

# Pilot Study: The Role of the Hemispheric Lateralization in Mental Disorders by Use of the Limb (Eye, Hand, Foot) Dominance

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## ABSTRACT

**Introduction:** Based on the previous studies, we know that the hemispheric lateralization defects, increase the probability of psychological disorders. We also know that dominant limb is controlled by dominant hemisphere and limb preference is used as an indicator for hemisphere dominance. In this study we attempted to explore the hemispheric dominance by the use of three limbs (hand, foot and eye).

**Methods:** We performed this survey on two samples, psychiatric patients compared with normal population. For this purpose, knowing that the organ dominance is stabilized in adolescence, and age has no effect on the people above 15, we used 48 high school girls and 65 boys as the final samples of normal population. The patient group included 57 male and 26 female who were chronic psychiatric patients.

**Results:** The result shows that left-eye dominance is more in patients than the normal group ( $P=0.000$ ) but the handedness and footedness differences are not significance. In psychotic, bipolar and depressive disorders, eye dominance had significant difference ( $P=0.018$ ). But this is not true about hand and foot dominance.

**Discussion:** Our findings proved that generally in psychiatric patients, left-eye dominance is more common, left-eye dominance is also more in psychotic and depressive disorders. It is less common in bipolar disorders.

## 1. Introduction

**H**emispheric lateralization is one of the subjects that give us many clues for better recognition of the brain functions. Negative emotions are more related to the right hemisphere. It became clear that evoking emotions is not occurred in both hemispheres symmetrically. Research history shows three principles about lateralization of emotions: 1- They are better recognized by the right hemisphere, 2- Controlling emotions expression and its related behavior is done by the right hemisphere, 3- The right hemisphere is responsi-

ble for negative feelings and the left hemisphere for the positive ones. Another group that studied asymmetric feature of the face concluded that negative feelings are related to the right hemisphere and positive feelings to both hemispheres. Other negative expressed emotions that are leaded toward the right side of the visual field are comprehended properly. In a fMRI survey, the image which displays the negative feelings is accompanied with increase in activities of right hemisphere and positive excitation comes with increasing the activity of the left hemisphere. EEGs that were recorded in newborns showed that the activity of right hemisphere in

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newborns who cried when they got separated from their mothers was higher than those who didn't.

Imaginary studies showed the over-activity of nerves in amygdala and in upper region of colliculus when the participants are exposed to the frightening experiments in the left visual field (this processing is done by the nearby right hemisphere because the optic nerves cross in optic chiasma region) while this doesn't occur in the right visual field. Over-activity of right hemisphere during fear is related to the strong connection between right hemisphere and HPA axis and sympathetic axis and brain-adrenal axis.

Pleasure seeking and positive emotions are related to left hemisphere. A study showed that smelling makes a specific activity in left hemisphere while smelling unpleasant odor caused activation in right hemisphere. Similarly, greater LH frontal activation, was associated with higher levels of self-reported well-being, the extent to which respondents endorse high levels of autonomy, environmental mastery, personal growth, positive relations with others, purpose in life, self-acceptance, life satisfaction, satisfaction in important domains (such as

work, etc.), frequent pleasant emotions and infrequent unpleasant emotions.

According to the above examples, an expected result was found, it was observed that deviation in normal hemispheric lateralization in brain increases the probability of psychological disorder. Thus, in some studies with knowing that the dominant limb is controlled by the dominant hemisphere, limb dominance is used as an indicator for hemisphere dominance. For example schiffman et al., (2005) in a study about limb dominance, concluded that in schizophrenic patients, left-eye dominance and bilateral eye dominance is more, but hand preference is not common. Denny (2009) in one international study on large sample, showed that left handers were vulnerable to depression.

By reviewing previous studies about pathology of depression, we understand the hypothesis stating that depression is associated with hyperactivity of the right hemisphere. Also, bipolar disorder (manic depressive) is accompanied by weak activation of lateral frontal cortex area and high activity in the left orbitofrontal. The secondary left medial lateral prefrontal and parietal cortex is better connected with the other parts of brain in patients with bipolar disorder (Benson et al., 2008).

**Table 1.** Number of participants in two samples (normal and inpatients).

Diagnostic categories	n
	Include
Psychosis	36
Depression	20
Bipolar	17
Sum	73
	Exclude
Addict	5
Personality disorder	2
OCD	2
Mental retardation	1
Sum	10
Total	83
Normal sample	n
Male	65
Female	48
Total	113

Unlike these findings, in some studies, regarding the differences in limb dominance, no differences were seen. But boles et al., (2007) believe that, most of the studies that used limb dominance assessment for investigation about hemispheric lateralization, often can't find differences.

Therefore we don't know dominant in which one of limbs and in which direction had related to mental disorders in psychiatric patients. Anyhow the role of the biological factors in chronic patients is higher, In this study we attempted to explore the hemispheric laterality by using three limbs (hand, foot and eye) in patients group and normal group, in order to make up for deficiencies in past studies.

## 2. Methods

### 2.1. Participants

We performed this survey on two groups, chronic psychiatric patients (they are hospitalized in September and October 2013 in a psychiatric hospital in Tehran) in comparison with the normal population. For this purpose, knowing that organ dominance is stabilized in adolescence has no effect on the limb dominance in people

above 15 (Wada, 1960) by using nonrandom sampling approach, two high schools were chosen, and high school girls and boys between ages of 17 and 19 years old were used as the samples of normal population. They were asked to participate in this study. These Participants were chosen from a group of 366 (191 males, 175 females), this final group included 65 male students and 48 female students that volunteered for participation. The patients group includes 57 male and 26 female psychiatric inpatients (total 83). Questions regarding the history of mental disorder were used for screening the normal group and by using clinical diagnostic Interview, patients with impaired judgment for completing the tests, were excluded from this study. Finally, the number of the above mentioned persons who entered the study come as follow (psychosis (n=36), depression (n=20), bipolar (n=17), addiction (n=5), personality disorder (n=2), OCD (n=1) and mental retardation (n=1). (DSM-V criteria used for diagnosis). Because three major inpatient groups cover the main body of our patient sample, we used psychotic, depressed and bipolar inpatients for comparing and low numbered categories were excluded. The information related to the kind of diagnosis (n) is provided in Table 1. As shown in Table 1, 36 patients were psychotic, 17 patients had bipolar disorder, and 20 patients were in depression class.

## 2.2. Measurement

### 2.2.1. Handedness

Participants responded to Edinburgh Inventory scale by indicating whether they used their right, left, or both hands for 10 common actions: handling an eraser; striking a match; thumbtacking; hammering; brushing their teeth; throwing; and using a pair of scissors, a knife, a screwdriver, and a shaver or lipstick. This scale ranges from -10 to +10; a "right" response is scored as +1, a "left" response is scored as -1 and a response of "either" is scored as zero. The traditional method (Asai, 2011) was used to classify the subjects into three groups based on handedness. In this method, if subject gets a score between -10 to -5, is left handed, between -4 to +7, is ambidextral, and between +8 to +10, is right-handed. Also, the traditional method used in most of previous researches, was used to classify subjects into 3 different groups based on foot-preference. In this method, subjects getting a score between 11 to 16 are considered right-handed, between 17 to 27, ambidextral, and between 28 to 33, left-handed. Outcomes were shown in Table 2.

### 2.2.2. Footedness

Chapman foot preference inventory required participants to respond by indicating whether they used their right, left, or both feet for 11 common actions: step on a spade; put on first stocking; stand on one's foot; be upmost when crossing legs; kick a ball; hop; stamp on an object; step forward; put on first shoe; step up on a stool; pick up object with. This scale ranges from 11 to 33; a "right" response is scored as +1, a "left" response is scored as +3 and a response of "either" is scored as +2. Except for handedness and footedness, higher scores for all questionnaires indicate a stronger tendency on the relevant dimension.

## 2.3. Eye dominance

For determining the dominant eye, a method such as looking through a hole (Dane, 2007) was used. This approach is used for activities that need accuracy such as shooting. To ensure that we have selected the correct dominant eye, we trained the participants.

### 2.3.1. Psychiatric assessments

Psychiatric diagnostic interview, based on criteria of the fifth edition of DSM-V (Diagnostic and Statistical Manual of mental disorders) was done. To increase accuracy of diagnosing, MMPI 2 test was used (considering the fact that in this research, only the clinical and standard scales were taken into account, the subjects were asked to answer the first 370 items). Also, diagnostic interview and Million clinical multi-axial inventory were used in order to diagnosis the disorders of axis II.

## 2.4. Procedures

As noted above, participants completed the Edinburgh Inventory Scale, Chapman foot preference inventory, MMPI-II (for mental disorders in two samples), MILLON-III (for mental disorders only for the patients). Eye preference is determined by three times attempting to look through a hole. Because there were too many items, so we asked participants to complete items in 2 or 3 sessions.

And to investigate psychiatric inpatients, by using routine programs in psychiatric hospital, a clinical psychologist (one of the investigators) surveyed all volunteered inpatients that hospitalized in a two months period. For determining mental disorders, in psychotherapy meetings, psychiatric interview performed by investigator

**Table 2.** Limb dominance statistics for two groups (normal and patients).

Limb	Eye			Hand			Foot		
	Right	Bilateral	Left	Right	Bilateral	Left	Right	Bilateral	Left
Inpatient	49	8	26	58	21	4	35	39	9
Normal	95	6	12	75	30	8	33	68	11

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and test interpretations was used to increase the accuracy of diagnosing in normal group.

### 2.5. Analysis

Because we have nominal variables, three categories, and limit group numbers, chi-square test in non-parametric tests was chosen for comparing the groups. The data was analyzed by chi square test by Spss 20.

### 3. Results

We summarized data about limbs preference in two samples (normal and inpatients) in Table 2.

Limb dominance statistics in diagnostic group summarized in Table 3. We observed a significant difference in eye dominance ( $P=0.000$ ). So the rate of left eye dominance is higher in chronic patient in comparison with the normal patients. For hand and foot preference, differences were not significant. And as shown in Table 1, the number of patients in 3 diagnostic groups of psychotics, bipolar and depressive disorders were higher. The differences of eye dominance among the diagnostic categories with left eye-dominance ( $P=0.018$ ) were significant; but there weren't any significant differences regarding the handedness ( $P=0.591$ ), and foot-dominant groups ( $P=0.730$ ).

### 4. Discussion

Our observations were in accordance with background of previous researches (Schiffman et al., 2005 & Denny, 2009). And in 3 diagnostic groups, results showed that in 3 psychiatric groups, patients with different eye-dominance (left eye, ambidextral and right eye), prevalence of 3 diagnostic category of mental disorders (psychotic, bipolar and depressive disorders) had significant difference ( $P=0.018$ ). In this research, the 3 mental diseases were prevalent in groups having different limb dominance. The observed differences in the 3 diagnostic categories of psychosis, depression and bipolar disorders are compatible with background of previous researches. Also, it was specified that prevalence of bipolar disor-

ders in the group of left-eye patients is trivial (0.05%). Knowing that the right eye is controlled by the left hemisphere, this result is matched with the result of Altshuler et al., (2008). In that research, they showed that bipolar disorders are associated with the right hemisphere of brain. Benson et al., (2008) also showed that patients who are affected by bipolar can connect the left forehead and parietal second cortex better with the other parts of brain. Dominance of the right hemisphere in these patients is matched with the results stating that being left-eye is trivial (that is a symptom of dominance of the right hemisphere) in patients affected by bipolar disorder. 40 percent of patients affected by depression disorders are left-eye and this is a high rate in comparison with the sample of healthy people in that only 105 of the total sample is left-eye. By reviewing depression etiology, Hecht (2010) found that depression is associated with hyperactive right hemisphere. Thus, left-eye dominance in the patients sample can be considered as a symptom of higher activity of their right hemisphere.

But the results of this research showed that there isn't a significance difference between the patients affected by the 3 diagnostic classes based on handedness ( $P=0.591$ ) and foot-preference ( $P=0.730$ ).

However, this fact that handedness and foot preference have not significance differences in this study and some other studies (Boles et al., 2007), is a complicated issue. The reason of this finding can be very complicated, but anyway, studying neurological bases of laterality can be useful in this way. A short glance at the cerebral function controlling the 3 limbs used in this study can help us to have a better landscape. In "medical physiology" by Guyton and Hal (2011) adjacent part of central fissure in frontal lobe area of cerebral cortex has been considered as motor area and vision path begins at optic chiasm and bypassing temporal area, forms vision way, and then synapses with lateral geniculate nucleus of thalamus, then fibers reach the primary vision cortex in occipital lobe, and also frontal vision area has been pulled from face related area in pre central Gyrus to central gyrus. Vision area of frontal lobe controls voluntary movements of eye precisely and acts independently of vision

**Table 3.** Limb dominance statistics for 3 diagnostic categories:

DIAGNOSIS	LIMB	DOMINANCE	NUMBER
Psychotic disorders	Eye	Right	15
		Bilateral	6
		Left	16
	Hand	Right	22
		Bilateral	12
		Left	3
	Foot	Right	15
		Bilateral	19
		Left	3
Bipolar disorders	Eye	Right	15
		Bilateral	1
		Left	1
	Hand	Right	13
		Bilateral	4
		Left	0
	Foot	Right	8
		Bilateral	7
		Left	2
Depressive disorders	Eye	Right	11
		Bilateral	1
		Left	8
	Hand	Right	14
		Bilateral	5
		Left	1
	Foot	Right	6
		Bilateral	10
		Left	4

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stimulations. Involuntary chase of mobile objects by eyes entails being connected to vision area of occipital cortex with frontal lobe by shared fibers (the cause seems to be involved in eye dominance). Finally vision path passes a longer surface areas of brain hemispheres while hand and foot motor area doesn't.

And some studies showed that our brain does not have the same processing methods for vision fields. Right hemisphere has tendency to process the images presented at the left vision field negatively. (Kimura et al., 2004 & Siman-Tov, 2009).

According to above-mentioned findings, there are at least two factors which influence eye-preference, these factors cause that we see more people with left-eye dominance in the community of psychiatric patients. Of course, this study was a pilot study and didn't cover all mental disorders. The results were obtained from limited groups of psychiatric patients. Therefore, in order to achieve definite results, it is required to use an extended sample which covers all psychiatry disorders and it is also

necessary to consider the various states of organ laterality such as cross dominance.

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