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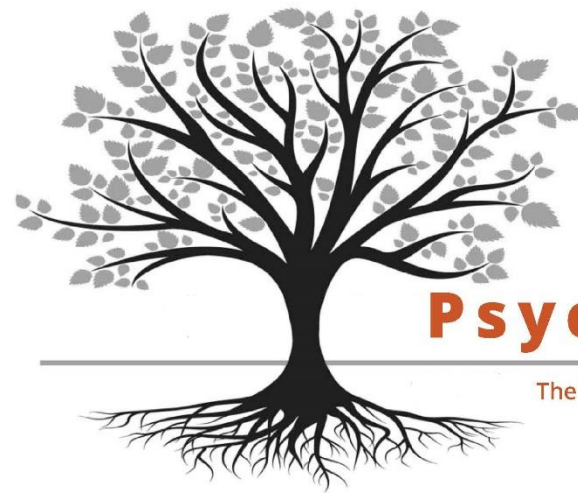
Department of Psychology



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Leftward biases in attention: Eye fixations as indicators of attention and memory encoding

Mostert, S.N., Maree, D.J.F.



Psychology

The Root of Human Interaction

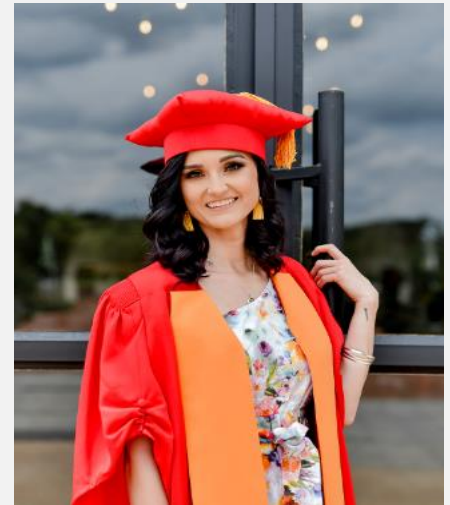
Speaker/Presenter

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- ❖ Tutor coordinator in the Department of Psychology, Faculty of Humanities, University of Pretoria.
- ❖ **Lecturer:**
 - ❖ First year medical students: Health Psychology
 - ❖ First year psychology students: Biological basis of behaviour
 - ❖ Honours psychology students: Health Psychology
 - ❖ Professional MA research psychology students: Community – and Cross-cultural psychology
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Primary focus areas:

1. Health Psychology: Health literacy; health communication; illness cognitions; self-efficacy
2. Cognitive Psychology: Attention and memory
3. Teaching and Learning : Student success; virtual learning



Research Profile:

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Introduction

This study was a replication of the research conducted by Sala and colleagues.

- Sala et al. (2010) conducted several experiments on a large group of participants. Random combinations of visual features were presented and participants were requested to memorise the bindings and report on the shape, colour and location of visual presentations
- Results: participants made significantly more errors for visual combinations presented on the right side compared to the left.
- **Conclusion:** Items on the left are better remembered suggesting a bias in forming and recalling information from visual short-term memory

The current study intended to determine if more items on the left are remembered by recording eye-movements using an eye tracker

Sala, S.D., Darling, S., & Logie, R.H. (2010). Items on the left are better remembered. *Quarterly Journal of Experimental Psychology*, 63(5),848-855. doi:10.1080/17470211003690672



Neglect and Pseudoneglect

NEGLECT:

Neurologically impaired patients show a tendency to attend to objects found in the **right** side of space while **ignoring objects located in the left visual field** (Foulsham et al., 2013; Loftus & Nicholls, 2012; Toba et al., 2011)

PSEUDONEGLECT:

Neurologically intact individuals show an inclination towards the left visual field. It is “...a slight but consistent misplacement of **attention toward the left** visual field, commonly observed in young healthy subjects” (Schmitz et al., 2011, p.382)

Pseudoneglect was originally identified by Bowers and Heilman (1980)



Pseudoneglect

- Prominent focus toward the left visual field- the right side is largely ignored
 - May have implications for subsequent cognitive functioning
- When viewing the visual world, **first saccades** are **generally directed toward the left** (Dickinson & Intraub, 2009)
- **Leftward bias is known as pseudoneglect** (Bowers, & Heilman, 1980), **and may selectively increase the representation of left-sided stimuli in memory** (Benwell et al, 2013; Brooks, 2014; Foulsham et al, 2013; Schmitz et al., 2011; Schneider, 2018; Szelest, 2014; Toba et., 2011)



Problem statement

- People sample the visual world through eye movements (Dolgünsoz, 2015), defined by the number of fixations (Schneider, 2018). **Eye movements demonstrate the allocation of attention** (Eimer, 2014; Hartman, 2015; Szelest, 2014; van Gog, et al., 2009).
- The way we direct our attentional resources determines what is encoded to memory. Attention = prioritise certain sensory stimuli (Thomas et al., 2017).
- The mechanisms underlying **attention is asymmetrically represented** in the brain (Nicholls et al., 2008; Sosa et al., 2010).
- **People do not attend equally to their right and left sides** (Dickinson & Intraub, 2009; Gigliotta et al., 2017; Nuthmann & Matthias, 2014)



Rationale

- The leftward bias in attention may impact what information is encoded to memory **but the exact nature of how is not yet well conceptualised** (Lee et al., 2004; Szelest, 2014)
- **If attention is biased to the left, the inclination is that these items are better remembered: “...[suggesting] a spatial asymmetry in forming or retrieving...visual short-term memory”** (Sala et al., 2010, p. 848)
- The findings may contribute to a better understanding of our cognitive processing system, pertaining to both attention and memory



Primary Aim

- The current study intended to examine the presence of a leftward bias in attention defined by the number of eye fixations
- **The aim was to explore a leftward bias in attention and whether this is related to visual long-term memory (VLTM) encoding**



Objectives

- To measure attention by means of an eye-tracker to determine the number of left and right fixations
- To measure a component of long-term memory, i.e., visual long-term memory (VLTm) using a computerised memory test. Participants had to indicate whether they recall seeing a stimulus based on a presented simulation



Hypothesis

It is hypothesised that a higher number of leftward fixations demonstrates perceptual pseudoneglect and this will favourably bias the memorisation of items presented in the left visual field

The following hypothesis was formulated:

H₁: A leftward bias influences attention and what is encoded to visual long-term memory.



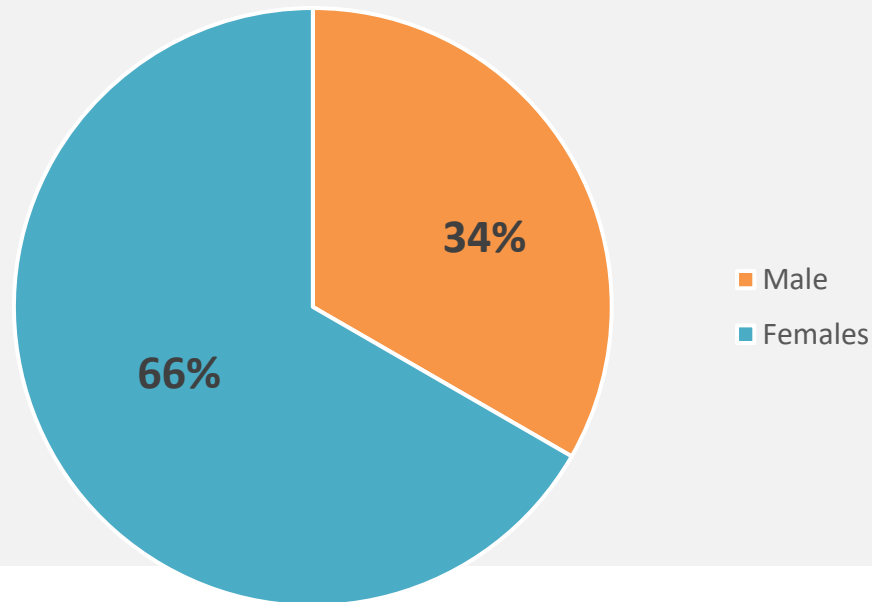
Sampling procedure

- Local university students and staff members were invited to participate in the study
- **Purposive sampling was used with the following inclusion criteria:**
 - Aged 18 – 60 years old
 - Computer literate
 - Proficient in English
 - No history of brain injuries
 - Normal/corrected vision
- **Exclusion criteria:**
 - History of brain injuries
 - Visual problems apart from near/farsightedness



Sample description

- The sample consisted of N=35 participants
- 12 males and 24 females
- Most participants were between the ages of 18 – 29 encompassing 62.8% of the sample
- The 50 – 60 age group comprised 17% of the sample



Data collection instruments: VLTM

- Participants watched a memory simulation containing several types of images presented in either the left – or right hemifield, or both
- The instruction was to memorise as much of the content as possible



Data collection instruments: Memory simulation

- The simulation included 37 slides uploaded to the Eye tracker programme, Tobii-pro-x3
- The presentation slides contained various stimuli including letters, images, and words – see the next slide for details
- The stimuli were presented in either the left/right side of a focal point marked by an 'x' in the center of the screen



SLIDE	Recode nr.	STIMULUS DESCRIPTION			Duration presented (ms)
		Left side	Centre	Right side	
3	1	E			3
5	2	B			3
7	3	AC		F	5
9	4	P		ZD	5
11	5	TU		RG	5
13	6	King of hearts			3
15	7			King of spades	3
17	8	Queen of diamonds		Jack of diamonds	5
19	9	Queen of spades		Queen of hearts Jack of clubs	5
21	10	Queen of clubs King of clubs		Jack of spades King of diamonds	5
23	11	60km Road sign			3
26	12		Fruit and vegetables		12
29	13	Word columns		Word columns	12
31	14			30km Road sign	3
33	15	Cat		Dog	5
36			Watches		12



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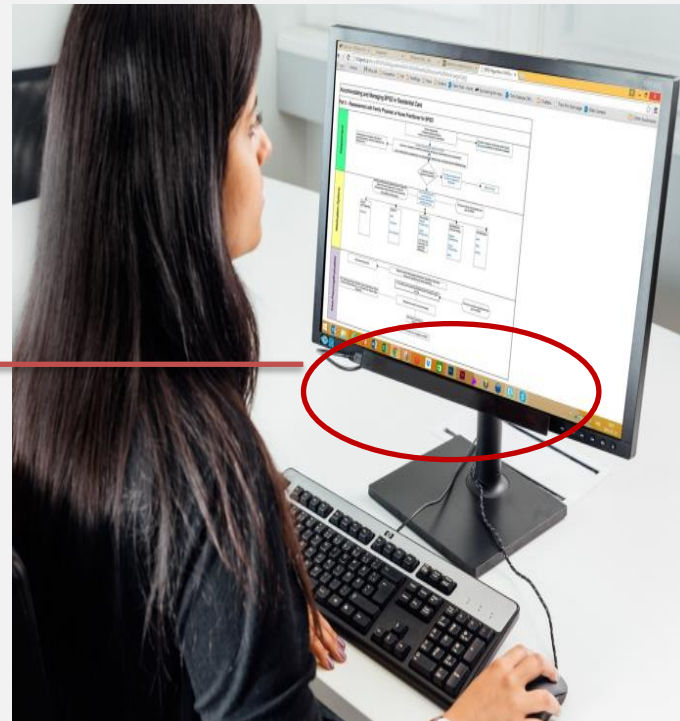
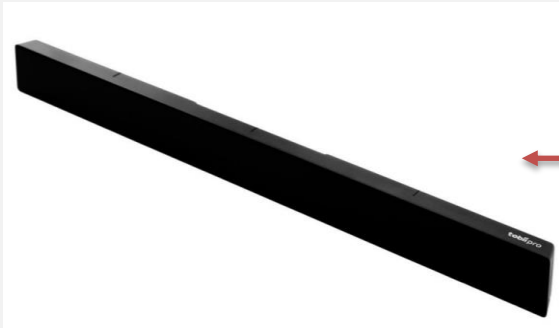
Data collection instruments: VLTM

- VLTM was assessed by means of a forced-choice test (Schurgin, 2018)
- A self-constructed memory questionnaire:
 - The questionnaire was designed to assess memory recall related to the memory simulation



Data collection instruments: Eye-tracker

The Tobii Pro X3-120 Eye Tracker version 1.0.7 was used



https://www.tobii.com/imagevault/public/hedmedia/tpxv3yo6y9c7qmlgeb7o/TobiiPro_X3_120_Eye_Tracker_2_1.jpg

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Data collection instruments: Attention = eye fixations

- An eye-tracker was used to measure the number of eye fixations
- The number of left – and right fixations was calculated to determine the number of fixations for each slide presented during the memory simulation



Ethical considerations

- Ethical approval was granted by the Faculty of Humanities Research Ethics Committee
 - Reference number: GW20160825HS
- Informed consent
- Confidentiality: no personal data was connected to the findings
 - Participant numbers were used



Statistical analysis: Eye tracking data

- The data was analysed using SPSS version 27
- Eye –movements:
 - The number of fixations details the number of times a participant focused on stimuli on the left/right side of the presented slide



Statistical analysis: Fixations

- To determine whether a leftward bias in attention was present, the differences between left – and right fixation patterns were explored by means of a two-way repeated measures ANOVA: 2 x 15, Side (Left/Right) x Slides for the number of fixations



Statistical analysis: VLTM

- A correct score was allocated if a participant selected a particular item that was part of the simulation
- The total number of correct responses for the left condition was 22 and 25 for the right condition
- Each condition's score was calculated as a percentage:
Left condition = $\text{Score}/22 \times 100$; Right condition = $\text{Score}/25 \times 100$



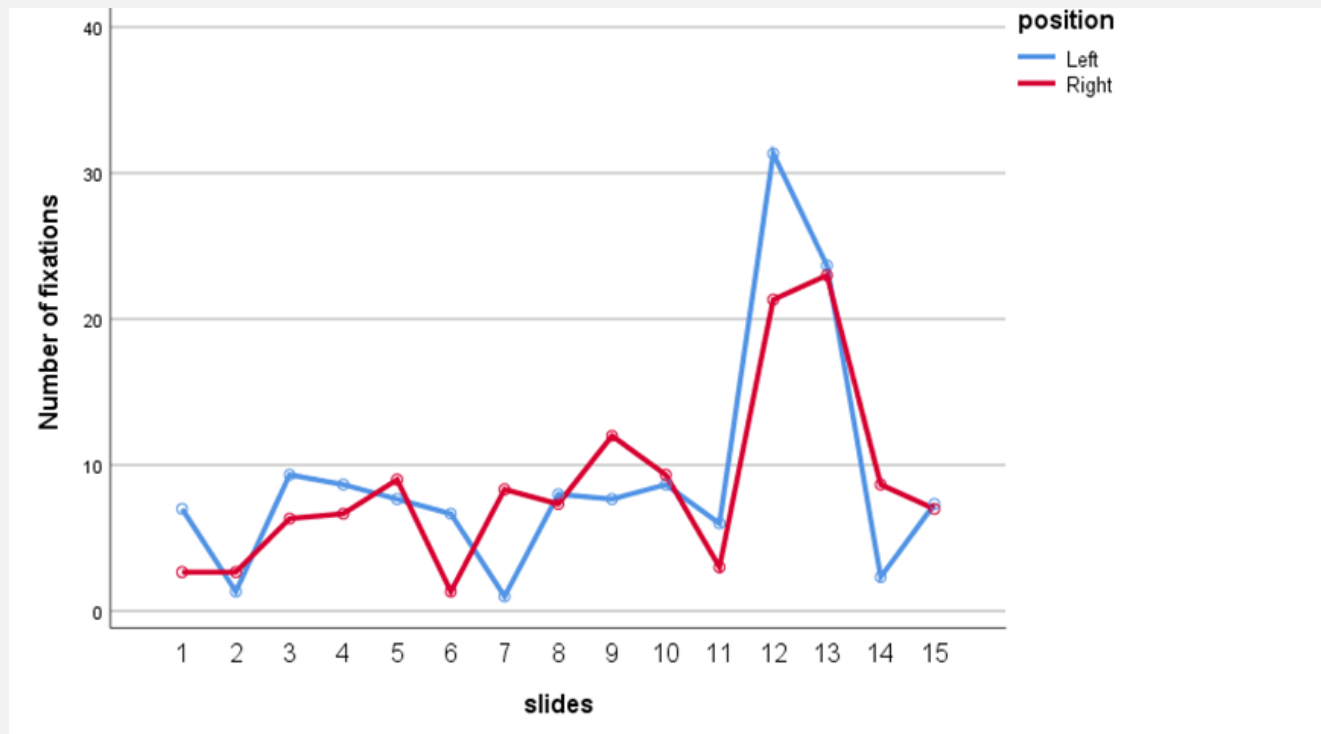
Statistical analysis: VLTM

- To explore whether more items on the left were recalled, a paired samples *t*-test was performed to compare the left and right memory scores
- To determine whether a leftward bias in attention is associated with what is encoded to memory, correlational analysis was conducted between the number of left/right fixations and the memory scores



Summary of the findings: Attention

Figure 1 provides the data for the average number of left and right fixations captured per slide



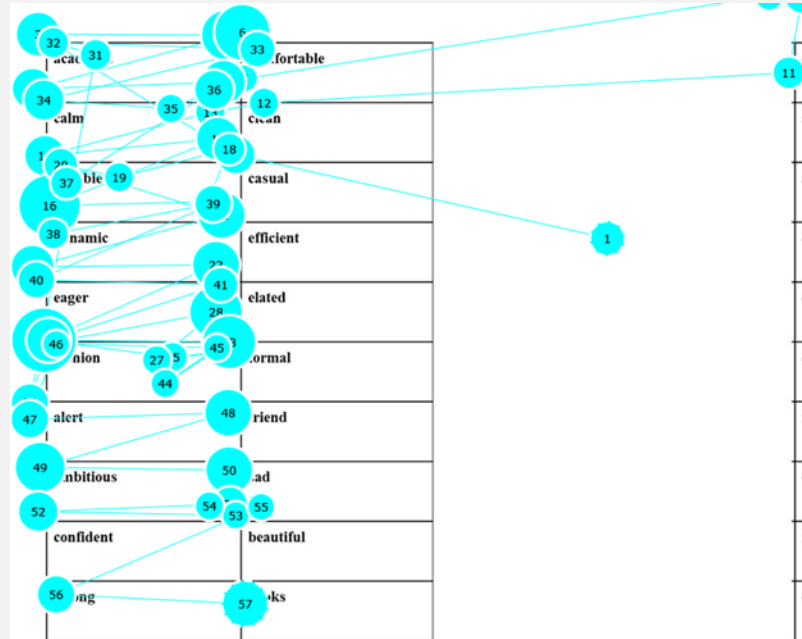
Summary of the findings: Attention

- The results show a significant interaction effect when the slides and left vs. right fixations were compared $F(14, 28) = 2.74$ $p = .01$, $\eta^2 = .58$, indicating a large effect size
- Based on the findings participants demonstrated significantly different fixation patterns in relation to the number of left and right fixations
- **Some participants fixation patterns are presented in the next slides**

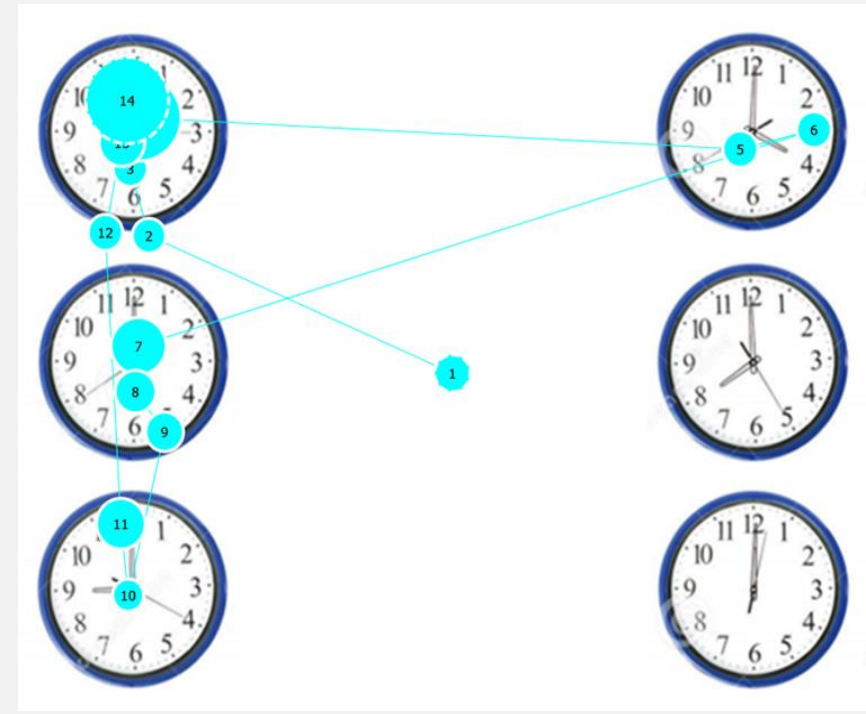
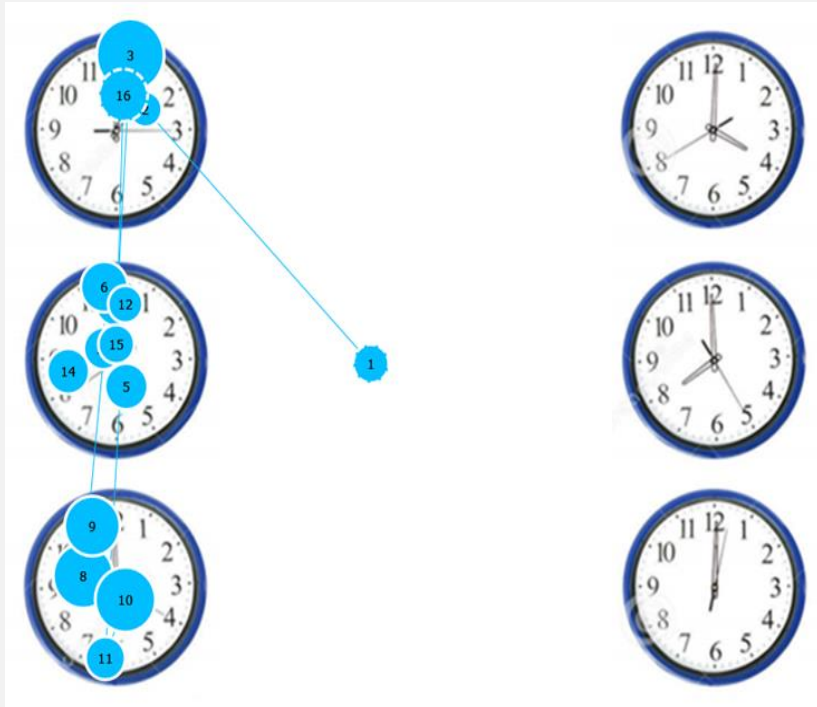


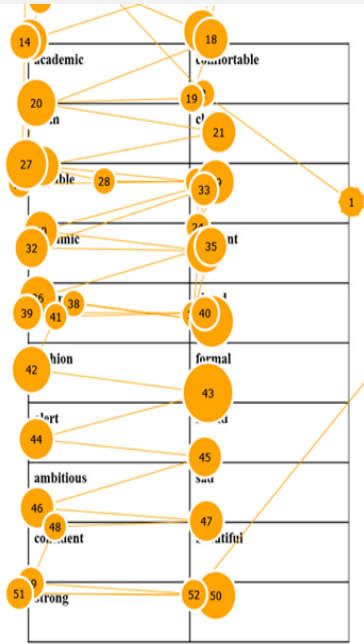


devoted	business
study	brain
adventure	happy
decent	work
ethical	health
determined	flower
mother	ocean
dynamic	change
family	great
dog	read

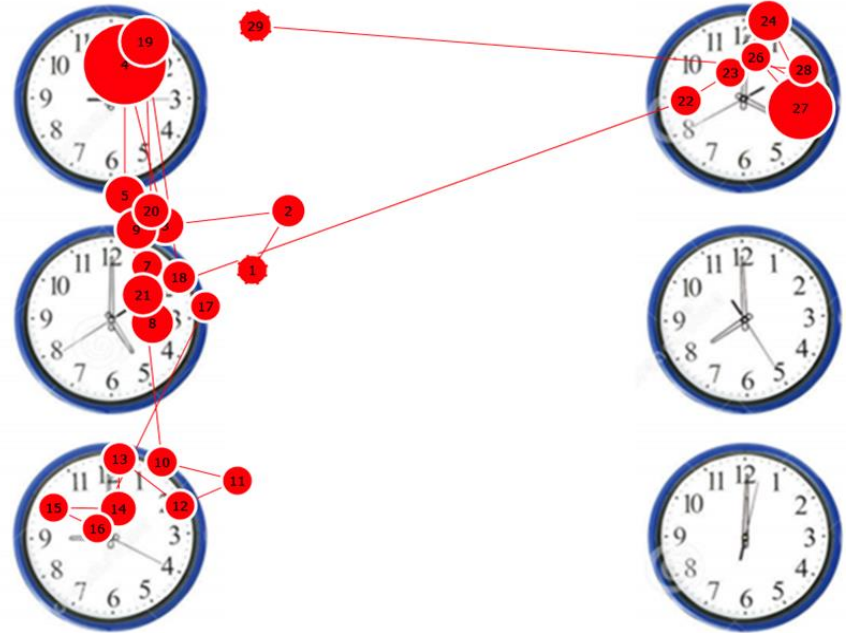


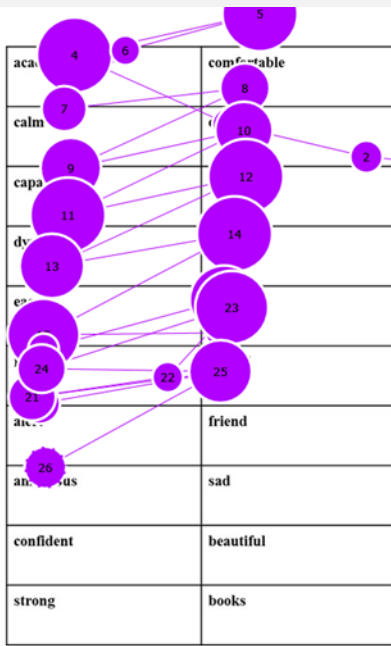
devoted	business
study	brain
adventure	happy
decent	work
ethical	health
determined	flower
mother	ocean
dynamic	change
family	great
dog	read





devoted	business
study	brain
adventure	happy
decent	work
ethical	health
determined	flower
mother	ocean
dynamic	change
family	great
dog	read





devoted	business
study	brain
adventure	happy
decent	work
ethical	health
determined	flower
mother	ocean
dynamic	change
family	great
dog	read



devoted	business
study	brain
adventure	happy
decent	work
ethical	health
determined	flower
mother	ocean
dynamic	change
family	great
dog	read

Summary of the findings: VLTM

- The findings showed that participants scored higher in the left condition ($M = 66.49$, $SD = 10.64$) compared to the right condition. ($M = 62$, $SD = 12.16$)
- A significant difference between the two memory conditions: on average, participants recalled more items on the left ($M = 66.49$, $SE = 1.8$) than on the right ($M = 61.60$, $SE = 2.1$), $t(34) = 2.86$, $p = .004$ (one-tailed). The eta squared (.483) indicated a small to medium effect size
- **Participants recalled more items presented from the left. The mean increase from the right memory scores to left memory scores was 4.89 with a 95% confidence interval ranging from 1.4 to 8.37**



Summary of the findings: VLTM and leftward bias

- To determine whether the higher number of leftward fixations was linked to a higher memory recall for items presented on the left, a one-tailed bivariate correlational analysis was performed
- No significant correlations between the number of fixations and the memory scores ($p > 0.5$).
- Based on the findings, the total number of fixations is not related to memory recall



Conclusion

The findings show that **attention seems to be asymmetrical in nature**. The **participants** appeared to **favour the left side**, similar to other findings (Benwell et al., 2013; Cocchini et al., 2007; Nuthmann & Matthias, 2014; Schmitz et al., 2011; Zago et al., 2017).

It appears that attention is not allocated equally across the visual field as participants demonstrated more fixations to the left hemifield. A lateral bias in attention is therefore plausible. Although more items from the left memory condition were correctly recalled, similar to the findings from Sala et al. (2010), and Szelest (2014), **the findings from this study showed no significant association between the leftward bias in attention and what was encoded to VLTm.**



Recommendations

No **definitive conclusions** are made due to the small sample.

It is recommended that future research explore the lateral bias in attention using a larger sample and to explore the potential mediating effect of age on pseudoneglect



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