estimates means that the minimum time feedback does not come out from the border (100-150) ml/ s (Luknowsky, 1997).

It was also found that that the more stimuli are the slower of reaction time becomes whether the stimuli were visual, audio or a mix of both, that means stimuli affects all the senses, as previous literature found if the duration of the stimulus was less than 5 ml/s the reaction time becomes less, it was also fund that if stimuli severe is similar on both ears in the same time reaction time is less and vice versa (Evitts, 2004)

Response speed and method vary according to the stimuli type, for instance, if power of stimuli is very similar the individual needs more time to be able to distinguish and identify the stimuli that needs a response, so the reaction time becomes longer or slower, i.e. if stimuli are similar physically recognizing becomes harder because stimuli follow the neural paths. (Jensen, 1998).

Luce (1986) indicated that recognized time reaction is the sum of two different times, one is related to decision-making by central nervous system which aims at defining the time the stimulus happened, and the other is related to the time of transferring the signal to the brain in addition to the time taken by the brain to send signal to activate the muscles to respond (Burk, 1999).

Mobility of Nerves Reaction Time

Psychologically reaction means the systematic integrated framework of responses to an incentive or a natural or social event, or it is a set of behaviors, actions and responses occurring by the individual when stimulated or faced by a certain event. The general integrated concept includes a series of processes, some of which are sensory while others are neurological and psychomotor. Reaction time (simple or composite, choice or discriminationreaction time)includes a set of processes starting with the process of stimulating one of the organs generating sensory expertise. A group of sensory cells are stimulated and they in turn stimulate the nerve endings of the sensory nerves that transfer sensory information to the brain stem where the network formation receives information filters it and allows certain pulses to pass through to certain nerve centers in the brain corresponding with certain senses. The nerve centers process information and give it meaning and give commands to the senses to respond through nerve impulses contained in the motor nerves (Okabe, Sato, Matsumoto, Ozawa &Sakamot, 2009).The sensory integration is the link between the brain and human behavior; for example, when someone pushes another the body automatically adjusts its position to avoid falling. All responses and reactions are the result of sensory integration that sends signals to the brain which sends back the proper behavior or movement (Kathleen &Eliassen, 1998).

The Reaction Time and the Brain

Physiologists believe that sensory incentives in reaction time that emerge in sensory expertise motivate a set of sensory cells and nerve ends which transfer the stimulus into the area of network formation for processing, analysis and filtration to allow a certain type of the pulses to connect information to specific centers in the cerebral cortex and then the motor response through motor nerves occurs (Schubert et al., 2002).

Reaction time is a psychomotor function based primarily on the central nervous system. It is described in general as the stimulus that triggers the receptors in the sense organ. The message is carried by the afferent nerve to the spinal cord then to the brain; it reaches the centers of each sense, is translated, and then travels back through the afferent nerve to the spinal cord into the muscle that controls the response (Mu et al., 2011).

The simple reaction time includes a set of limbic and central processes such as attention, sensory lag, nerve transition from the stimulus into the brain, central encoding of the stimulus, nerve transition from the brain into the muscles, muscle lag, and response execution time. Ganglia-thalamocortical circuits play an important role in generating simple behavioral actions (Alexander, De &Strick, 1986), movement, limbic system, and knowledge circles emerging from the cortex back to basal ganglia and hypothalamus (Parent &Hazrati, 1995).

The temporal lobes in the cortical region are responsible for processing audio stimuli. They are divided into primary and secondary regions; primary regions are responsible for the process of reflecting external audio stimuli, while the secondary regions are responsible for precise recognition of voices (Starr, 2013). Studies have found special centers in the cortical regions responsible for differentiating between sounddegrees and intensity which we encounter in the same and between the secondary regions of the temporal lobes (Kamel, 1997).

To explore reaction time correlation with the cortical frontal lobe and hippocampus, Joshua (1999) studied a sample of experimental mice which had a surgical intervention. The results showed that the slow reaction time for PFC and ILn groups may indicate motor dysfunction due to disruption of cortico-basal ganglia-thalamo-cortical connections that are innervated in the striatum by the ILn.

To examine the thalamocortical role in mobility preparation and implementation, Schubert et al., (2002) studied 5 Parkinson patients. By deep stimulation of the brain, it was revealed that the subcortical-cortical circuitry plays a role in human sensory response.

Leon, Aron, &Nachum (2005) studied the relationship between the two hemispheres among a sample of a stroke patient group (32 right hemisphere stroke patients and 16 left hemisphere stroke patients) and a control group. The authors utilized a computerized test to measure the responses. Results illustrated that RHS patients were statistically slower in their responses than LHS patients.

Menning, Hans, Hermann, Hertricand Marthiak (2005) in a study titled "Spatial auditory attention is modulated by tactile priming" studied brain responses related to the event among 4 individuals through a brain magnetic device. Results illustrated that processing via the media influences perception in various nerve cell levels.

In Collignon, Renier, Bruyer, Tranduyand Veraart's (2006) study titled "Improved selective and divided spatial attention in early blind subjects", which explored behavioral and nerve reorganization among early blind individuals, the spatial attention models were utilized using audio or sensory stimulation. Two groups participated in an experimental study of 6 early blind individuals and a control group of 5. It was found that there are no statistical differences in the sensory responses or task performance reaction time.

Auditory and sensory responses among 8 blind (5 male and 3 female) individuals were studied by Collignon, &De Volder(2009). Authors used a device to measure reaction time after exposing the participants to various stimuli (auditory and sensory). It was noticed that auditory reaction time is shorter than sensory reaction time among the blind. These results confirm not only the previous reports of blind people's superiority in auditory attention tasks but also expand our knowledge of the mechanisms underlying compensation.

To explore brain correlation with reaction time through the white matter distribution,Konrad, Vucurevic, Musso, Stoeter and Winterer (2009) assumed a correlation between the white matter and reaction time. Data was obtained from MRI of 43 individual agedbetween 22.7 and 81.8 years, measuring reaction time to a sensory task. Analysis illustrated a statistically significant positive correlation between reaction time and white matter distribution in the right hemisphere, and a limited negative correlation between reaction time and white matter distribution in the right temporal. Overall results indicate that the structural subcortical characteristics of dorsal and ventral visual streams are correlated with information processing speed.

In studying the ischemia effect on mice reaction,Jiang, Rajale, Wever, Tuand Li(2010) conducted their study based on preventing blood from reaching the brain in 4 phases to examine the reaction. The cerebral artery was blocked for 6, 12, 24, 48, and 72 hours. Results illustrated that the cerebral ischemia decreases reaction time in mice.

Bilateral presentationsof emotions and reaction time were examined by Rose (2011) who used words and pictures to find hemispheric differences. Results suggested that reaction time was faster when exposed to pictures compared to words and that emotional stimuli contributed in the reaction time speed in the right hemisphere compared with the left hemisphere.

Fassbender, Lesh, Ursuand Salo(2015) explored the cognitive dynamics to measure reaction timein drug abuse. The participants were allocated into two groups—the experimental group of drug abusers (No. 30) and a control group of non-drug abusers (No. 27) underwent functional MRI while performing the Stroop taskto measure the relationship between the study variables and the functional brain activity. A relationshipwas found between reaction time and conflict related brain activity of the frontal lobe cortex among the control group subjects, while the experimental group subjects' brain activity was high only in the right frontal lobe cortex.

To reveal voluntary brain reaction, Gabriel et al (2015) tried to develop an awareness assessment for consciousness disorders patients. Twenty participants' fMRI tests illustrated that the best performance of voluntary brain reaction was in the mental images tasks.

Sallard, Barral, Duffauand Bonnetblanc (2015) studied reaction time speed among a group of patients who had had brain tumors removed. The experimental group included three patients aged 41,

59 and 59 years and a control intact individual aged of 44 years. Differences were found between the two groups in favor of the experimental group. It was also found that the left hemisphere was faster in reaction time compared with the right hemisphere.

To explore reaction time and the processing of emotional stimuli in both hemispheres,Cimino (2015) conducted two experiments—1. reaction time using neutral stimuli followed by an emotional stimulus, 2. measuring heart rate and skin conductance. The results showed the left hemisphere is faster in reacting toward emotional response.

According to studies by Konrad et al.,(2009); Rose(2011); Fassbender et al.,(2015) on the relationship between the two hemispheresand reaction time speed, it is noticed that there is a relationship between the reaction time speed and the right hemisphere. There is also a correlation between reaction time speed and the left hemisphere, according to Leonet al., (2005); Cimino(2015); Sallardet al., (2015). A little negative correlation between reaction time and the white matter was found in the right temporal according to Konrad et al., (2009).There was a relationship between reaction time and conflict-related brain activity, according to FassbenderFassbender et al.,(2015).Many results clarified that reaction time speed may be correlated with the integrated brain. thecortico-basal ganglia-thalamocortical (Joshua, 1999); the subcortical-cortical circuitry (Schubert et al., 2002); nerve cells (Meaning, Hans, Hermann, Hertric&Marthiak, 2005); and the prefrontal cortex (Matthew,2011). Voluntary brain responses are found in brain image tasks (Gabriel et al., 2015); ischemia significantly decreased reaction in mice (Tu et al., 2010). Other studies explored the reaction time speed among blind and sighted people.. No differences were also found between the early blind and the sighted in sensory sense and reaction time of a task (Collignon et al., 2006). But Collignon,&De Volder(2009) found that auditory reaction time among the blind is shorter than sensory.

The current study tried to explore the predictive correlation between the brain styles (right, left and integrated) and reaction time, not just the two hemispheres and this reflected accuracy in the results; in addition, it adopted a certain age group that had not been explored before. It is also considered the first in an Arab environment as far as the author knows.

Problem of the Study

Reaction time is considered one of the psychomotor abilities which have a correlation with left, right or the integrated brain, but this correlation is not conclusive and needs more evidence to support it by using experimental tools capable of measuring reaction time among the study sample.

Reaction time is constantly applied to measure information processing speed; it has been used also to measure mental activities among sighted individuals and patients with neurological and psychological disorders. Despite the fact that the differences between the individuals have been considered, the biological neural underlying mechanisms that determine the differences are not yet fully understood. (Konradet al., 2009).

As far as the author knows, no one has studied reaction time region in the brain among undergraduates in an Arab environment; hence,research hypotheses wereformulated:

HO_1: No statistical differences at $\alpha \geq 0.05$ in the auditory reaction timeattributable to the brain styles (right, left or integrated) among the participants of the study.

$HO_{2:}$ Noa statistical correlation at $\alpha \geq 0.05$ in the auditory reaction time attributed to the brain styles (right, left or integrated).

$HO_{3:}$ can'tpredict auditory reaction time by the brain style categories (right, left or integrated).

Study Importance

Revealing the nature of the correlation between the brain styles (right, left and integrated) and reaction time may add new information and reveal important aspects in human information processing, which will henceforth reveal deficiencies and ambiguities in cognitive learning strategies among learners.

Identifying the dominant hemisphere inreaction time helps those interested in planning and designing curriculums. Italso helps in developing programs to enhance reaction time among learners,

and it adds new information to the educational and developmental procedures such as qualifying teachers by acquainting them with the skills to manage classes. It introduces memory-enhancing methods in addition to training them on modern assessment methods which correspond with brain research outcomes. Results of the study may help in decision making, such as the introduction of new materials or activities that belong to reaction time efficacy.

Results concerning preference of one brain style over the other based on reaction time are not decisive; hence, further studies are required to be able to get results more clearly about the nature of the correlation. The study contributes to core information on behavior in general by adding information to the time correlations between mental processes and the physical and physiological changes; individual performance may be compared with the speed of solving problems. The current study emerged from the quality of tests used; it includes global psychometric standardized tests.

Research Methodology

Participants

The study sample included 54 participants with a mean age of 21.4 years. They were undergraduate students enrolled in King Saud University randomly assigned to the study. A descriptive analytical approach was employed in the study.

Instruments

To achieve the aim of the study, the author used two tests—the auditory reaction time test and the hemisphericity test.

The Brain Style Test

adults version is used, and it includes 36 items, each of which has three choices to measure participant's use of right, left or the integrated brain (Torrance, Reynolds, Riegel&, Ball 1977).To insure content validity of the brain styles test, 11 education professors provided observations on the test items in terms of representation of dimension, it was agreed that the items verify the purpose of the study, which means the scale has an acceptable validity degree scoring 85%.Test Reliability was implemented within an interval of two weeks. Correlations arecalculated by Pearson correlation, total test reliability scored was 80%.preference of brain styles for different tasks may be revealed by t-scoring of more than 120, a mean of 100, and a standard deviation of 20 (Torranceet al., 1977). Subject chooses one statement in each item and after completing the test gets 36 degrees divided into the three styles.

The Auditory Reaction Time Test

Device (GBK1991) was utilized. Participants were guided to press a button when they hear the voice tune, and the device times the interval between emergence of the tune and the pressing on the button.

In the current study, participants were given three training tries. Then they were examined with 20 stimuli; means of the trieswere calculated, and auditory reaction time was categorized into high (325-506 ml/s), medium (507-920 ml/s) and low (920-2660 ml/s).

Statistical Analyses

Repetitions, percentages, means, standard deviations, Pearson correlation and multiple regression analyses are calculated.

Results and Discussions

The study aimed at exploring the brain style and its relationship with auditory reaction time by Examine the hypotheses.

To Examine the firsthypothesisof "HO_1: No statistical differences at α ≥ 0.05 in the auditory reaction time attributable to the brain styles (right, left or integrated) among the participants of the study." averages and standard deviations of auditory reaction time based on the brain styles (right, left and integrated) are calculated as table 1 illustrates.

Table 1: Means and Standard Deviations of the Auditory Reaction Time Based on the Brain Styles

Brain Style	No.	Mean	Standard Deviation
Right	12	1.01	0.377
Left	23	0.65	0.288
Integrated	19	0.95	0.529
Total	**54**	**0.84**	**0.430**

In table 1 it is noticed that there is an apparent difference in means and standard deviations of auditory reaction time attributed to the brain style. To examine the differences in function between means, ANOVA analysis is conducted as illustrated in table 2.

Table 2: ANOVA Analysis of the Brain Styles Based on Auditory Reaction Time

Source of variance	Sum of Squares	Degree of Freedom	Squared Means	F Value	Sig.
Between the Groups	1.392	2	0.696	4.218	0.020
Within the Groups	8.419	51	0.165		
Total	**9.812**	**53**			

From table 2 we infer differences at α ≤ 0.05 attributed to the brain styles; to find significant differences the Least Significant Differences (LSD) posttest is conducted as seen in table 3:

Table 3: LSD Posttest Differences of Brain Style Effect on Reaction Time

Brain Style	Mean	Right	Left	Integrated
Right	1.01			
Left	0.65	.36 *		
Integrated	0.95	0.06	.30- *	

* functional at (α=0.05)

In table 3 there are statistical differences at α ≤ 0.05 between the left brain and both of the right and the integrated brain in favor of the left.

The superiority of the left brain may be attributed to the participants being students and having educational expertise that requires language usage mainly, since the language center region is located in the left brain. It is expected that the activity of the two hemispheres depends on the nature of the external task or activity processed (Belger, 2002; Nishiizawa, 1994)

The dominant teaching methods enhance the dominancy of the left brain among the students; lots of educators and teachers focus teaching on developing the functions of the left brain such as linear, logical and verbal processing of information. A deep review of the educational institutions' teaching and learning methods reveals that most of them admit that they use a left brain-oriented style which leads to neglect of the right brain. (Sousa, 2001)

To Examinethe second hypothesisof the study "HO_2: No a statistical correlation at α ≥ 0.05 in the auditory reaction time attributed to the brain styles (right, left or integrated)." Pearson correlation coefficient between auditory reaction time and the dominant brain style, table 4 illustrates that.

Table 4: Pearson Correlation Coefficient between the Auditory Reaction Time and the Brain Styles

Brain Style		Reaction time
Right	Pearson coefficient of correlation (r) Statistical significance No.	0.084 0.544 54
Left	Pearson coefficient of correlation (r) Statistical significance No.	.469 ** 0.000 54
Integrated	Pearson coefficient of correlation (r) Statistical significance No.	.475** 0.000 54

** functional at (α=0.05)

There is a correlation between auditory reaction time and the left and integrated brain styles as table 4 illustrates, but there was no correlation between reaction time and the right brain. The left brain includes the processes of logical and verbal analysis, the right brain includes nonverbal thinking processes such as spatial memory (Bear, Connors &Paradiso, 2015). Each hemisphere seems to be able to process different skills but this is different from efficacy and skill, language and speech which depend on the left brain and the skills of spatial recognition such as graphs and unclear images which depend on the right brain (Eagleman, 2012).Since the right hemisphere is more active in visiospatial ability, it may enhance the left visual region, but this does not mean that both hemispheres are totally separate in performance, but that individuals use each hemisphere based on the special abilities system (Roig& Cicero, 1994).

There is no absolute hemispheres dominancy; each hemisphere plays its role in the behavior of an individual (Schold, 1998; Hobler, 1992). We find a correlation between the audio reaction time and both of the left and the integrated brain; hence, explaining the relationship between reaction time and hemispheres is often not easy. It is hard to recognize the reasons in the light of the fact that result hemisphericity does not follow the law of all or nothing. Some participants use both hands with the same efficacy; does this mean that they do not have dominancy of any of the hemispheres (Frohlich, 2004)?

The cross motor skills correlated with speed and tools usage seems more correlated with the left hemisphere (Leonet al., 2005).

This result agrees with the studies of Leonet al., (200); Cimino(2015); Sallardet al., (2015); little correlations are found between reaction time and the white matter in the right temporal as in the study of Konradet al., (2009); and disagreed with the studies of Konradet al., (2009); Rose (2011); and FassbenderFassbender et al.,(2015), all of which indicate a correlation between reaction time and the right brain style.

Results also agree with those of Menninget al., (2005); Katherine, Tyler, Stefan, Ruth (2014); Joshua (1999); Schubert et al.,(2002); Matthew (2011); Gabriel et al. (2015); Tu et al. (2010), all of which found a relationship between reaction time and cerebral cortex, cortico-basal, thalamo-cortical, subcortical and cortical circuits.

*To Examine the thirdhypothesis of "HO$_{3:}$*Can'tpredict auditory reaction time by the brain style categories (right, left or integrated)." multiple regression analysis is conducted based on brain styles andauditoryreaction time as table 5 illustrates.

Table 5: Multiple Regression Analysis of the Effect of Brain Styles on Auditory Reaction time

Independent Variable	Beta	t Value	t Significance	Correlation	Explanatory variable	f Value	f Significant
Right Left Integrated	-0.028 0.316 0.326	-0.239 2.371 2.439	0.812 0.022 0.018	0.552	0.305	7.317	0.000

It is observed in table 5 that the explanatory variable scored 0.305, meaningthat all the brain styles explain 30.5% of auditory reaction time; right brain did not have a statistical effect on auditory reaction time, *t* score (-0.239) with a significance of 0.812; left brain had a significant effect on auditory reaction time*t* score (2.371) with a significance of 0.022 as well as a significant effect of the integrated brain where *t* score is 2.439 with a significance of 0.018, total prediction coefficient correlation was 55.2%.

The left brain scored high; this is attributed to the characteristics of the hemisphere which is called "analysis and rationality". It is proved that the brain controls analytical thinking such as problem solving, priorities and creativeness, in addition to skills such as features and characteristics identification, making observations and distinguishing between similar and different things, comparing and contrasting, assembling, tabulating and classifying, building standards, recognizingrelations, predicting, guessing, expecting, determining cause and result, and measuring (Herrman, 1995). All these skills form properties of undergraduate education (Wordsworth, 1989).

The integrated brain explained the speed of reaction time. Several studies revealed that individuals depend on the brain in a holistic manner in the emotional respect rather than depending on a single hemisphere. Musical analysis, for instance, is located in the left hemisphere with the verbal skills, while tasting is located in the right hemisphere (Bozan, 1990; Send, 1991; Springer &Dentsch, 1999).

The serotonin existence in the brain is responsible for the sense of comfort and relaxation and is known as the mode material. Because of mode fluctuations resulting from high and low proportion of serotonin there is activation in emotions centers. Serotonin is one of the chemical substances known as neurotransmitters and it stimulates emotional responses by transferring or conducting emotional messages from the brain into various body parts of the body. Serotonin increase leads to a decrease in aggression and hatred (Jensen, 1998).

The system concerned in organizing the motor habits behind the cerebral cortex, slowness of muscle fiber movements and existence of impediments of the blood flow that reduces muscle tension and contraction contribute in raising the level of responsiveness to stimuli (Thomas, 2000).

Implications

In light of the results, the author suggests conducting more studies concerning reaction time and hemisphericity by engaging larger samples, specially the left-handed, different age groups, especially children, to recognize the correlative nature between reaction time and the brain. There is need to study the cognitive and motor functions that reflect the functional symmetry and cooperate with neuroscientists, researchers and educators in this field.

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