

## Interhemispheric Interaction in Task Redundancy: A Function of Handedness

Prerita Bahri, Trayambak Tiwari, Shreshtha Yadav, Anil Kumar Yadav,  
Banaras Hindu University, Varanasi

Anju Lata Singh

Vasant Kanya Mahavidyalaya, Varanasi

Left-handedness has been associated with certain advantages in the functioning of the corpus callosum, contrarily it is also highly correlated with development of psychopathology. This article tests the former, using bilateral presentation redundancy tasks on both left and right-handed individuals (N=60). Participants were instructed to identify where the meaningful word was presented whether in right visual field (RVF), left visual field (LVF), or bilateral visual field (BVF). Handedness was assessed on the revised Edinburgh Handedness Inventory (Veale, 2014). Reaction time and accuracy were tested across visual presentations using Wilcoxon signed-rank test. Findings indicated that left-handers responded quicker compared to right handers in bilateral condition, displaying superior interhemispheric communication. Though, this trend did not follow in terms of accuracy. However, right handers did demonstrate higher accuracy in contralateral presentation to the left hemisphere. Additional analysis (using Mann-Whitney U test) showed that females presented shorter reaction time latencies, though such trends did not follow in terms of accuracy, leaving scope for further research.

**Keywords:** Redundancy gain, Handedness, Interhemispheric interaction, Unilateral and bilateral visual fields,

Redundancy gain effect is the amplified efficiency of detection time and accuracy of one stimulus in the presence of another. It originates in divided attention (Miller, 2004), the ability of individuals to divest their cognitive resources to multiple external cues. In other words, it is the brain's ability to use non-target stimuli to leverage better performance in detecting the target stimuli. It is observable when a pair of target and redundant stimuli are presented simultaneously in similar or dissimilar modalities. The shorter response latencies and higher accuracy are characteristic of redundancy gain effects. It is a popular method of assessing interhemispheric interaction (Badzakova-Trajkov et al., 2004).

Handedness is the preference of an individual for using one hand more frequently

than the other for various activities. The majority of the human population is right-handed, ranging between 85% and 90% (McManus, Davison, & Armour, 2013; Brandler & Paracchini, 2014; Marchant & McGrew, 1998; Corballis, 1991). A child's preference is observable at 6 months of age (Parma et al., 2017). There are four primary ways of determining an individual's handedness: (1) narrative identity handedness/self-identified, (2) questionnaire-based handedness assessment, (3) observable handedness in manual actions, and (4) performance-based hand skill assessment. Questionnaires, like the Edinburgh Handedness Inventory, Waterloo Handedness Questionnaire, etc., assess handedness on a list of tasks. A laterality index (LI) is calculated, which

reflects on the total handedness. Questionnaires are one of the most widely used ways of assessing handedness but are not free of limitations. For instance, the results may be highly varied and can lead to inconsistent categorizations. Some others have a poor capacity to accurately measure mixed-handedness.

Right-handedness is associated with greater asymmetry in the left calcarine gyrus (visual network), the right superior gyrus, and the precuneus (default mode network). Differences typically exist in the surface area asymmetry between the two handedness groups, in the precentral cortices, anterior insula, anterior middle cingulate, and the fusiform, and a reduced leftward thickness asymmetry along the postcentral gyrus in left-handers (Sha et al., 2021). Neuroanatomical and morphological studies indicate a difference in fibre density, with higher corpus callosum density in left-handers, in the posterior third, namely the isthmus, splenium, and genu (Amunts, Jancke, Mohlberg, Steinmetz, & Zilles, 2000), the anterior regions (Tuncer, 1998), and the overall larger size of the corpus callosum in the isthmus, which connects the parietal association areas of the two hemispheres involved in asymmetrical brain processes such as lateralization, splenium, and genu (Witelson 1985, 1989; Hampson & Lee, 1998).

The structural differences, likely to manifest into functional ones in the fundus of the superior temporal visual area (FST) and lower laterality index in the regions like the premotor area (6d), cerebellum (CER), and the somatosensory area (BA1) (Tomasi & Volkow, 2024). Thus, structural and functional distinctions exist, that influence the efficiency with which both groups process information.

The role of interhemispheric interaction in task performance has been explored

across multiple studies, with a consistent focus on the benefits of distributing processing across the two hemispheres. Banich and Belger (1990) suggest that when task requirements are demanding, performance improves by dividing processing between the hemispheres, enhancing task performance. Similarly, Norman et al. (1992) found that bilateral presentations resulted in faster responses and fewer errors, with a growing bilateral advantage relative to right visual field (RVF) responses as task difficulty increased.

Research literature demonstrated “significant handedness effects, suggesting that left-handed individuals tend to have more efficient hemispheric interactions” (Cherbuin & Brinkman, 2006), and faster RTs (Datta, 2021). The higher efficiency may be explainable by (1) lower hemispheric lateralization in left-handers and (2) superior corpus callosum density/fibers in left-handers. Individuals with dominating left-handedness often display a relatively independent hemifield processing reflecting on lower asymmetrical processing for word stimulus (Miller & L.K., 1983). Studies by Habib et al. (1991) and Witelson (1985) show that mixed-handers (including left-handers) have larger corpus callosum, which is associated with greater interhemispheric interaction (Potter & Graves, 1988).

Given that interhemispheric interactions influence redundancy gain effects, as previous research would suggest superior performance is demonstrated by left-handers in tasks that require coordination of bilateral hemispheres, it becomes an essential question whether this advantage would extend to redundancy tasks. Reduced lateralization and a denser and larger corpus callosum may result in more efficient interhemispheric interaction, potentially influencing the reaction time efficiency and accuracy across redundancy conditions. To address whether left-handers indeed

demonstrate better interhemispheric interaction, we had participants from both groups perform on a redundancy task. We hypothesised that left-handed participants would perform better, both in terms of reaction time efficiency and accuracy, compared to right-handers on bilateral visual field presentations. Owing to the inconclusiveness of previous studies, we also ran an exploratory analysis to identify any gender difference in performance.

### **Method**

The study aimed to examine whether left and right-handed individuals will differ in their performance. The objectives of the studies were to (1) examine whether left-handed and right-handed individuals exhibit faster reaction times on bilateral visual field (BVF) presentations compared to unilateral visual field (RVF and LVF) presentations, indicating superior processing efficiency in BVF conditions (2) assess the differences in accuracy between left visual field (LVF) and right visual field (RVF) conditions in left-handed and right-handed individuals and (3) explore gender differences in reaction time efficiency (RVF, LVF, and BVF) and accuracy (LVF and RVF) across the visual conditions.

### **Sample**

The study was carried out on 60 participants, a handedness group with 30 participants each. It constituted of 26 males and 34 females. All participants were currently pursuing undergraduate or postgraduate studies at Banas Hindu University, Varanasi. Participants had normal and corrected to normal (6/6) eyesight verified through a simple standardised vision Snellen chart test.

### **Experimental Tools and Materials**

*Stimulus List:* About 900 words were extracted from the “Shabd: A psycholinguistic database for Hindi words”, ranging from the most to the least frequent words based on

their usage across popular newspapers and news sites (Sikarwar, Yadav & Verma, 2023). A randomised list was created using 300 out of the 900 most frequently used Hindi words (Kim, 2022).

*Edinburgh Handedness Inventory:* A 4-item (revised) version (Veale, 2014) of the original Edinburgh Handedness Inventory was used, which assessed hand preference on four major tasks that had the highest factor loading, “Writing”, “Throwing”, “Toothbrush” and “Spoon”, that the participants had to respond on a 5-point scale. Scoring for the questionnaire was as follows: “Always right”: 100 “Usually right”: 50 “Both equally”: 0 “Usually left”: -50 “Always left”: -100 The 4-item inventory had a composite reliability quotient value of 0.87, indicative of high internal consistency and had a factor score determinacy value of 0.90, reflecting its ability to predict handedness accurately. The revised version has good validity and measures a single-handedness factor.

### **Experimental Task and Instructions**

The fixation point was presented in the centre of the screen for 100 ms, followed by a stimulus in the left, right or the bilateral visual fields of the screen for 200 ms, followed by a mask for 1800 seconds. The short duration of the stimulus presentation was to avoid gaze shifting to the unilateral stimulus/visual field. The unilateral condition consisted of a string of symbols (“X#@X#@”) simultaneously presented in the opposite visual field of the word. In the bilateral condition, meaningful words were presented in both visual hemifields. This task was only analysed for its reaction time efficiency. Overall, the participants had to decide where the word was presented during mask periods when a blank screen was presented after the deletion of the target. A schematic illustration of the experimental procedure is shown in Figure 8. The task was composed of about 300 total number of trials with 100 trials per

condition (LVF, RVF and BVF). The participants were asked to identify where the word was presented on the screen in the unilateral and bilateral conditions while keeping their eyes fixated on the fixation point (“+”). Participants were instructed to press “Z” if the word appeared on the left half of the screen and “M” if it appeared on the right. The participants were asked to place their left-hand and right-hand index fingers on the “Z” and the “M” keys respectively. The task was then measured for how fast (reaction

time/RT) the participants responded correctly to a word across all three conditions and how accurately they responded to a word (accuracy) in the LVF and RVF conditions. Before the experiment, all participants were tested on the Snellen chart for normal or corrected-to-normal vision, followed by the four-item Edinburgh Handedness Questionnaire. Participants then completed 22 practice trials to familiarize themselves with the task, followed by the actual experimental session, which lasted approximately 15 minutes.

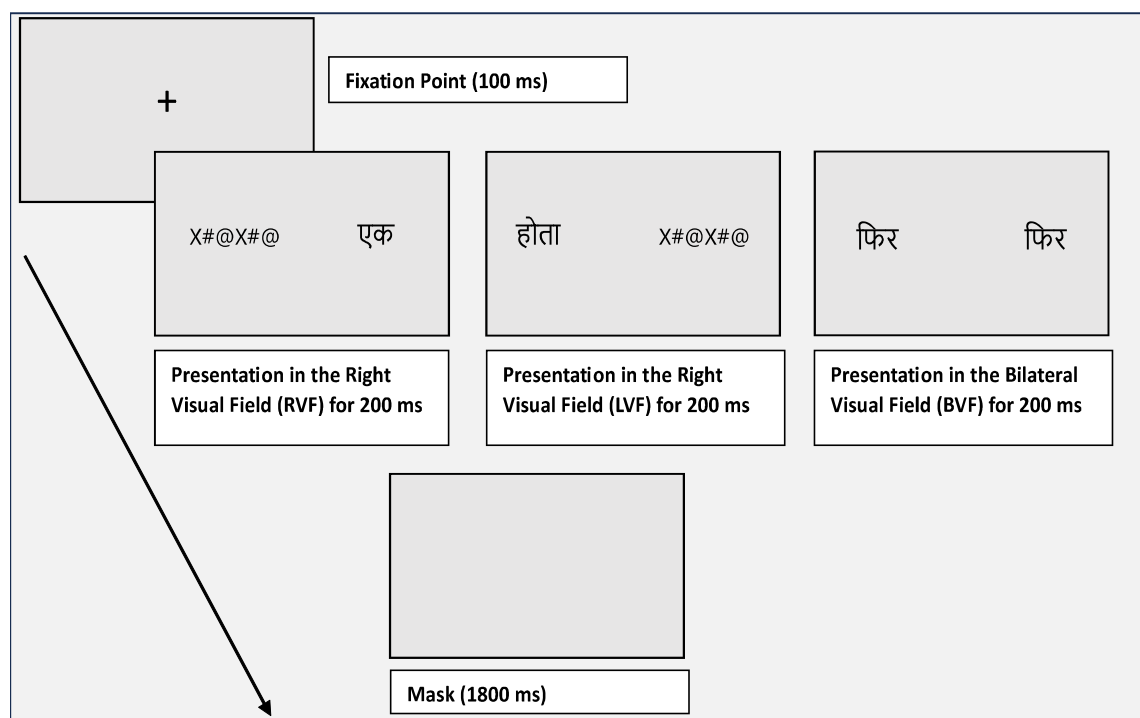


Figure 1. Schematic Illustration of Experimental Task

### Results

There was no significant difference in reaction time efficiency between RVF and LVF, with a  $p = 0.349$  in left-handed individuals, suggesting that LVF (RT) was faster (see Table 1). A comparison of RVF with BVF showed a significant difference,  $p = 0.008$ , significant at the 1% level and a quicker response on BVF. Participants

performance indicated significant difference between RTs of BVF and LVF,  $p = 0.03$ , significant at the 5% level ( $p < 0.05$ ). However, only RVF and LVF reaction time efficiency difference was significant, with  $p = 0.03$ , significant at the 5% level ( $p < 0.05$ ) for right-handers.

Table 1. Bilateral Gain in Reaction Time Efficiency for Left-handed and Right-handed participants

		LVFrt-RVFrt	BVFrt-RVFrt	BVFrt-LVFrt
Left-handers	Z	-.936 <sup>b</sup>	-2.664 <sup>b</sup>	-2.173 <sup>b</sup>
	Asymp. Sig. (2-tailed)	.349	.008	.030
Right-handers	Z	-2.170 <sup>b</sup>	-.381 <sup>b</sup>	-1.368 <sup>c</sup>
	Asymp. Sig. (2-tailed)	.030	.704	.171

Note: LVF = left visual field, RVF = right visual field, BVF = bilateral visual field and rt = reaction time

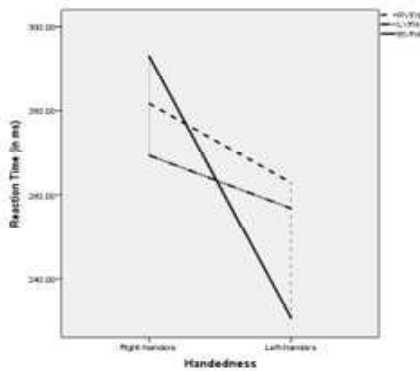


Figure 2. Reaction Time Efficiency for Left-handed and Right-handed participants

Accuracy assessments suggest no significant difference between LVF and RVF for left-handed participants (see table 2). Nevertheless, our results demonstrated accuracy differences for right-handers between LVF and RVF, with and  $p = 0.005$ , significant at the 1% level ( $p < 0.01$ ). The mean rank suggests better accuracy in RVF than LVF.

Table 2. Mean Accuracy Performance for LVF and RVF in Left-handed and Right-handed participants

		LVFcr-RVFcr
Left-handers	Z	-1.393 <sup>b</sup>
	Asymp. Sig. (2-tailed)	.164
Right-handers	Z	-2.826 <sup>b</sup>
	Asymp. Sig. (2-tailed)	.005

Note: LVF = left visual field, cr = correct response, RVF = right visual field.

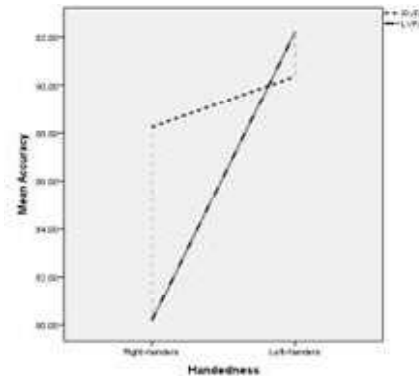


Figure 3. Mean Accuracy performance for RVF and LVF in Left-handed and Right-handed participants

The results indicate significant differences between the male and female sample in all three conditions, significant at the 5% level ( $p < 0.001$ ), with  $p = 0.037$  and  $p = 0.035$  for LVF and BVF respectively (see Table 3). Analysis of accuracy scores across visual field conditions revealed no differences (see table 4).

Table 3. Reaction Time Efficiency across Visual Field Conditions (RVF, LVF, BVF) for male and female sample

	RVFrt	LVFrt	BVFrt
Mann-Whitney U	366.500	302.500	300.500
Wilcoxon W	961.500	897.500	895.500
Z	-1.126	-2.081	-2.111

Asymp. Sig. (2-tailed).260.037.035 Note: LVF = left visual field, RVF = right visual field, BVF = bilateral visual field and rt = reaction time

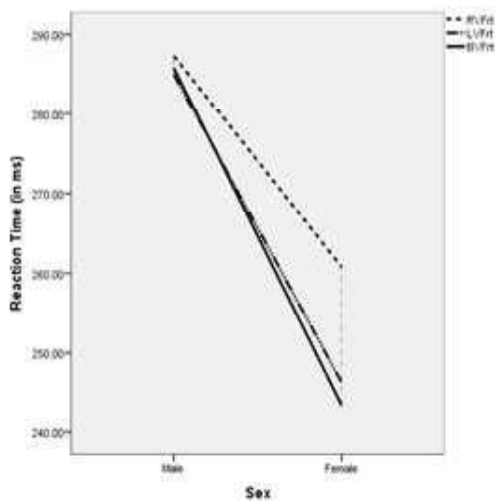


Figure 4. Reaction Time efficiency Across Visual Field Conditions (RVF, LVF, BVF) for male and female sample

Table 4. Mean Accuracy Performance across RVF and LVF for male and female sample

	RVFcr	LVFcr
Mann-Whitney U	390.000	400.000
Wilcoxon W	985.000	995.000
Z	-.778	-.628
Asymp. Sig. (2-tailed)	.437	.530

Note: LVF = left visual field, cr = correct response and RVF = right visual field.

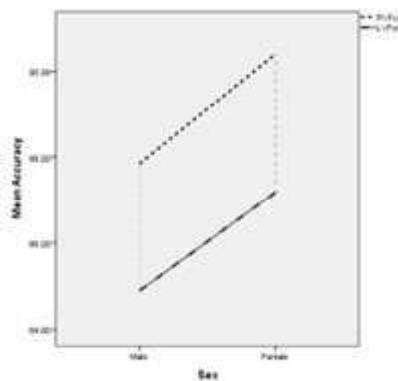


Figure 5. Mean Accuracy Performance in RVF and LVF for male and female sample

## Discussion

The findings of the study indicated superior reaction time efficiency (RTs) for bilateral visual field presentation relative to both right and left visual fields. (RVF and LVF). Bilateral redundancy gain (BRG) in left-handed participants was high, in parity with studies that reported superior interhemispheric interactions in left-handers than in non-left-handers, such as the study by Cherbuin and Brinkman (2006), which reported a linear relationship between RTs and interhemispheric interactions in left-handed participants. Significant bilateral redundancy gain reflects on stronger interhemispheric cooperations observed in bilateral presentation tasks (Hasbrooke et al., 1998), independent of stimulus characteristics (Marks & Hellige, 2003), aided by lower symmetrical processing of stimulus (Miller & L.K., 1983) and greater corpus callosum density of left-handed participants (Amunts, Jancke, Mohlberg, Steinmetz, & Zilles, 2000; Tuncer et al., 1998; Witelson, 1985, 1989; Potter & Graves, 1988). An association can be drawn between the bilateral field advantage and the level of interhemispheric interaction (Brown & Jeeves, 1993) to derive these results.

We predicted similar results in right-handed participants; however, no significant differences were found in reaction time efficiency across unilateral and bilateral conditions. Reaction time efficiency was notably better on right visual field presentations than left-visual field, in right-handed participants. Faster responses were induced by the stimulus presented in the right visual field. Thus, the superior ability to process information quicker is presented in the hemifield contralateral to the left hemisphere, representing highly specialized functional lateralization/asymmetry of word processing in right-handers to the left hemisphere; while such heterogenous division of function and lower interaction was

less evident for left-handed participants (Tzourio, Crivello, Mellet, Nkanga-Ngila, & Mazoyer, 1998; Johnstone et al., 2021; Tomasi & Volkow, 2024).

Accuracy variation did not exist in the obtained data over the two visual fields RVF and LVF in left-handed participants. The minimal differences can be understood in the light of greater symmetry or reduced specialized functional lateralization. In right-handers, however, a statistically significant difference was noted through analysis, which corroborates with the lateralization of specific tasks more strongly in right-handers than left-handers (Sha et al., 2021; Eviatar, Hellige, & Zaidel, 1997). Right-handed participants respond more accurately to the stimuli presented to their right visual field, indicating stronger and more efficient language processing (Tomasi & Volkow, 2024) capabilities of the left hemisphere.

Females responded quicker on redundancy task than males in reaction time tasks across all visual field conditions (RVF, LVF, and BVF) which may indicate towards higher interhemispheric interaction efficiency to process tasks of divided attention; posing the question; are women better at multitasking? The hunter-gatherer hypothesis would suggest yes, which states that through evolutionary division of tasks, men have developed advanced abilities of spatial nature. On the other hand, women demonstrate advanced multitasking abilities. Thus, lower RT latencies may be explained by resistance to distractibility that developed in women when performing tasks of divided attention (Stoet et al., 2013) and ability to shield against task-irrelevant features (Stoet et al., 2017). Therefore, the results of our study corroborate with existing literature (Gur & Gur, 2017; Hirnstein, Hugdahl, & Hausmann, 2018; Sommer, Aleman, Bouma, & Kahn, 2004). However, these studies lack a common ground or standardised methods of assessment; their interpretations should

be used with caution. Understandably, more research is required to draw conclusive results to understand the underlying mechanisms behind this difference, if there exists any.

## References

- Amunts, K., Jäncke, L., Mohlberg, H., Steinmetz, H., & Zilles, K. (2000). Interhemispheric asymmetry of the human motor cortex related to handedness and gender. *Neuropsychologia*, 38(3), 304–312. [https://doi.org/10.1016/S0028-3932\(99\)00075-5](https://doi.org/10.1016/S0028-3932(99)00075-5)
- Badzakova-Trajkov, G., Hamm, J. P., & Waldie, K. E. (2004). The effects of redundant stimuli on visuospatial processing in developmental dyslexia. *Neuropsychologia*, 43(3), 473–478. <https://doi.org/10.1016/j.neuropsychologia.2004.06.016>
- Brandler, W. M., & Paracchini, S. (2014). The genetic relationship between handedness and neurodevelopmental disorders. *Trends in Molecular Medicine*, 20(2), 83–90. <https://doi.org/10.1016/j.molmed.2013.10.008>
- Brown, W. S., & Jeeves, M. A. (1993). Bilateral visual field processing and evoked potential interhemispheric transmission time. *Neuropsychologia*, 31(12), 1267–1281. [https://doi.org/10.1016/0028-3932\(93\)90097-j](https://doi.org/10.1016/0028-3932(93)90097-j)
- Cherbuin, N., & Brinkman, C. (2006). Hemispheric interactions are different in left-handed individuals. *Neuropsychology*, 20(6), 700–707. <https://doi.org/10.1037/0894-4105.20.6.700>
- Corballis, M. C. (1991). *The lopsided ape: Evolution of the generative mind*. Oxford University Press.
- Datta, Diyotima (2021) "Handedness: Does it affect interhemispheric transfer?," *The Plymouth Student Scientist*: Vol. 14: Iss. 2, Article 6. <https://doi.org/10.24382/mqky-dq85>
- Eviatar, Z., Hellige, J. B., & Zaidel, E. (1997). Individual differences in lateralization: Effects of gender and handedness.

- Neuropsychology*, 11(4), 562–576. <https://doi.org/10.1037/0894-4105.11.4.562>
- Gur, R. C., & Gur, R. E. (2017). Complementarity of sex differences in brain and behavior: From laterality to multimodal neuroimaging. *Journal of Neuroscience Research*, 95(1-2), 189–199. <https://doi.org/10.1002/jnr.23830>
- Habib, M., Gayraud, D., Oliva, A., Regis, J., Salamon, G., & Khalil, R. (1991). Effects of handedness and sex on the morphology of the corpus callosum: A study with brain magnetic resonance imaging. *Brain and Cognition*, 16(1), 41–61. [https://doi.org/10.1016/0278-2626\(91\)90084-L](https://doi.org/10.1016/0278-2626(91)90084-L)
- Hasbrooke, R. E., & Chiarello, C. (1998). Bihemispheric processing of redundant bilateral lexical information. *Neuropsychology*, 12(1), 78–94. <https://doi.org/10.1037/0894-4105.12.1.78>
- Hirnstain, M., Hugdahl, K., & Hausmann, M. (2018). Cognitive sex differences and hemispheric asymmetry: A critical review of 40 years of research. *Laterality*, 24(2), 204–252. <https://doi.org/10.1080/1357650X.2018.1497044>
- Kim, S., Kim, J., & Nam, K. (2022). Familiarity with words modulates interhemispheric interactions in visual word recognition. *Frontiers in Psychology*, 13, 892858. <https://doi.org/10.3389/fpsyg.2022.892858>
- Marks, N. L., & Hellige, J. B. (2003). Interhemispheric interaction in bilateral redundancy gain: Effects of stimulus format. *Neuropsychology*, 17(4), 578–593. <https://doi.org/10.1037/0894-4105.17.4.578>
- Mcmanus, I. C., Davison, A., & Armour, J. A. L. (2013). Multilocus genetic models of handedness closely resemble single-locus models in explaining family data and are compatible with genome-wide association studies. *Annals of the New York Academy of Sciences*, 1288, 16–32. <https://doi.org/10.1111/nyas.12102>
- Miller, J. (2004). Exaggerated redundancy gain in the split brain: A hemispheric coactivation account. *Cognitive Psychology*, 49(2), 118–154. <https://doi.org/10.1016/j.cogpsych.2003.12.003>
- Miller, L. K. (1983). Hemifield independence in the left-handed. *Brain and Language*, 20(1), 33–43. [https://doi.org/10.1016/0093-934X\(83\)90030-5](https://doi.org/10.1016/0093-934X(83)90030-5)
- Marchant, L.F., McGrew, W.C. Human handedness: an ethological perspective. *Hum. Evol.* 13, 221–228 (1998). <https://doi.org/10.1007/BF02436506>
- Potter, S. M., & Graves, R. E. (1988). Is interhemispheric transfer related to handedness and gender? *Neuropsychologia*, 26(2), 319–325. [https://doi.org/10.1016/0028-3932\(88\)90084-X](https://doi.org/10.1016/0028-3932(88)90084-X)
- Parma, V., Brasselet, R., Zoia, S., Bulgheroni, M., & Castiello, U. (2017). The origin of human handedness and its role in pre-birth motor control. *Scientific Reports*, 7(1), 16804. <https://doi.org/10.1038/s41598-017-16827-y>
- Sha, Z., et al. (2021). Handedness and its genetic influences are associated with structural asymmetries of the cerebral cortex in 31,864 individuals. *Proceedings of the National Academy of Sciences*, 118, e2113095118. <https://doi.org/10.1073/pnas.2113095118>
- Sikarwar, V. S., Yadav, H., & Verma, A. (2023, September 27). Shabd: A psycholinguistic database for Hindi. *OSF Preprints*. <https://doi.org/10.17605/OSF.IO/XFBHD>
- Sommer, I. E. C., Aleman, A., Bouma, A., & Kahn, R. S. (2004). Do women really have more bilateral language representation than men? A meta-analysis of functional imaging studies. *Brain*, 127(8), 1845–1852. <https://doi.org/10.1093/brain/awh207>
- Stoet, G., O'Connor, D. B., Conner, M., & Laws, K. R. (2013). Are women better than men at multi-tasking? *BMC Psychology*, 1(1), 18. <https://doi.org/10.1186/2050-7283-1-18>
- Stoet, G. (2017). Sex differences in the Simon task help to interpret sex differences in selective attention. *Psychological*

- Research*, 81(3), 571–581. <https://doi.org/10.1007/s00426-016-0763-4>
- Tomasi, D., & Volkow, N. D. (2024). Associations between handedness and brain functional connectivity patterns in children. *Nature Communications*, 15, 2355. <https://doi.org/10.1038/s41467-024-46690-1>
- Tuncer, M. C., Hatipođlu, E. S., & Ozatep, M. (2005). Sexual dimorphism and handedness in the human corpus callosum based on magnetic resonance imaging. *Surgical and radiologic anatomy: SRA*, 27(3), 254–259. <https://doi.org/10.1007/s00276-004-0308-1>
- Tzourio, N., Crivello, F., Mellet, E., Nkanga-Ngila, B., & Mazoyer, B. (1998). Functional anatomy of dominance for speech comprehension in left handers vs right handers. *NeuroImage*, 8(1), 1–16. <https://doi.org/10.1006/nimg.1998.0343>
- Veale, J. F. (2014). Edinburgh Handedness Inventory—Short Form: A revised version based on confirmatory factor analysis. *Laterality: Asymmetries of Body, Brain and Cognition*, 19(2), 164–177. <https://doi.org/10.1080/1357650X.2013.783045>
- Witelson S. F. (1985). The brain connection: the corpus callosum is larger in left-handers. *Science (New York, N.Y.)*, 229(4714), 665–668. <https://doi.org/10.1126/science.4023705>
- Witelson S. F. (1989). Hand and sex differences in the isthmus and genu of the human corpus callosum. A postmortem morphological study. *Brain: a journal of neurology*, 112 (Pt 3), 799–835. <https://doi.org/10.1093/brain/112.3.799>

**Acknowledgement:** The Corresponding Author/s wish to acknowledge the research grant received from IoE, BHU under Development Scheme- 6031 and to the Cognitive Science Laboratory, BHU, Varanasi for providing essential support for data collection and analyses.

**Prerita Bahri**, PG Student and Principal Author, Cognitive Science Laboratory, Department of Psychology, Banaras Hindu University, Varanasi-221005. Email: preritabahri0311@gmail.com

**Trayambak Tiwari**, PhD, Associate Professor and Corresponding Author, Cognitive Science Laboratory, Department of Psychology, Banaras Hindu University, Varanasi-221005. Email: trayambak@bhu.ac.in; Orcid id: 0000-0001-6047-9701

**Shreshtha Yadav**, PhD, Assistant Professor and Corresponding Author, Assistant Professor, Cognitive Science Laboratory, Department of Psychology Banaras Hindu University, Varanasi-221005. Email: shreshtha@bhu.ac.in; Orcid id: 0000-0001-9611-1925

**Anil Kumar Yadav**, PhD, Assistant Professor and Corresponding Author, Cognitive Science Laboratory, Department of Psychology, Banaras Hindu University, Varanasi-221005. Email: anilyadav@bhu.ac.in; Orcid id: 0000-0003-1409-2092

**Anju Lata Singh**, PhD, Associate Professor and Corresponding Author, Department of Psychology, Vasant Kanya Mahavidyalaya, College admitted to the privileges of Banaras Hindu University, Kamachha, Varanasi -221005. Email: anjubhu@gmail.com; Orcid id: 0000-0001-8417-5980