

# Xianhui He

Zhejiang University, Hangzhou, China

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## EDUCATION

### B.S. Zhejiang University

Hangzhou, China

Department of Psychology and Behavioral Science

September 2017 – June 2021

- **Core Courses:** Cognitive Neuroscience (89/100); Cognitive Psychology (94/100);
- GPA: 3.91/4; Major GPA: 3.99/4; Top 3 in my major; TOEFL iBT: 100

### M.Ed. Zhejiang University

Hangzhou, China

Department of Psychology and Behavioral Science

Expected September 2021 – March 2024

- **Core Courses:** Advances in Visual Attention Research (92/100); MRI data analysis (92/100); Introduction to Bayesian Data Analysis (98/100);
- **Supervisor:** Associate Research Fellow [Cai Ying](#)

### Interactive student

Online

Neuromatch Academy (NMA) 2022

July 2022

- **Course and Project:** Computational Neuroscience ([my certificate](#));
- **Mentor:** Postdoc [Huihui Zhang](#) (Peking University)

## Presentation & Poster

- **He, X.H.**, Wang, H.Y., Rachmadani, H., Ali, R., Chen, N. (2022). Does Imagery share similar neural mechanisms with the actual movement? Neuromatch Academy ([virtual talk video](#));
- **He, X.H.**, Zhong, Y., Cai, Y.\* (2022). Do confidence and uncertainty differ in visual working memory? Working Memory Symposium ([virtual talk slides](#));
- Yao C.Y., **He, X.H.**, Cai, Y.\* (2022). Spatial processing mediates the effect of electrical stimulation over posterior parietal cortex on visual short-term memory. Cognitive Neuroscience Society Annual Meeting ([virtual poster](#)).

## RESEARCH EXPERIENCE

### Hippocampal ripples and hippocampal-cortical communications support visual short-term memory and long-term memory?

Hangzhou, China

Supervisor: Associate Research Fellow [Ying Cai](#) & Assistant Professor [Jing Liu](#) (The Hong Kong Polytechnic University)

March 2022 – present

- Proposal: Hippocampus is a subcortical node underlying memory consolidation. Extant evidence suggested hippocampal ripples and hippocampal-cortical communication contributed to human declarative memory. However, it remains largely unknown 1) whether visual short-term memory and associative memory also engage such neural substrates, 2) the contribution of hippocampal-cortical communication to the dynamics of visual short-term memory and associative memory. **Using stereo-EEG recordings, we have been examining whether the hippocampal ripples and hippocampal-cortical interactions support the transformation of visual representations from encoding to short-term memory maintenance to long-term Memory retrieval.**
- My part: Research Design; Data Analysis.

### Memory load modulates neural activities in frontal cortex, parietal cortex, hippocampus, and their interactions

Hangzhou, China

Supervisor: Associate Research Fellow [Ying Cai](#) & Professor [Shaoming Zhang](#) (Zhejiang University)

September 2021 – present

- Proposal: Recent works found that memory load modulated neural activities broadly, from temporal cortex (Boran et al., 2022) to hippocampus (Boran et al., 2019), from parietal (Fukuda et al., 2015) to frontal (Brzezicka et al., 2019). The distributed nature of the neural activities suggests a potential network, which encodes workload in a memory task. **In this project, we have been 1) identifying the workload network by looking at the low-frequency power change of the seeg signals, and 2) examining whether the interactions within the network support working memory.**
- My part: Research Design; Data Collection, Preprocessing & Analysis.

### Parietal-hippocampus communications support memory binding

Hangzhou, China

Supervisor: Associate Research Fellow [Ying Cai](#) & Professor [Shaoming Zhang](#) (Zhejiang University)

September 2021 – present

- Proposal: Hippocampus plays an important role in forming bindings between memory context and contents. Parietal cortex is another typical binding area linking to human memory, particularly in working memory. However, it remains unclear how hippocampus interacts with parietal cortex to support memory binding and their dialogue may vary in different stages. For example, **during the encoding stage, parietal cortex can code the binding relationship between memory content and context through conjunctive encoding, which is projected to hippocampus to store the binding information. However, when provided a memory context, hippocampus retrieves the corresponding content via pattern completion and communicate it to parietal cortex. Using stereo-EEG recordings, we plan to directly examine the above hypothesis.**
- My part: Research Design; Data Collection, Preprocessing & Analysis.

### Does Imagery share similar neural mechanisms with the actual movement? ([NMA project](#))

Online

Supervisor: Postdoc [Huihui Zhang](#) (Peking University)

July 2022

- Abstract: Imagined motor movement ("Imagery") plays a crucial role in preparing actual movements and learning of complex motor skills. However, the neural substrates and neural representations of imagery still remain largely unknown. The present study examined whether imagery shares similar mechanisms with actual movement at different levels. With electrocorticography (ECoG) dataset in seven human subjects during actual movement and kinesthetic imagery of the same motion type (hand & tongue), we investigated the channel-level mechanisms by looking at the differences between actual movement and imagery in the power of specific frequency bands (i.e. alpha/beta/gamma). Furthermore, we investigated the population-level mechanism by performing the multivariate classification and the neural trajectory analysis. Specifically, we trained the classifier on actual movement/imagery and tested it on imagery/actual movement to see whether the decoding can be generalized to each other. Also, using t-SNE, we examined whether the imagery and actual movement activated in the same sequence at the neural subspace. **Our results suggest that in addition to common neural substrates shared by imagery and actual movements at channel level, there also exists imagery-specific neural substrates at the population level.**
- My part: Group leader; Research Design; Data Analysis.

### Does confidence and uncertainty differ in visual working memory?

Hangzhou, China

Supervisor: Associate Research Fellow [Ying Cai](#)

January 2021 – June 2022

- Abstract: Recent model studies have posited that confidence derives from both heuristics (e.g., stimuli contrast) and processing quality while uncertainty mainly originates from the latter. Here, we directly tested this hypothesis in visual working memory (VWM). In Exp.1 (n=23), subjects completed a delayed recall task for orientations in different contrasts, after which they reported memory uncertainty by adjusting an arcsize from 0° (most certain) to 180° (most uncertain) and then rated confidence in a 4-point scale. We found confidence increased with higher contrast, but recall error and uncertainty did not change. In Exp.2 (n=27), we modified our task, asking subjects to report either uncertainty or confidence from similar response wheels (0-180°). We replicated the results of Exp.1. Moreover, we estimated individuals' trial-level metacognitions by correlating uncertainty/confidence to recall error, and estimated individuals' condition-level metacognitions by obtaining the fixed effect of contrasts in a linear mixed model (controlled recall error). We found contrasts did not affect trial-level confidence/uncertainty. Both of them tracked recall error and correlated individually. By comparison, contrasts affected condition-level confidence but uncertainty, with no individual correlations. **Altogether, our results provided empirical evidence of the dissociations between confidence and uncertainty during VWM.**
- My part: Group leader; Research Design; Data Analysis.
- This work is presented in Working Memory Symposium ([WMS](#)) annual meeting 2022 ([slides](#))

### Spatial processing mediates the effect of electrical stimulation over posterior parietal cortex on visual short-term memory

Hangzhou, China

Supervisor: Associate Researcher [Ying Cai](#)

November 2020 – June 2021

- Abstract: The causality between posterior parietal cortex (PPC) and visual short-term memory (VSTM) is still controversial. Accumulating studies found PPC played a critical role in spatial processing, and we examined whether spatial processing mediates the function of PPC in VSTM. Using within-subject design (n=30), we explored whether and how anodal electrical stimulations over PPC affected recall performance in delay estimation tasks for locations and colors. Every three days, subjects accepted PPC stimulation (P4 electrode in 10-20 EEG recording system, 2mA, 20min), occipital stimulation (active control: Oz, 2mA, 20min), and sham stimulation (passive control: half subjects in P4 and half in Oz, 2mA, 30s). Before and after each stimulation, subjects completed delay estimation tasks for locations and colors (set size = 8), and the 3-factor mixture model was used to estimate the recall precision, the probability of recalling target (pT), non-target (pNT), and random guessing (pU), respectively. Our results revealed, in the

location WM task, the PPC stimulation decreased the random guessing compared with occipital/sham stimulation ( $ps < 0.024$ ), but didn't change recall precision ( $ps > 0.444$ ). In contrast, in the color WM task, the PPC stimulation increased the recall precision compared with the sham condition ( $p = 0.04$ ; compared with the occipital stimulation:  $p = 0.20$ ), but didn't change random guessing ( $ps > 0.170$ ). Moreover, the interaction effects between tasks and PPC-sham differences were significant (compared with sham:  $ps < 0.03$ ). Together, our results suggest PPC plays a general casual role in VSTM, but its specific function is mediated by spatial processing.

- My part: Research Design; Data collection; Data Analysis.
- **This work is presented in Cognitive Neuroscience Society (CNS) annual meeting 2022 ([poster](#))**

### **Precision from Iconic Memory to Working Memory**

**Hangzhou, China**

Supervisor: Associate Professor [Zhi Li](#)

September 2019 – May 2020

- Abstract: Human memory is thought to be not a unitary process but consists of multiple stores. The visual information is first registered in the iconic memory system (also known as sensory memory). Afterward, a subset of the contents is transferred to a more durable visual working memory system. Although earlier studies suggested iconic memory as a gradual decay system, some research, followed the method proposed by Zhang & Luck (2009), showed that iconic memory died a sudden death. We tested whether iconic memory gradually decayed or died a sudden death by two different paradigms. Our results supported the former mechanism.
- My part: Research Design; Data analysis; Writing.

### **Using human factor engineering to improve the effectiveness of infection prevention and control: Improving Personal Protective Equipment (PPE) guideline compliance (a chapter of book in Chinese; [Amazon link](#))**

**Hangzhou, China**

Supervisor: Professor [Zaifeng Gao](#)

March 2020

- Abstract: Personal protective equipment (PPE) and its correct use protect those who care for patients with infectious viruses. However, researchers had found that though having received training on PPE use before the simulation, most health care professionals (HCP) still experienced contamination (e.g., American Centers for Disease Control and Prevention (CDC) said HCP were infected in the outbreaks of Ebola because of poor PPE doffing (removal) practice). The paper provided advice on improving HCP's compliance with PPE guideline from four aspects: PPE design, workflow, PPE guideline, and training.
- My part: Literature Review; Writing.

### **Visual Persistence**

**Hangzhou, China**

Supervisor: Associate Professor [Zhi Li](#)

June 2019 – August 2019

- Abstract: Visual Persistence (VP) is a period of iconic memory where information can be processed. Some researchers claim that the temporal dynamics of visual information processing are an essential component in one of the perceptual processes of forming "object files" – individuation. Our research utilized a special stimulus consisting of random dots, which disappeared as soon as it was presented on the background also consisting of random dots with the same brightness, to a) measure the duration of its VP by missing dot paradigm and b) test whether another perceptual process of forming "object files" – identification is also involved in this period by dual-task paradigm. The results suggested that VP of this stimulus lasts 1300 ms and even when the participants' working memory was occupied, they showed no difficulty in identifying the stimulus. Our results provide a deeper understanding of the basic mechanism of VP and help improve another researcher's work in our lab.
- My part: Research Design; Data analysis

### **Subitizing**

**Hangzhou, China**

Supervisor: Associate Professor [Zhi Li](#)

April 2019 – June 2019

- Abstract: Subitizing is the immediate apprehension of the exact number of items in small sets and its exact nature and origin are debated: previous studies hypothesized that subitizing range is constrained by a fixed number of mental tokens termed FINSTs while others viewed it limited by shared resource, which also limited working memory capacity. Our research tested the latter hypothesis utilizing a dual-task paradigm, and the result suggested early interaction between the subitizing range and visual working memory capacity.
- My part: Research Design; Data analysis

## INDEPENDENT PROJECT EXPERIENCE

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### Atypical functional connectivity between subcortical structure and socially engaged brain regions in children with Autism Hangzhou, China

*MRI data analysis Course Project*

October 2021

- Using resting fMRI data of 54 children provided by Erasmus University Medical Center in Rotterdam to repeat the study of Jasmin in 2019 to examine the relationships between autism and the functional connectivity between subcortical structure (thalamus and striatum) and social brain network.
- My results showed reduced functional connectivity in both the striatum-IFG pathway and thalamus-temporal lobe pathway, contrary to Jasmin's results, which suggested the mixed role of striato- and thalamocortical relationships with socially engaged brain regions in the condition of autism.

### The interaction between selective attention and working memory (review)

Hangzhou, China

*Advances in Visual Attention Research Coursework*

January 2021

- Over the past decades, researchers have explored the relationship between selective attention and working memory: how attention influences working memory and how working memory guides attention. Goal-directed modulation is considered the core attribute of these interactions, which occurs in the encoding, maintenance, manipulation, and even the preparation or expectation of stimuli.

### Influence of Executive Function on Attribute Amnesia (as the leader of my team)

Hangzhou, China

*Developmental Psychology Proposal*

June 2019

- Testing children's ability of Attribute Amnesia, Cognitive Flexibility, Inhibitory Control, and Working Memory before and after the training. Afterward, to calculate the correlations among them and test the causal effect.

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## SKILLS & INTERESTS

### Technical Skills:

- MATLAB (Advanced, mainly used for experiment programming, data analysis)
- PYTHON (Intermediate, mainly used for data analysis, [an example](#))
- R (Basic, mainly used for data analysis and reading [Computational Modeling of Cognition and Behavior](#))
- SPSS (Intermediate, mainly used for data analysis)
- JASP (Intermediate, mainly used for data analysis)

### Interests:

In my spare time, I enjoy watching movies (my favorite director is Ryusuke Hamaguchi) and playing volleyballs. I also love water sports, such as dragon boat racing (I am a helmsman!) and Stand Up Paddle (SUP).