Handedness Modulates Spatial Attention – Insights From Individual Variations In Lateralization Of Cognitive Functions

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Structural & Functional Asymmetry

Lateralization: Preferential processing of a certain stimulus in one hemisphere over the other

LH

- Speech, syntax, phonetic decoding
- Local processing, relatively high spatial frequency (HSF)

RH

- Lexical tone, context, prosody
- Global processing, relatively low spatial frequency (LSF)

Language and visuospatial processing are said to be left, and right-lateralized, respectively**.** But **both hemispheres are usually involved** in any given cognitive function

MOTIVATION

1. Increased **atypical lateralization** of language and other cognitive functions in left-handers
2. Left handers population has increased incidences of neurodevelopmental and psychiatric disorders
3. Increased left-handers and atypical lateralization in almost all **neurodevelopmental and psychiatric populations**

Left-handedness and hemispheric asymmetry are related to atypical behavioural patterns

KNOWLEDGE GAP

- Most cognitive psychology studies focus on Right-handers. But right handed people do show some left-hand preference
- Dilutes the effects of handedness on cognitive functions by failing to capture individual variations
- Speech and fine motor control are left-lateralized irrespective of handedness. But the lateralization of global-local and face processing reverses in left-handers
- Input asymmetry principle suggests lateralization of higher level functions depends upon lateralization of lower-level SF information

QUESTION

How does the lateralization of lower-level (spatial frequency, global/local attention) and higher-level (face, word) visual processes change with the degree of handedness?

HYPOTHESIS

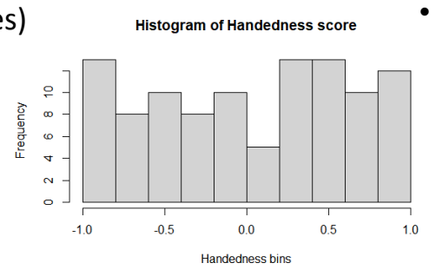
Handedness could differentially influence lateralization of visual processes

METHODOLOGY

Campus-wide modified Edinburg handedness survey
Captured the entire handedness continuum, controlling for the degree of handedness

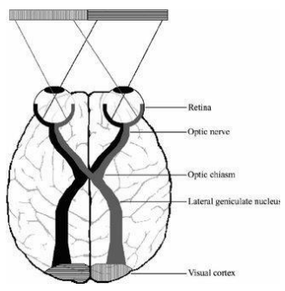
COHORT

IIT Kanpur(60), NIT Calicut (42)
Uniform (D (102) = 0.12, p = 0.480)
n = 102 (14 females)
Age: 22(4)



DESIGN

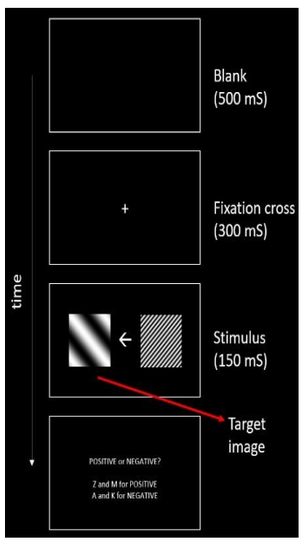
- Divided visual half paradigm
- Bilateral stimulus presentation
- Bimanual response to control the dominant hand response bias



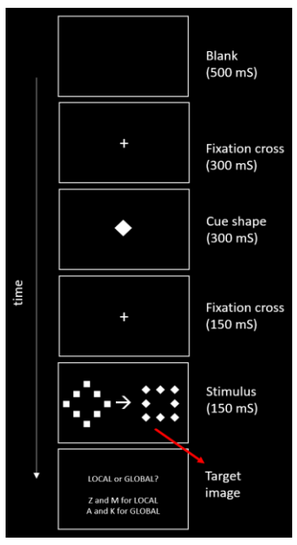
EXPERIMENTS

2 low-level (E1 - spatial frequency, E2 - global/local attention)
2 higher-level (E3 - face, E4 - word)

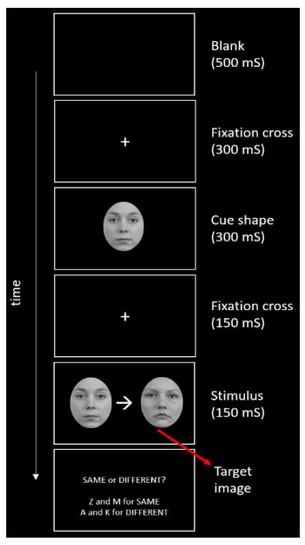
E1



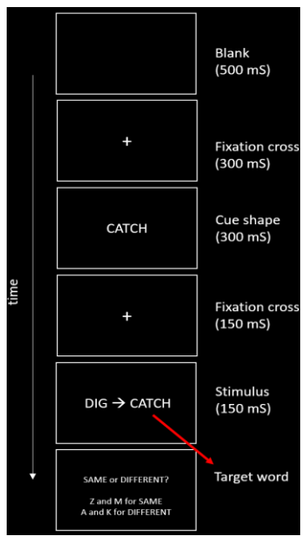
E2



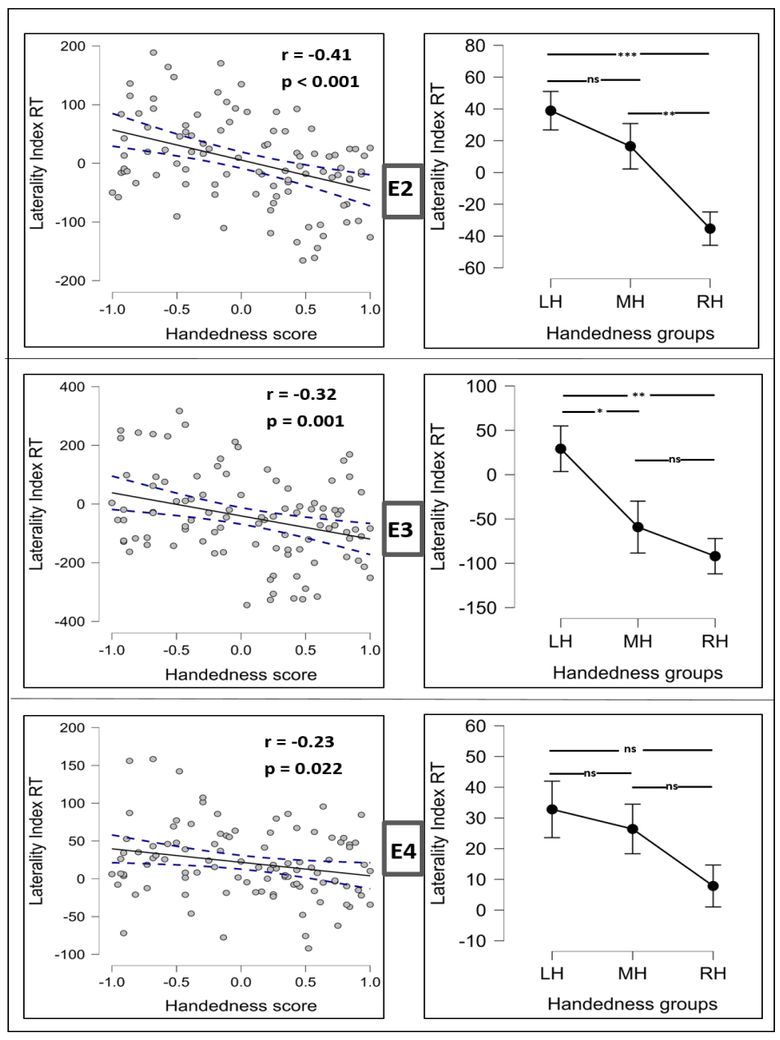
E3



E4



RESULTS & OBSERVATIONS



Failed to find effects of handedness on lateralized SF processing

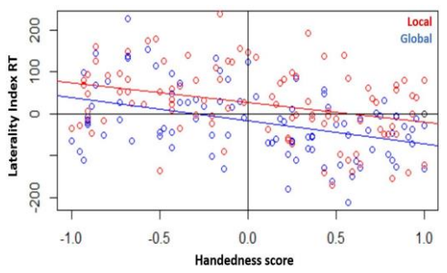
Change in **degree and direction** of lateralization of spatial attention with degree and direction of handedness

Change in **degree but not the direction** of lateralization of high-level face and word

Face processing is lateralized to the right hemisphere. However, left-handers show some left-lateralization

Word processing is lateralized to left hemisphere, for all handedness

Global-local processing showed a similar pattern of lateralization across participants



Reaction Time

Experiment	n	r	p
E2_G	98	-.42	<0.001*
E2_L	98	-.33	<0.001*
E2_Avg	98	-.41	<0.001*
E3_Face	98	-.32	0.001*
E4_Word	100	-.23	0.022*

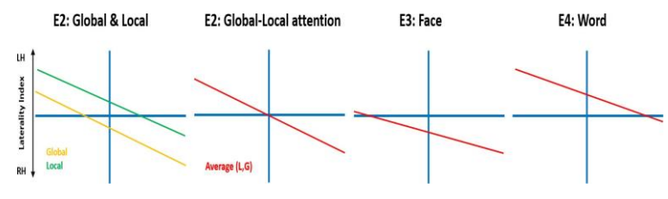
Accuracy

n	r	p
98	.24	0.019*
98	.24	0.016*
98	.29	0.005*
98	-.29	0.003*
100	.08	0.441

Group difference

ANOVA	DF	F	p
E2_Avg (RT)	2, 95	10.669	<0.001*
E3_Face (RT)	2, 95	6.733	<0.002*
E3_Face (Accu)	2,95	6.784	0.002*
E4_Word (RT)	2,97	2.876	<0.061

Handedness spectrum captures a **continuum of individual variation** in the lateralization of cognitive processes



CONCLUSIONS

- **Handedness dependent** lateralization of global-local attention
  (Right handers - RH, Left handers – LH) suggests unexplored **relationship between attention and action**
- **Handedness independent** lateralization of higher-level functions (word, face) - phylogenetic predisposition for specialization in one hemisphere at the population level
- Supports input asymmetry principle

Handedness differentially influence lateralization of visual processes

SIGNIFICANCE

1. Degree of handedness is an unexplored dimension that could **capture a significant amount of individual variations** in the lateralization studies
2. **Action-dependent lateralization of spatial attention** suggests that handedness and spatial attention could have a shared neurodevelopmental origin
3. The continuum approach could be beneficial in addressing **functional aspects in atypical, neuropsychiatric population**

LIMITATIONS

- The design could be improved by including the incongruent condition to evoke relative SF processing
- Lacks performance score on cognitive task to comment on relative behavioural responses

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