Brain Semi-hemispherical Side-bias Preferences and Decision Making

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大脳半球の左右差と決断力の研究

Surender KUMAR, Yong Seob KIM, and Kun Seok OH

Abstract

Japanese 2nd year and 3rd year university students were examined on Handedness, footedness, eyedness, earedness responses for unilateral activities using a scale sampling procedure on one time. Side-bias questionnaire was utilized to choose the activities for side preferences. Students exhibited strong hand and foot preferences, but not to the same extent in eye and ear sidedness preferences. Right-handers exhibited more than 8% use of their left-side preferences, and left handers showed more than 23% use of their right-side preferences in their decision making but brain's both semi-hemispheres take integral decisions according to the input task.

Introduction

It is well known that about 10 percent of human population is left-handed and 90 percent population is right-handed. Social sanctions usually influence the side preferences in hand, and these are behavioral oriented as seen globally. Mostly hand preferences are seen as a social stigma in Asian countries, while the leg, eye and ear preferences do not become such issues interestingly. Parents usually point out for hand side use from infant to elementary school age, and many times exhibit a strong pressure to make use of the right hand as found in many Asian countries. Though the side influence on foot is relatively less; and hardly observed to be pointed out in eye and ear side use (Kumar, Kim, Oh, 2017). The normal process of side bias involves asymmetrical use of paired organs (like hand, foot, eye, and ear) for most behavioral functions. By

side bias we mean preferential use of one side of the body as a function of preference or performance (Bryden, 1982;Mandal, Bulman-Fleming, & Tiwari, 2000). Side bias is considered important for the purpose of resource allocation and effective motoric-coping with the environment. The asymmetrical use of paired organs is primarily controlled by the two sides of the human brain. Since the left hemisphere is dominant for most individuals (about 90%), the contralateral side of the body (the right hand, the right foot) is more preferred for motor functions. The right hemisphere controls the left side of the body, and the left hemisphere controls the right side. In most people, the left hemisphere regulates language and speech, and the right hemisphere controls nonverbal, spatial skills. If the right side of the brain is damaged, movement of the left arm and leg, vision on the left, and/or hearing in the left ear may be affected. Injury to the left side of the brain affects speech and movement on the right side of the body. The left-brain is responsible for rational thought processing, logical sequencing, and analytical considerations. The right brain helps out with creative thought, intuition, and looking at the big picture. Right brain left-brain functions work together to create a complete human brain for decision making process. It's often thought that those who use their right hands are left brain dominant, and then the reverse for left-handed individuals. Even when one side of the brain may be considered in charge, it does not mean that both sides are not part of the decision making process. It is not necessarily a right brain or left brain issue. One side may have stronger pull over the other, but there are other influences involved-and parts of the brain (Funderstanding.com, 2018).

The Decision Making Process: Right and left-brain differences do play a role in how a decision is made within the brain, but so do other parts of the brain system. Through experiments conducted on rats, it was discovered that when faced with a challenge, rats used their hippocampus to replay past experiences to help make decisions. A cognitive map was created to assist in determining correct and incorrect decision making, with the research potentially helping aide in fighting ailments that affect decision making in humans. The decision making process of the human brain is a series of connections strung together to come to a final result. Human behavior also effects the final decision making process, with small influences such as mood, circumstances, and conditions playing a part. The brain sometimes challenges itself, causing arguments amongst its regions when coming to a final decision and we use the emotional, gut-reaction, other than relying on their controlled, rational decision making skills. The hippocampus works with the brain in developing memory. Memory is a large part of how the brain makes decisions. No matter how your brain comes to your final decision, take the time to feel good about how you got there. Your brain is a wonderful thing and when you feel positive that you come to making a final conclusion, it benefits making future decisions. The right and left-brain functions are different but work together to create a whole being-including helping to make those tough decisions. Right and left

brain differences are what make our brains unique and each of the right and left brain characteristics play a big role in helping to come to a decision. Most of us find one side of the brain more dominant, leading into understanding which side of the brain may take charge when coming to decisions. With a majority of the population being left-brain dominant allowing their rational side to take charge, most make realistic and rational decisions. But, sometimes using the intuitive right brain may be of assistance. So, when faced with determining which way you need to turn the next time you are lost, you can go with your gut reaction, or take a moment to work out your decision making process. There are simple tests you can take to figure out whether you are left brain or right brain dominant. If you determine that you are more of a left-brain thinker, you may find yourself comfortable with the decision to pull over and consult the map. Those right brainers out there may continue driving and feel comfortable seeing where the road leads (Funderstanding.com, 2018).

Each half of the brain is divided into main functional sections, called lobes. There are four lobes in each half of the brain: the Frontal Lobe, Temporal Lobe, Parietal Lobe, and Occipital Lobe. Other important sections of the brain are the Cerebellum and the Brain Stem. Although not usually divided into lobes, the cerebellum and brain stem both have different parts. Each of the brain hemispheres and lobes, cerebellum, and brain stem has specific functions, and they all work together: Frontal Lobe: most anterior, right under the forehead; the frontal lobe controls intellectual activities, such as the ability to organize, as well as personality, behavior, and emotional control. Parietal Lobe: near the back and top of the head above the ears; the parietal lobe controls the ability to read, write, and understand spatial relationships. Occipital Lobe: most posterior, at the back of the head; the occipital lobe controls sight. Temporal Lobe: side of head above ears situated immediately behind and below the frontal lobes; the temporal lobe controls memory, speech and comprehension. Brain Stem: lower part of brain, leads to spinal cord; the brain stem contains nerve fibers that carry signals to and from all parts of the body. The brain stem also regulates body functions such as consciousness, fatigue, heart rate, and blood pressure. Damage to the brain stem can cause loss of consciousness. Cerebellum: located at the base of the skull; it is a curved mass of nerve tissues that regulates balance and coordinates fine motor skills; it enables us to move quickly and smoothly. Grey and White Matter: The brain is made up of two types of tissue, grey matter and white matter. Grey matter is involved in analyzing information. White matter conducts information between grey matter areas. The ratio of grey to white matter changes over the lifespan (Northeastern.edu, 2010).

The landmark work by Geschwind–Behan–Galaburda (Geschwind & Behan, 1982; Geschwind & Galaburda, 1986), known as G-B-G model, implicated anomaly in hemispheric dominance associated with neurodevelopmental disorders including autism. Subsequently studies

were conducted to examine the GBG model with all forms of developmental disorders too. The general findings suggested a left hemisphere dysfunction associated with the disorders while some researchers also suggested atypical dominance indicating lack of dominance in either hemisphere of the brain (Bishop, 1990).

Further, anomalous dominance pattern has been observed in other studies as well with a somewhat different notion. For example, in deaf children, anomalous hand dominance has been reported (Mandal et al., 1999, 2001). Language deficit is also found to be associated with atypical handedness in mental retardation (Lucas et al., 1989). These studies link atypical or anomalous handedness with reduced activation in the dominant hemisphere or some form of pathology in the brain including early cerebral insult. The use of side preferences was found different in the children with developmental disorders (Kumar et. al, 2010). Though some social prepositions are there to points out to the phenomenon which seems to be invariant to cultural predisposition. To avoid cultural predisposition, footedness was included as a measure of side bias. In a recent study it has been found that there is a clear interrelatedness between the long limbs (hand, foot) with the cerebral lateralization pattern (Kumar et al., 2012), pointing out to a common biological mechanism for side bias including eyedness and earedness.

Keeping these issues in view, we examined hand, foot, eye, and ear preference of university students using a self-rated scale method. We decided to examine side bias through this method to ensure the consistency in performance of an activity. Footedness was included as a measure to examine side bias in long limbs, in general. Foot behavior, unlike handedness, is not subjected to social sanctions, less likely the eye, and least likely the ear subjected to the social sanctions, therefore, these are found to be the reliable indicators of side bias. It would be interesting to examine the relationship of brain hemispherical role in hand, foot, eye, ear use side preferences in decision making.

Method

Sample

University second year and third year students in Japan were considered for the study. The students did not have any apparent motor difficulty that may hinder their daily functioning or any kind of disability or disease in hand, foot, eye, and ear. A brief introduction of the study was given to the students and informed consents were taken prior to administer the study questionnaire. They were asked to rate the items as per their own recognitions and feelings as they use in their day to day life to avoid any initial pressure of changing their hand, foot, eye, ear preferences.

The Japanese participants were female students (2nd year, N=227, Mean age 19.3yr., SD=.51; 3rd

year, N=77, Mean age 20.4yr., SD=.48). Japanese Right and Left handers were further analyzed for their opposite side preferences. The students did not have any other kind of motor problem or mental health problem as none of them reported.

Tools & Procedure

Japanese version of the Questionnaire for Hand-Foot-Eye-Ear Preferences (QHFEEP) were administered among the students. There were total 26 items in the scale. 10 items on handedness, 6 items on footedness, 5 items on eyedness and 5 items on earedness. They were asked to rate each item information as they use their right side (R) or left side (L) in day to day life. Laterality quotient was not studied.

The questions Included in the hand preference activities were (a) using a chopstick, (b) combing hair, (c) picking up a book from a rack, (d) picking up a suitcase, (e) brushing teeth, (f) throwing a ball to hit a target, (g) unscrewing a jar lid, (h) using an eraser on paper, (i) hammering a nail, and (j) writing on paper. The foot behavior was also rated. Included in these activities were (a) kicking a ball, (b) picking up a pebble with toes, (c) stumping on an insect, (d) stepping up on a chair, (e) first foot use when climbing on the stairs, and (f) foot use when start riding a cycle. The eyedness included as (a) seeing in a telescope, (b) seeing in a pipe, (c) seeing into a bottle, (d) seeing into a narrow slit, and (e) seeing through the door peephole. The earedness included as (a) listen to a phone call, (b) listening to a small unclear voice, (c) listening to a voice coming from your back side, (d) putting an earphone, and (e) listening to a small voice coming from a closed room. The items were newly framed and some were part of a Side Bias Questionnaire which was earlier validated in other countries including Japan (Ida et al., 2001; Mandal et al., 1992; Mandal et al., 2001). Questionnaire items were self-rated by the participants and third person observers were not included.

Results & Discussion

The mixed data on right and left hand preference response rating for each subject was averaged across items for handedness, footedness, eyedness, and earedness separately, and in total. These scores were then for percentage calculations for each subject. The mean scores were not calculated as the items were marked on, right side as labelled 1, and left side as labelled 2. *Table 1* suggests the handedness, footedness, eyedness, and earedness pattern of each subject. This time we further analysed the Japanese data to filter the Right Handers who responded on Left side preferences in hand, leg, eye, and year and similarly, the Left Handers who responded on Right side preferences in hand, leg, eye, ear, and leg.

Side preferences of Japanese students were found to be in total of hand, foot, eye, and ear was 80.49% the right side preference and; 19.51% the left side preference. The total preference was similar to that of any Asian country.

On handedness, 3rd year students exhibited slightly more use (16.62%) than 2nd year students (15.22%) in left side. On right side, 2nd year students showed more use (86.78%) than 3rd year students (83.34%). In total, left side was 14.08%, and right side was 85.92%. The finding is a sharp departure of what we observe in normal population. About 90% of the human population is said to be right handed. The incidence of left-handedness has been found to be as low as four to six percent in traditional societies like Asia and Africa (for example, India 6.8%: Mandal, Pandey, Singh, & Asthana, 1992; Japan 4.7%: Ida, Dutta, & Mandal, 2001), while in modern societies like the United States, Canada, and England it averages at 15-20% (Perelle & Ehrman, 1994; Suar, Misra, Mandal, & Suman, 2008). The study hand preferences were close to the European or American preferences.

On footedness, 3rd year students did not differ (13.42%) than 2nd year students (12.63%) in left side use. On right side also, 3rd year students did not differ (86.58%) than 2nd year students (87.37%). In total, left side was 12.83%, and right side was 87.17%. Again the footedness results were close to the handedness. Foot preferences were more reliable without much influence of social behaviour restrictions or sanctions.

On eyedness, 3rd year students did differ at large extent (24.68%) than 2nd year students (28.55%) in left side use. On right side also, 3rd year students differed (75.32%) than 2nd year students (71.45%). In total, left side was 27.57%, and right side was 72.43%. Eyedness results also did not altered by social behaviour constraints. Eyedness results showed that side use is not so much related to the handedness or footedness. Use of eye though was preferred as per the side but strongly rated greater than on hand or foot use.

On earedness, 3rd year students did differ remarkably (34.03%) than 2nd year students (29.07%) in left side use. On right side also, 3rd year students differed (65.97%) than 2nd year students (70.93%). In total, left side was 30.33%, and right side was 69.67%. Ear sidedness results also did not altered much by social behaviour constraints or sanctions and a frequent use of ear was shown without considering the side bias, though right hand preference students rated more the right ear use. Earedness results showed that side use is not so much related to the handedness or footedness or eyedness. Use of ear was also preferred as per the side but remarkably rated greater than on hand or foot use. Study findings exhibited the trend that there are more chance that handedness was strongly influenced on side-bias, footedness relatively less influenced by side-bias, eyedness very less influenced by side-bias, and earedness was least influenced by the side-bias. The side preferences were greater than the Asian countries and slightly less than the European countries.

Further the data were analysed for the Right Handers who used Left sides preference in Hand, Foot, Eye, and Ear; and the Left Handers who used Right sides preference in Hand, Foot, Eye, and Ear in their side-preferences decision making among 2nd year and 3rd year Japanese students.

It was revealed from the *Table 2* that Right-handers were using their Left Hand too in certain day to day activities as 2nd year=8.05%, 3rd years=9.71% and in total 8.45%. Right-handers were using their Left Foot as 2nd year=9.76%, 3rd years=6.28% and in total 8.90%. Right-handers were using their Left Eye as 2nd year=26.86%, 3rd years=17.97% and in total 24.66%. Right-handers were using their Left Ear as 2nd year=26.1%, 3rd years=30.72% and in total 27.24%. Left-handers were using their Right Hand too in daily living activities as 2nd year=22.94%, 3rd years=23.75% and in total 23.20%. Left-handers were using their Right Foot as 2nd year=51.96%, 3rd years=25.0% and in total 43.33%. Left-handers were using their Right Eye as 2nd year=50.59%, 3rd years=17.5% and in total 40.0%. Left-handers were using their Right Ear as 2nd year=34.12%, 3rd years=37.5% and in total 35.2%.

It is clearly reflected that the person who are right-handers also use around 8% of their left hand and foot, but more than 24% use of left eye and ear. Oppositely, the left-handers make use of their right hand 23%, and more than 35% use of foot, eye, and ear. It can be said that the right-handers take most of their decisions through use of right sides preferences and some through left-side use. Differently, the left-handers were found to make use their right-side preferences more than the right-handers. Left handers were found to make decisions using more than 25% of their right-side preferences too. It concluded that the role of brain hemisphere is not restricted to the respective side but the brain's left and right hemispheres take integral decision responsibilities according to the mental involvement input task in both left- and right-handers and these findings are in the direction of Szeligo, Brazier, Houston. 2003. So, the belief that right-handers use their right sides and left-handers use their left sides of body parts seems doubtful. The limitation of 3rd years sample size may alter the findings and therefore, a broad data analysis can be a future study work and to be tested in different cultural groups.

Table 1. Japanese context Handedness, Footedness, Eyedness, Earedness Mean, SDs, and Percentage of 2nd Year (*N*=227, *Mean age*=19.3yr., *SD*=.51) and 3rd Year (*N*=77, *Mean age*=20.4 yr., *SD*=.48) and Total students (*N*=304, *Mean age*=19.6yr., *SD*=.67) university students.

Preferences	2 nd Year			3 rd Year			Total		
L=Left R=Right	*Side*	*Items*	%	*Side*	*Items*	%	*Side*	*Items*	%
Handedness	L	300	15. 22	L	128	16. 62	L	428	14. 08
	R	1970	86. 78	R	642	83. 34	R	2612	85. 92
Footedness	L	172	12. 63	L	62	13. 42	L	234	12. 83
	R	1190	87. 37	R	400	86. 58	R	1590	87. 17
Eyedness	L	324	28. 55	L	95	24. 68	L	419	27. 57
	R	811	71. 45	R	290	75. 32	R	1101	72. 43
Earedness	L	330	29. 07	L	131	34. 03	L	461	30. 33
	R	805	70. 93	R	254	65. 97	R	1059	69. 67
Total	L	1126	19. 08	L	416	20. 78	L	1542	19. 51
	R	4776	80. 92	R	1586	79. 22	R	6362	80. 49

Table 2. Japanese context Handedness, Footedness, Eyedness, Earedness Mean, SDs, and Percentage of 2nd Year (*N*=227; *R*= 210, *L*=17, *Mean age*=19.3yr., *SD*=.51) and 3rd Year (*N*=77; *R*=69, *L*=8, *Mean age*=20.4yr., *SD*=.48) and Total students (*N*=304, *R*= 276, *L*=25, *Mean age*=19.6yr., *SD*=.67) university students.

Side-preferences	*Right-handers using Left-sides in %*	*Left-handers using Right-sides in %*
Handedness	2 年生＝8. 05 3 年生＝9. 71 Total＝8. 45	2 年生＝22. 94 3 年生＝23. 75 Total＝23. 20
Footedness	2 年生＝9. 76 3 年生＝6. 28 Total＝8. 90	2 年生＝51. 96 3 年生＝25. 0 Total＝43. 33
Eyedness	2 年生＝26. 86 3 年生＝17. 97 Total＝24. 66	2 年生＝50. 59 3 年生＝17. 5 Total＝40. 0
Earedness	2 年生＝26. 1 3 年生＝30. 72 Total＝27. 24	2 年生＝34. 12 3 年生＝37. 5 Total＝35. 2

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Questionnaire for Hand-Foot-Eye-Ear Preferences (QHFEEP) (For Participants)

Demographic data:

Name:＿＿＿＿＿＿＿＿＿＿　利き手：右　・　左　Age:＿＿＿＿　Sex: M　F

Date: ＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

L for left-side or R for right-side　どちらかを選んでください。

どちらの「手」を使いますか：		
1．お箸を持つとき	L	R
2．髪の毛をとくとき	L	R
3．棚から本を取り出すとき	L	R
4．スーツケースを持つとき	L	R
5．歯を磨くとき	L	R
6．目標に向かってボールを投げるとき	L	R
7．瓶のふたをひねって開けるとき	L	R
8．消しゴムを使うとき	L	R
9．釘を打つのにハンマーを持つとき	L	R
10. 紙に書くとき	L	R
どちらの「足」を使いますか：		
11. ボールをけるとき	L	R
12. 足の指で石を拾うとき	L	R
13. 虫を踏みつぶすとき	L	R
14. 椅子に上るとき	L	R
15. 階段を上り始めるとき	L	R
16. 自転車をこぎだすとき	L	R
どちらの「目」を使いますか：		
17. 望遠鏡で見るとき	L	R
18. パイプをのぞくとき	L	R
19. 外から見えない瓶などの入れ物の中身を見るとき	L	R
20. 隙間に入ったものを見るとき	L	R
21. ドアののぞき穴から見るとき	L	R
どちらの「耳」を使いますか：		
22. 電話で話すとき	L	R
23. 聞きづらい小さな音を聞くとき	L	R
24. 後ろから聞こえてくる音にどちらの耳をかたむけますか	L	R
25. イヤーフォーンをどっちの耳に先に着けますか	L	R
26. ドアが閉まった部屋の中から聞こえる音を聞きたいとき	L	R

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