# Attention is necessary for flicker-induced hallucinations

Yeseul Kim[1], Chai-Youn Kim[1], & Joel Pearson[2]

1 Department of Psychology, Korea University  2 School of Psychology, University of New South Wales

## Introduction

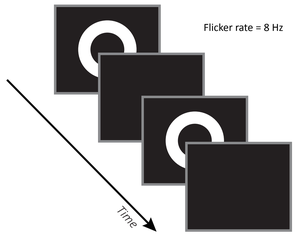
Hallucinations are generally defined as an awake, percept-like experience in the absence of the appropriate causative stimulus. One hypothesis is that differential processing in high-level attentional networks produce pathological hallucinations [1, 2], accordingly attentional deployment should alter hallucination processing. To test this we utilized luminance flicker to induce visual hallucinations [3].

## Methods

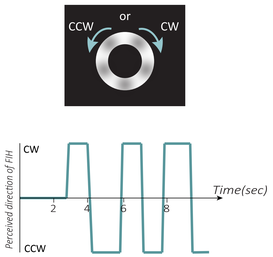
### Flicker-induced hallucination (FIH)

A white annulus flickering on a black background induces reliable hallucinated content (blobs) that rotated around the annulus either clockwise or counter-clockwise direction. The direction of hallucinated motion alternates in several seconds.

*Visual presentation*



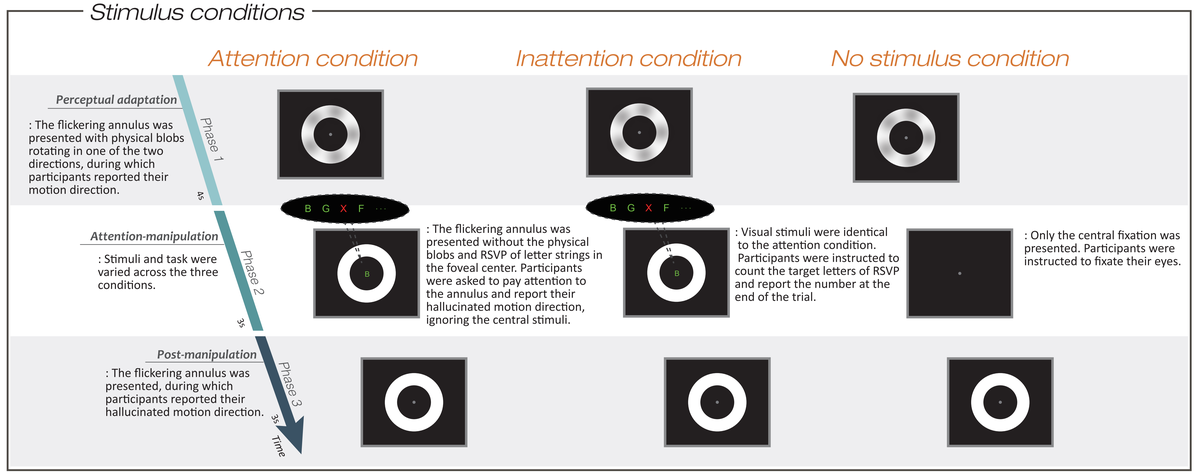

*Perceived*




*Participants* 12 participants (6 females, 6 males)

*Procedures* Each condition consisted of three phases (perceptual adaptation, attention manipulation and post-manipulation). [4]

### Stimulus conditions




### Analyses

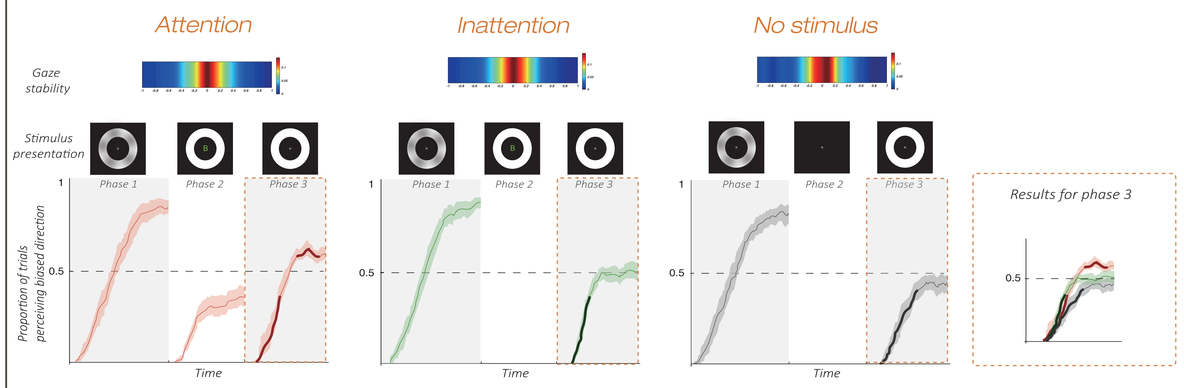
- ***Main analysis***: we analyzed proportion of expected hallucinated direction, if adaptation-effect exists, for each condition and compared them in terms of final stimulus after attention modulated.
- ***Reshuffling analysis***: trials from each physical direction was randomly selected (N=1000). With the reshuffling procedure based on bootstapping method, 95% confidence intervals of distribution of reshuffled data was extracted.

## Results

### Screening

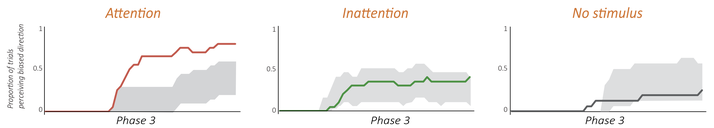
| Ratio of eliminated trials | | | mean RSVP performance |
|---|---|---|---|
| *Attention* | *Inattention* | *No stimulus* | |
| 0.012 | 0.001 | 0.026 | 0.891 |

### Main results




Dark color lines on the curve indicate data points significantly different from 0.5 (one sample t-test, $p<.05$, done only for phase 3). Initially adapted direction gained dominance again only in the "Attention" condition, whereas in the other conditions either direction tended to be perceived equally.
These data suggest that disregarding a flicker induced hallucination is equivalent to having it removed from view.

### Reshuffling results




One participant's actual results for phase 3 and gray shade indicates 95% confidence intervals of reshuffled data.
Results of the "Inattention" and "No stimulus" conditions belong to effect-absence intervals, whereas ones of the "Attention" condition show highly deviated from effect-absence intervals.

## Conclusion

Inattention abolishes flicker induced hallucination, supporting the role of top-down attention in hallucination formation.

## References

[1] Shine et al. (2011). *Movement Disorder*, 26*(12)*.
[2] Shine et al. (2014). *Human brain mapping*, 35*(5)*.
[3] Billock & Tsou. (2007). *PNAS*, 104*(20)*.
[4] Brascamp & Blake. (2012). *Psychological Science*, 23*(10)*.

## Acknowledgement

Supported by National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (NRF-2013K2A1A2053850).