Role of Right Parietal Cortex in Change Blindness

By: Carol Chu

Hi, my name is Carol and the article i want to present to you today is about Change blindness. This is a study performed by Diane Beck and her colleagues back in 2006 at Princeton University.

What is change blindness?

- Inability to detect large changes in a scene
- Produced by a saccade or artificial obstruction
- Example: http://www.syntagm.co.uk/design/articles/cb.htm

If you recall from first year psychology, change blindness is when we don't notice big changes in a scene because of a brief flicker between successive views of a visual scene. For example, a saccade which are rapid eye movements that your eye makes to focus on a scene or artificially produced. To demonstrate what i mean by artificial; take a look at this scene and see if you can see what the difference is between the 2 scenes.

Past research...

- Cause of visual awareness deficits:
  - Occipitotemporal cortex lesion
  - Parietal cortex disruptions
    - Causal role or by-product of awareness?

In the past, research has determined that lesions to the occipitotemporal area have led to deficits in people's ability to analyze activity in the visual field.

Recently, parietal cortex has also been implicated. Beck et al. (2001) found enhanced activity in the parietal lobe when subjects consciously detected a change in the visual field but not when subjects were blind to the change.

However, these fMRI only demonstrates an association between the two and it is not certain whether the parietal lobe plays a causal role, could just be result of awareness and not necessarily producing awareness.

Purpose

- Assess role of parietal lobe in change detection
  - Apply rTMS over left or right parietal cortex
  - Measure participant's reaction time

The purpose of the study is to determine whether parietal activity is involved in change detection. They applied TMS (transcranial magnetic stimulation) over either the left or right parietal cortex to disrupt neural activity while the subject tries to detect a change in an image across a brief blank interval.

Hypothesis

- If parietal lobe plays causal role, subjects ability to detect changes decreases with TMS

They hypothesized that if parietal activity plays causal role in the conscious detection of change, then subjects performance should be worse during TMS.

Subjects

- 9 right-handed subjects (3 female), age 23-40, normal vision

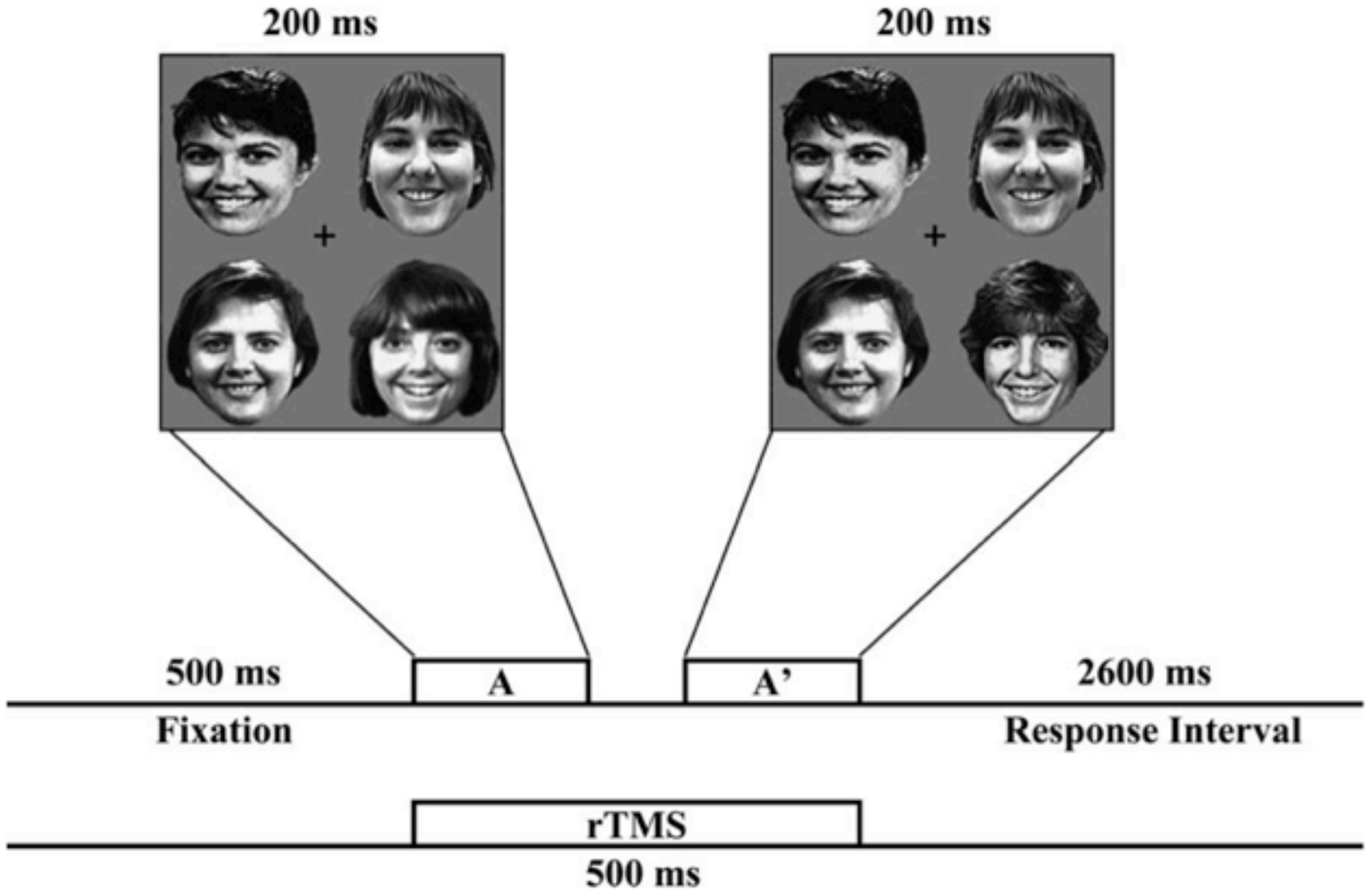
As we talked about in class, transcranial magnetic stimulation is based on using a magnetic field to stimulate parts of the brain. Duration and frequency of the stimulation is important. In this case, stimulation is at 10Hz, which constitutes rapid TMS, if you recall, a slow TMS would be able 1Hz.
500ms is a relatively long stimulation which causes a temporary lesion/ suppression of the area.

Patients received 2 blocks of 60 trials of each condition: basically, 120 trials for each of the three conditions.

Method

- TMS at 10Hz, for 500ms
- Patients received one of 3 conditions:

1. Right parietal TMS
2. Left parietal TMS
3. No TMS

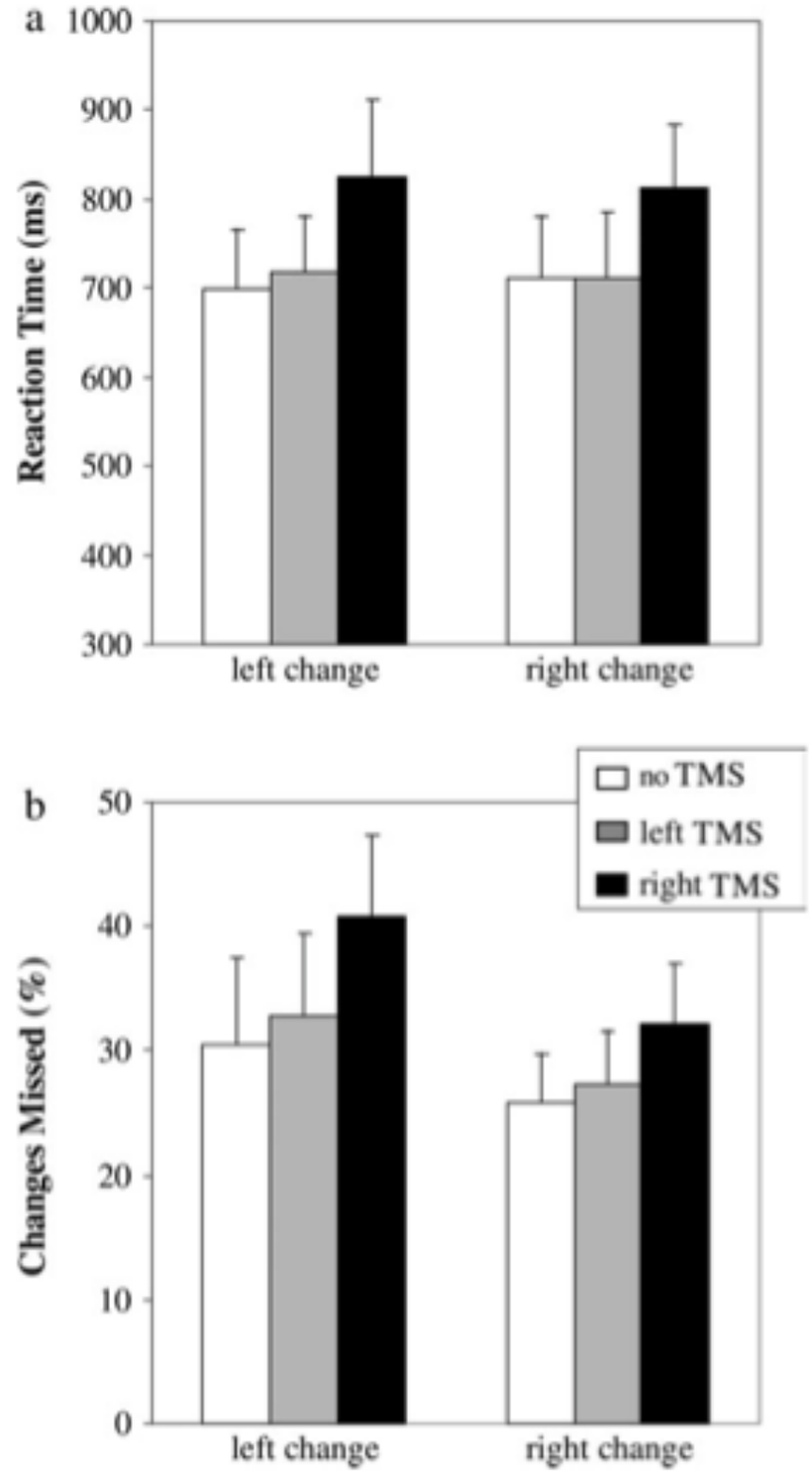


The participant is shown 2 successive displays of faces. Following the diagram above, they spend 500ms fixated on the cross in the middle (no faces) and then 200ms display then 100ms blank, then shown 200ms display of faces.
They are allowed 2.6s to respond whether faces have changed by pressing one of 2 buttons on a response pad under right hand.

Results

-Right parietal TMS produced slower responses

-Left parietal TMS produced no impairments



Based on average reaction time during right, left or no TMS and the side of change (which means which side of the screen changed) they found that the right parietal TMS produced slow change detection responses, approximately 819ms.
Left parietal TMS produced an average rxn time of 714ms. Relative to no TMS which produced a reaction time of about 706ms.

In part b of the graph, the amount of missed changes is recorded. Similarly, under right parietal TMS stimulation, participants missed about 40% of the changes while participants with no stimulation or left parietal stimulation only missed about 30% of the changes.

This trend is true for either visual field.

What does this data show?

- Right parietal is a critical component in change detection
- rTMS to the right impairs both sides of visual field
- Left parietal unaffected by TMS

What this data indicates is that the right posterior parietal cortex plays a causal role in the conscious detection of change in the change blindness paradigm. The rTMS applied to the PPC impairs their ability to detect changes in either visual field.

What is going on?

- Bilateral vs. unilateral detection
  - Left parietal directs info to right side
    - Right parietal has bilateral view

Previous studies have actually labeled change detection as a bilateral function. Researchers in 1981 actually found that that the L parietal directs attention to the contralateral space, this means the right visual field, while the R parietal has a bilateral representation of the visual space. This means that when the left side is lesioned by the TMS, the R parietal can take over and compensate for the disruption.

Future possibilities...

- Top-down vs. bottom-up
- Two top-down processes:
  - 1. Attention
  - 2. Visual short term memory
- Is parietal cortex necessary for visual awareness?

From previous psych courses we know that detecting a stimuli requires bottom up and top down processes. Bottom up processes start are based on our senses which relays information up to the brain while top down is based on our own knowledge which shapes what we sense. In the case of change blindness, our bottom up signals are fuzzy because of the saccade. So we rely on top down processes. However there are two things that the parietal cortex is involved in.

1 is attention around the image and selecting the specific things to focus on in order to find the change. 2 is visual short term memory

Based on this, we can say that the parietal cortex is necessary for awareness in general but further research with other awareness paradigms will allows us to determine if it is specific to visual awareness.

References

- Beck D,M., Muggleton, N., Walsh, V., & Lavie, N. (2006). Right parietal cortex plays a critical role in change blindness. Cerebral Cortex, 16, 712-7.
- Beck, D.M., Rees, G., Frith, C.D., & Lavie, N. (2001). Neural correlates of change detection and change blindness. Nature Neuroscience, 4, 645-650.
- Mesulam M.M. (1981). A cortical network for directed attention and unilateral neglect. Annals of Neurology, 10, 309-325.
- Rensink, R.A., O'Regan, J.K., Clark, J.J. (1997). To see or not to see: the need for attention to perceive changes in scenes. Psychological Science, 8, 368-373.
- Todd JJ, Marois R (2004) Capacity limit of visual short-term memory in human posterior parietal cortex. Nature, 428, 751-754.