UNIVERSITY OF LINCOLN
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Migraine and the Motion Streak

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Key Points

•Migraine is a common neurological disorder, with strong associations with visual processing, specifically with processing motion or flicker.

•This could be due to differences integrating visual information over time.

•The "motion streak" task showed evidence to suggest that the speed of processing might be different in migraine compared to controls.

•This has implications for potential therapy from transcranial electrical stimulation.

Migraine as a disorder

Migraine is a common and debilitating neurological disorder, affecting around 13% of adults (Steiner et al., 2003), and is among the ten most debilitating disorders according to the World Health Organisation (Stovener et al., 2007). The causes of the disorder are unknown, and current therapies available are commonly drugs, whose mode of action for alleviating migraine is also unclear. Investigating the mechanisms of migraine will help the development of alternative therapies.

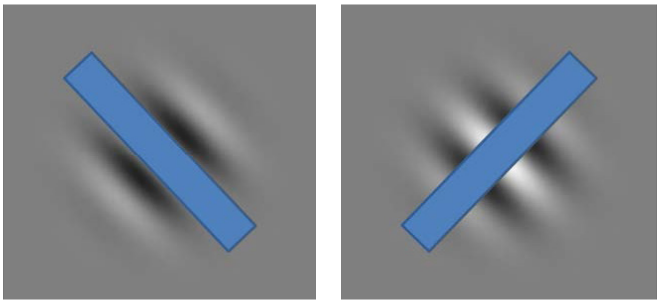
Visual processing in migraine

Vision is a significant component of migraine: 30% of sufferers experience visual auras, 80% are light sensitive (Lipton et al., 2001), while for some visual stimuli can even trigger migraine attacks (Kelman, 2007). There are also differences in visual processing in migraine (O'Hare and Hibbard, 2016), particularly motion processing (Antal et al., 2005; Ditchfield et al., 2006; McKendrick et al., 2006; Webster et al., 2011; Shepherd et al., 2012; Tibber et al., 2014). Successful motion processing involves integration of signals over time (Dakin et al., 2005). Audio-visual integration operates over a longer time window in migraine compared to controls (Yang et al., 2014).

Detection of motion

The motion streak task depends on integrating
the target motion, using orientation detectors to more effectively discriminate direction of motion (Geissler, 1999). The presence of a background introduces external noise to the task, interfering with the task and reducing performance. Including a background orientated parallel to the direction of motion causes the most interference, and so the poorest performance on the task.

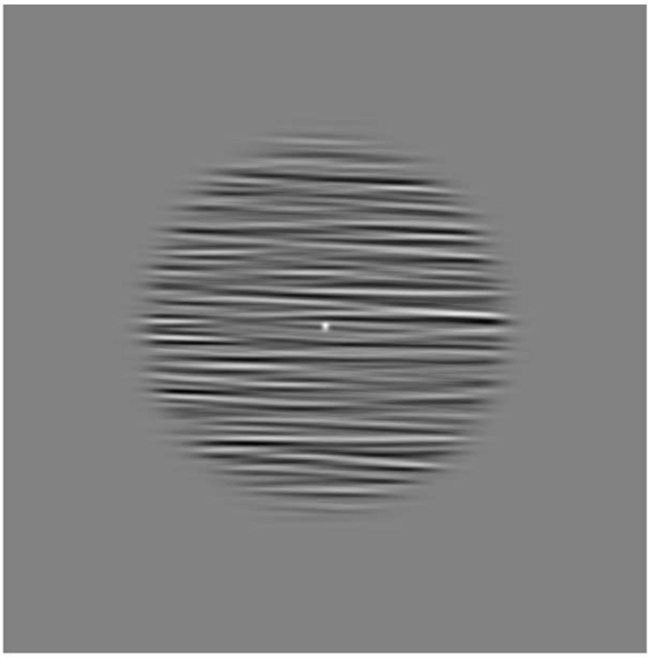
The cells of the visual system can detect oriented lines. If the motion is fast enough, this creates a "streak", similar to speedlines used in cartoons to depict motion. When there is no background interference, these orientation detectors can be used to discriminate the direction of motion more effectively than motion detectors alone. By contrast, if there are orientations in the background, this can interfere with this process and reduce performance.



Schematic diagram showing orientation detection in the early visual areas of the brain. The diagram shows the shape of the "receptive field" characteristic of the cells of the visual areas of the brain - a stimulus falling in the white areas will excite the cell, a stimulus that falls in the black areas will inhibit the cell's response. Left shows the blue bar stimulus falling in the white areas predominantly, therefore eliciting a strong-response from the cell. The stimulus on the right falls evenly in the excitatory and inhibitory regions, eliciting a weak response from the cell.

Temporal Integration in migraine

If there is a problem with motion integration, migraine groups should show poorer performance overall compared to control groups on this task.
Migraine groups are thought to be more susceptible to the effects of external noise compared to control groups, and so it was predicted that if this is the problem, there will be poorer performance seen in migraine groups with the addition of a background.

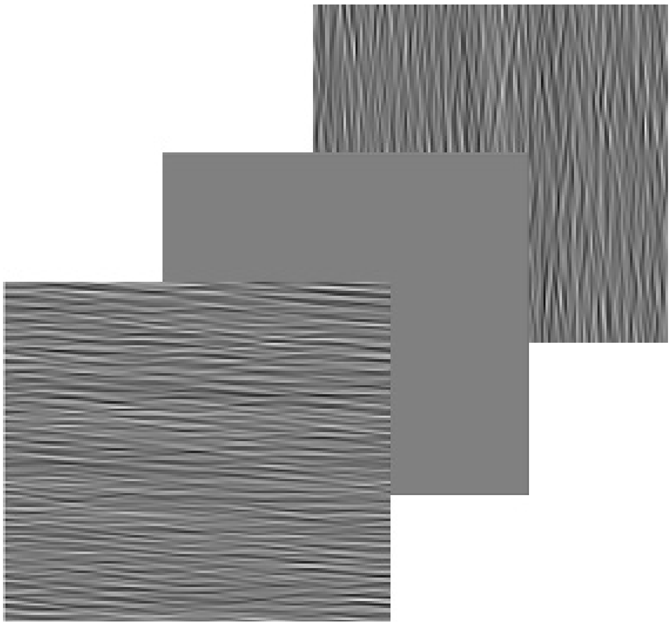


A schematic diagram of the motion streak task - the dot moves against the background. The dot can either move up, down, left or right. The observer indicates the direction of motion using the computer keyboard.

Method

60 participants took part in the study. Migraine was determined as those fulfilling the International Headache Society Criteria (2013). Control group were headache-free. All observers had corrected-to-normal vision and no differences were found in tests of contrast sensitivity.

Schematic diagram showing the three backgrounds - plain grey, parallel to motion and orthogonal to motion. Results were normalised against the performance for the plain background, in order to compare individuals.

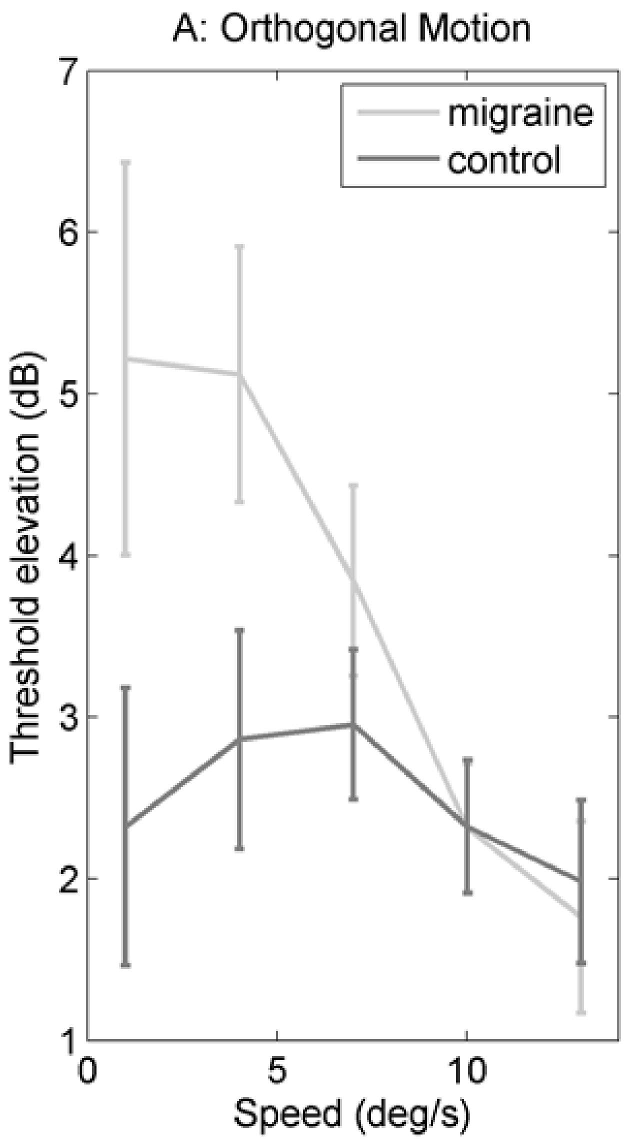


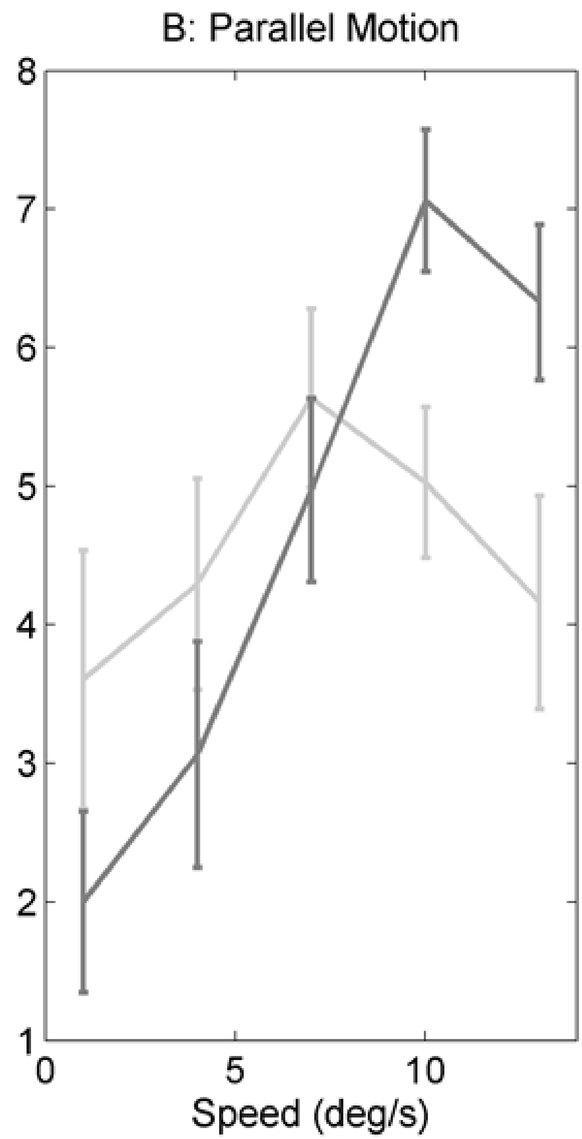
Results

Results can be seen below threshold elevation (poorer performance) can be seen against speed for (A) orthogonal motion and (B) parallel motion.

There was a substantial cost of slower speeds for the migraine group for motion orthogonal to the background (A). This is a different pattern to the control group, indicating a different critical speed for those with migraine.

For parallel motion (B) there is again a different pattern of results against speed for the migraine group compared to the control group. The control group show a greater cost of increased speeds compared to the control group. This shows evidence of differences in temporal integration in migraine, as the critical speed is different between the groups.

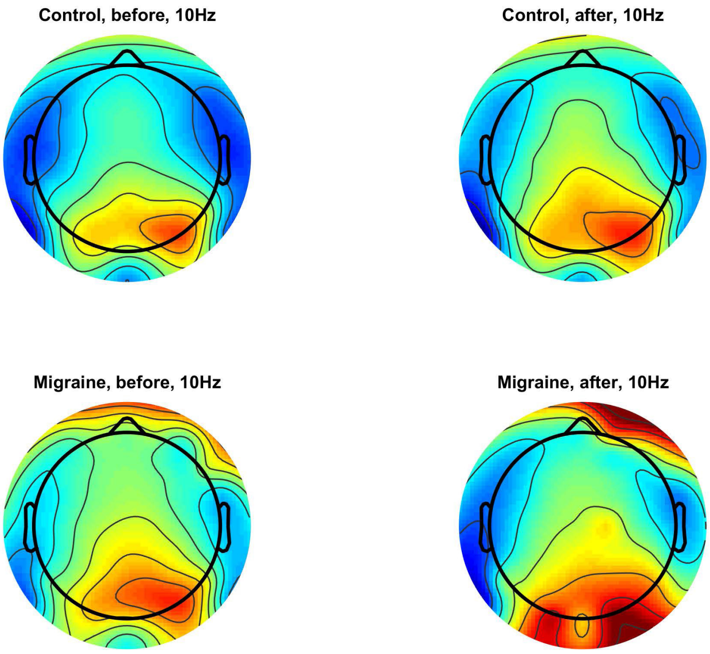




Window of excitability

The temporal integration window is thought to be controlled by the neural oscillations (Jensen et al., 2014), which vary from individual to individual.

Specifically, neural oscillations in the alpha frequency band (8-12Hz) have been associated with controlling the rate of visual information processing, acting as a “window of excitability” (Dugue et al., 2011).



Neurostimulation

It is possible to manipulate the temporal integration window using neurostimulation techniques (Cecere et al., 2015). Neurostimulation involves placing electrodes on the scalp and applying a very low electrical current. Neurostimulation has been found to be effective for some individuals with migraine, but the stimulation protocol and the mechanism for it needs to be identified before this can be used as a therapy. Understanding integration processes is the first step to the development of this potential new treatment. This is important as current medication carries side effects and also is not always suitable or effective for all of those with migraine. Finding alternatives hat do not involve such side effects would help reduce the substantial burden on society posed by migraine.

In Conclusion

Those with migraine show differences on the motion streak task compared to control groups.

This could indicate differences in temporal integration between the two groups.

Temporal integration is controlled by neural oscillations, particularly those in the alpha band.

Manipulating alpha band oscillations using transcranial electrical stimulation could present a non-invasive therapy for migraine.

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