

The Effects of Eliminating Accommodation-Vergence Dissociation in Stereoscopic Displays

Stereopsis

- Stereopsis is one of the depth cues the human visual system uses to perceive the 3D world.
- The disparity of two slightly different projections of the world onto the retinas of the two eyes is interpreted by the visual brain yielding the sensation of depth.

Stereoscopic Displays

- There are various methods to present a different image to each eye on a screen and produce a virtual 3d stereoscopic display.
- Many studies have shown advantages of stereoscopic displays, including some of our own studies.

For example:

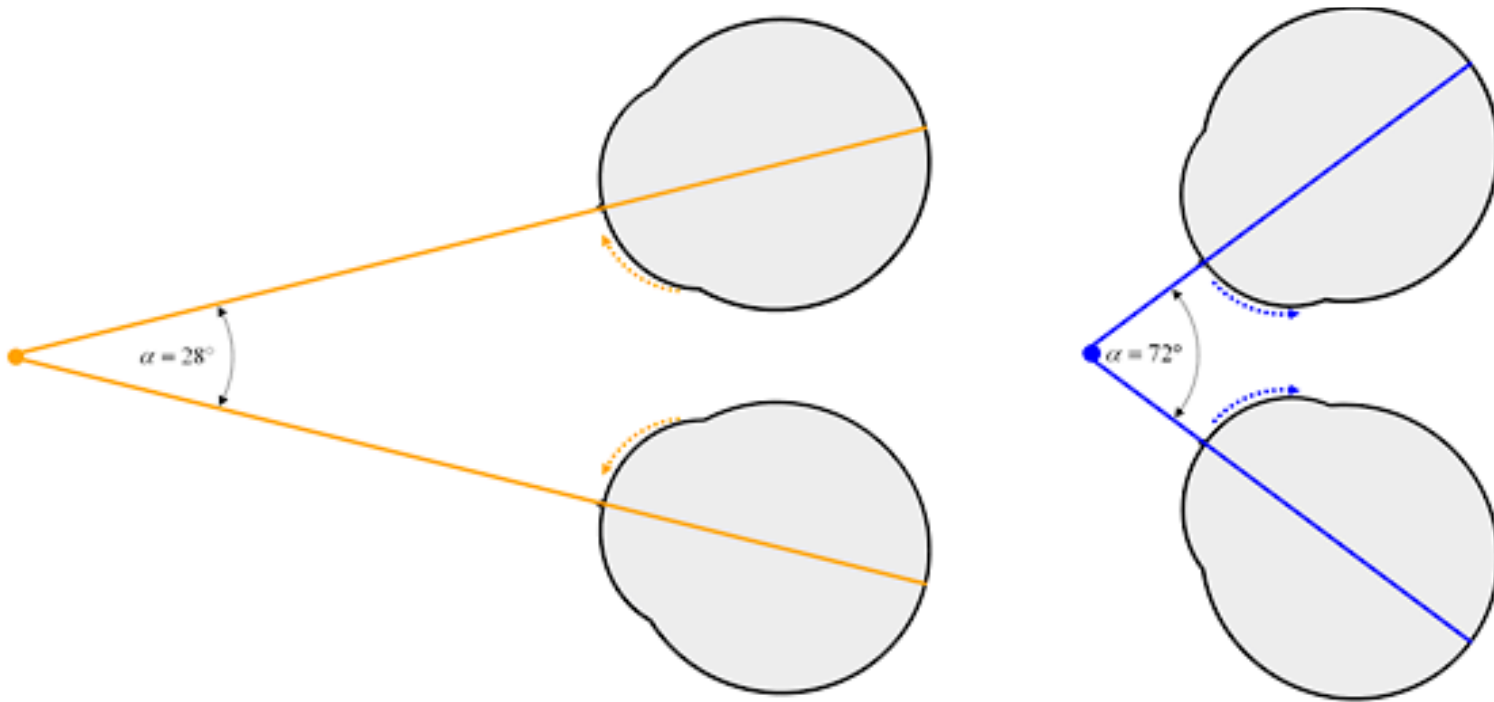
Better target detection in X-Ray luggage screening.

Better distance estimation.

Faster visual search in cluttered displays.

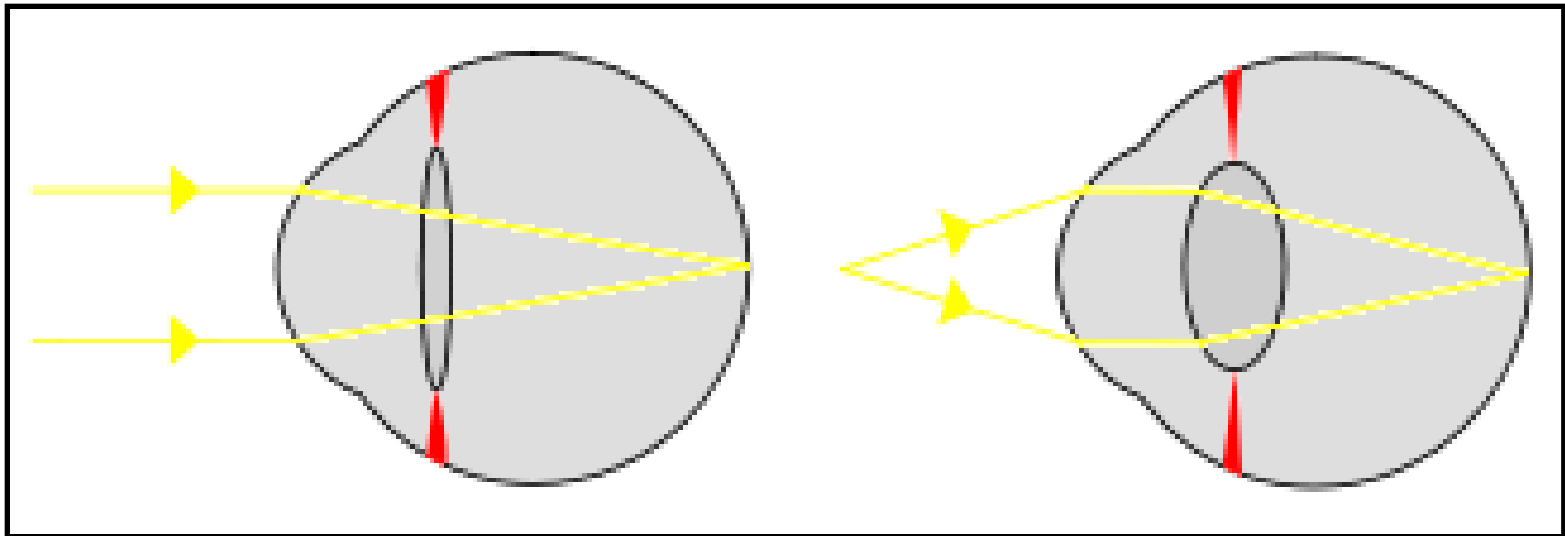
- Unfortunately, people who perform long term stereoscopic tasks, complain about various symptoms of visual fatigue.
- The most commonly accepted cause for the development of those symptoms is the incompatibility of the two visuomotor systems: The vergence system and the accommodation system.

The vergence system



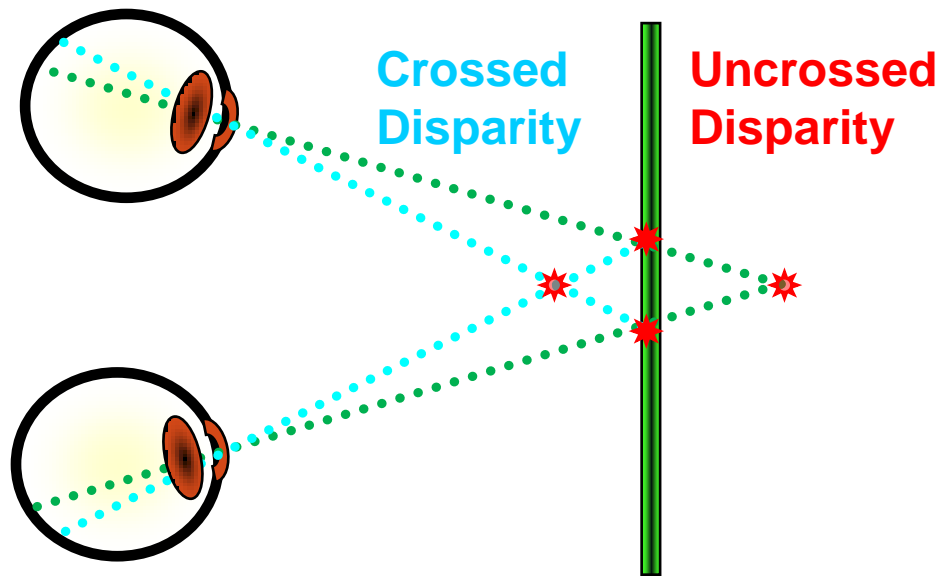
The eyes converge toward a close target and diverge toward a distant one

The accommodation system



The eye's lens increases its convexity in order to focus a near object. The lens is flattened when focusing a distant object.

- In natural situations these two systems work together: they are yoked.
- In stereoscopic displays they are dissociated. The eyes accommodate on the screen to get a clear image while the binocular disparity causes the eyes to converge on the virtual 3D image.

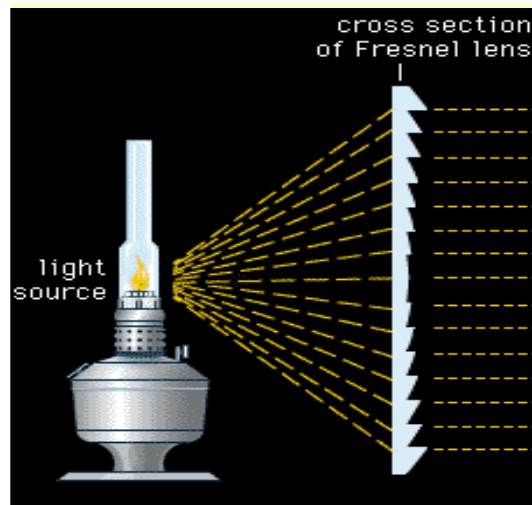


Research Aim

- To examine whether the elimination of the dissociation between accommodation and convergence attenuates the visual fatigue that stems from long term use of stereoscopic displays.

Basic Idea

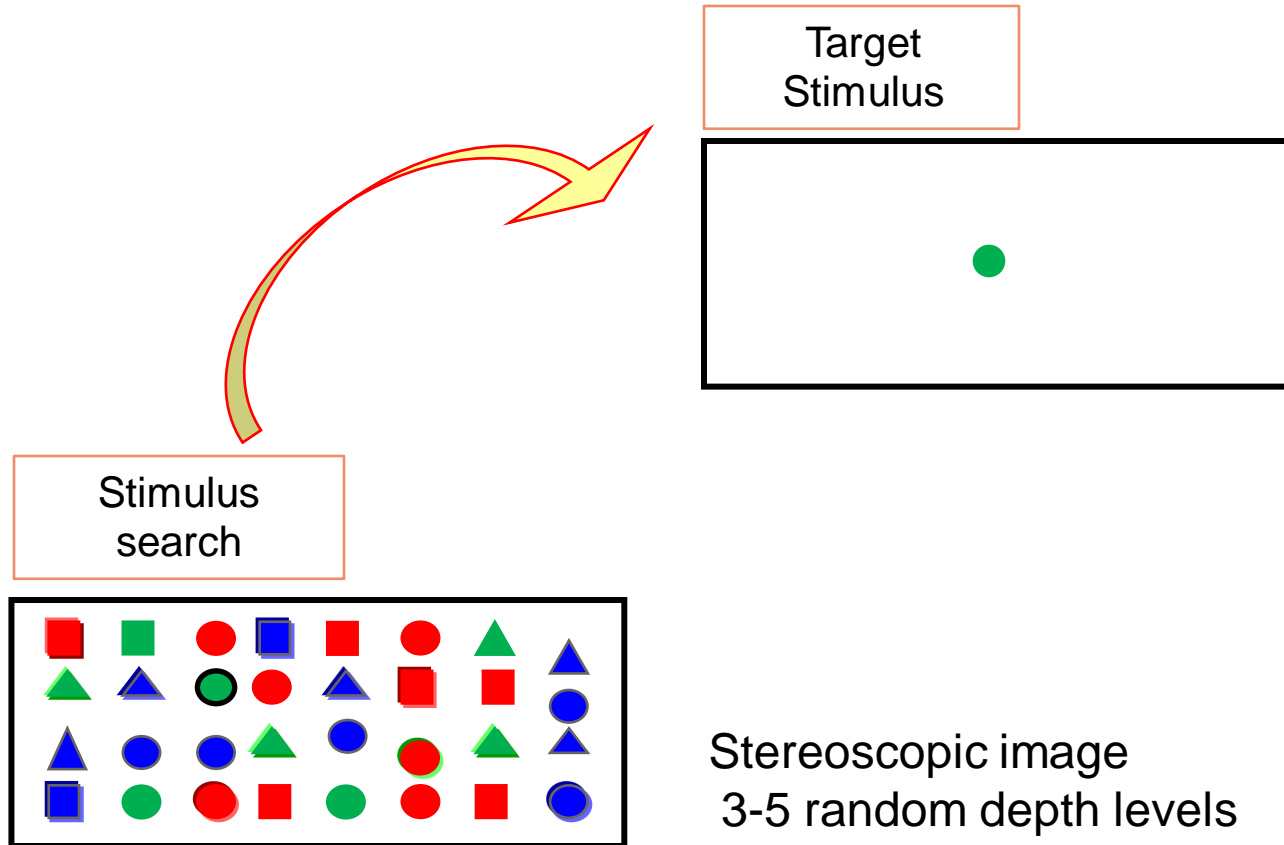
- To use lenses which collimate the light beam from the screen to optical infinity.
- Beyond 2 meters, accommodation has a limited effect on depth perception.
- On the other hand disparity both as a cue for depth and as an input to the vergence system, is effective for tens of meters.



Research Method

- 20 subjects, 2 meetings.
- In one of the meetings they performed a stereoscopic task for 20 min.
- In the other meeting they performed the same stereoscopic task with a collimating lens.
- Before and after each task their visual fatigue was evaluated by a battery of physiological tests.
- In addition, they were asked to answer a detailed questionnaire aimed at assessing their subjective feelings.

The Stereoscopic Task

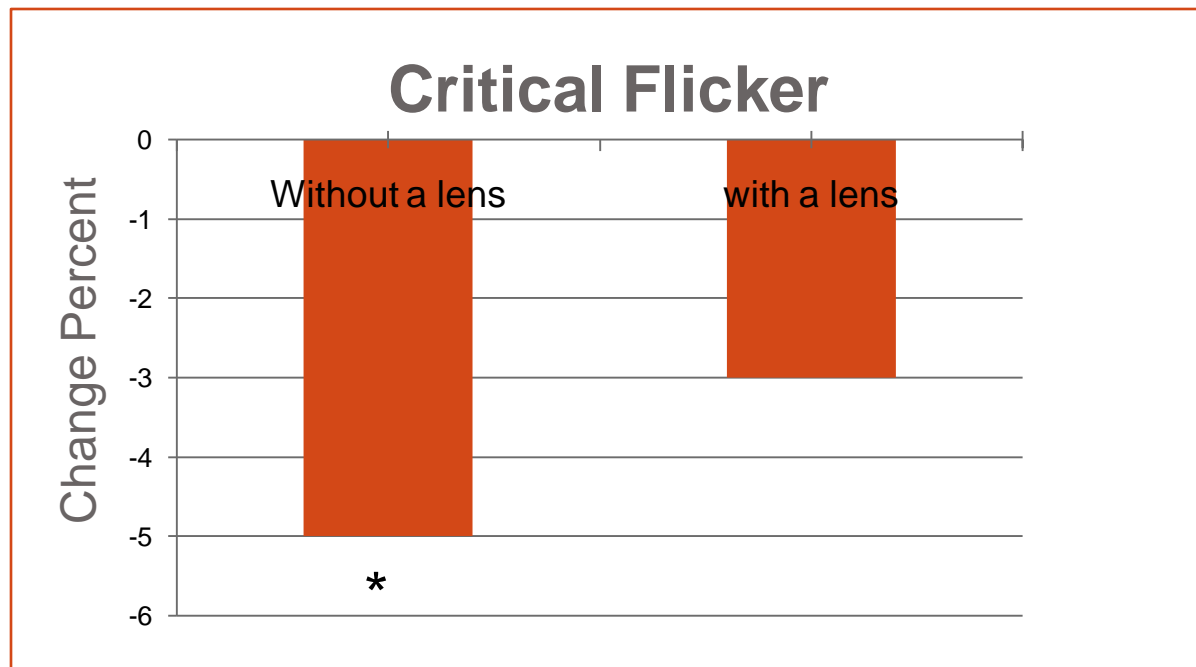


Stereoscopic image
3-5 random depth levels
1-3 target stimuli

Results

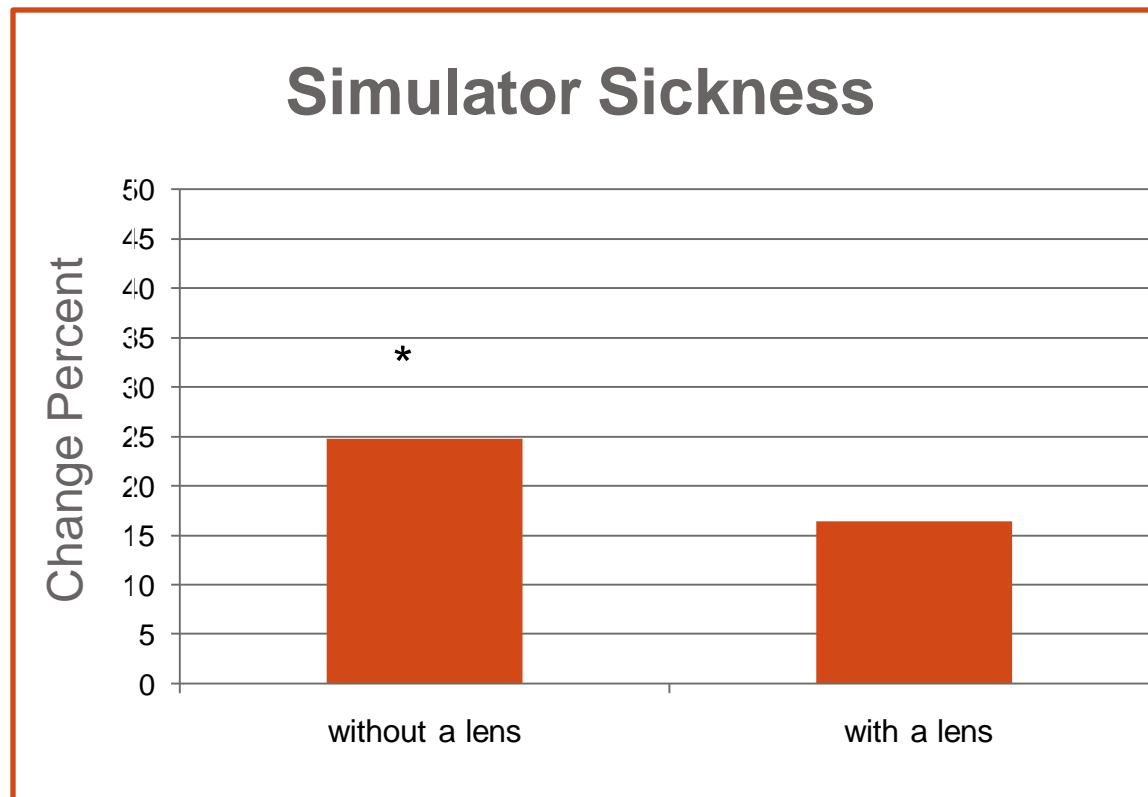
- A near-significant change in Tonic Accommodation (TA) was found.
As expected, the TA without the lens drew nearer, while the TA with the lens drew further away.
- Similarly, the Near Point of Vergence was further after the no lens condition than after the lens condition.

- CFF - Critical Flicker/Fusion Frequency is the threshold frequency for perception of a flickering light .
At any higher frequency, the subject sees a steady light source.
- Decrease in CFF is known to be an indicator of visual fatigue.

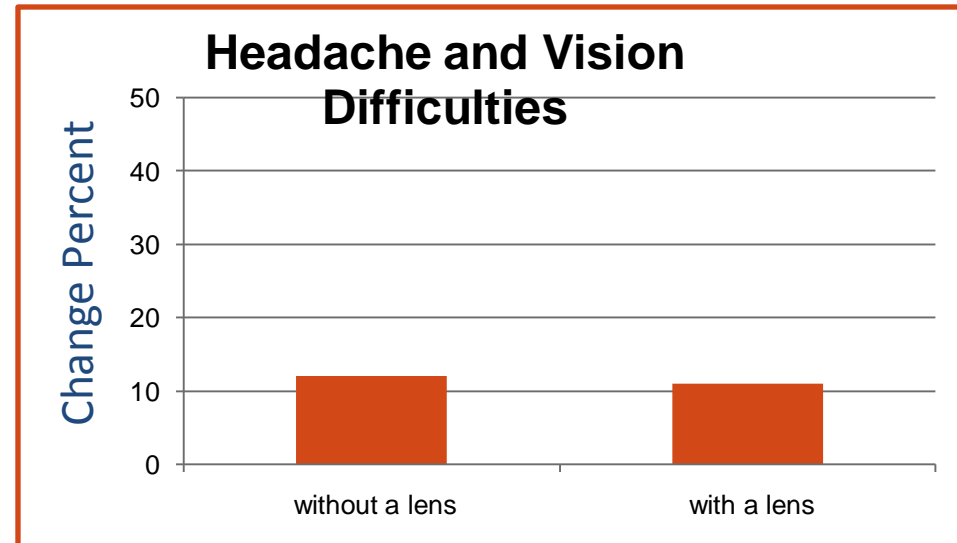
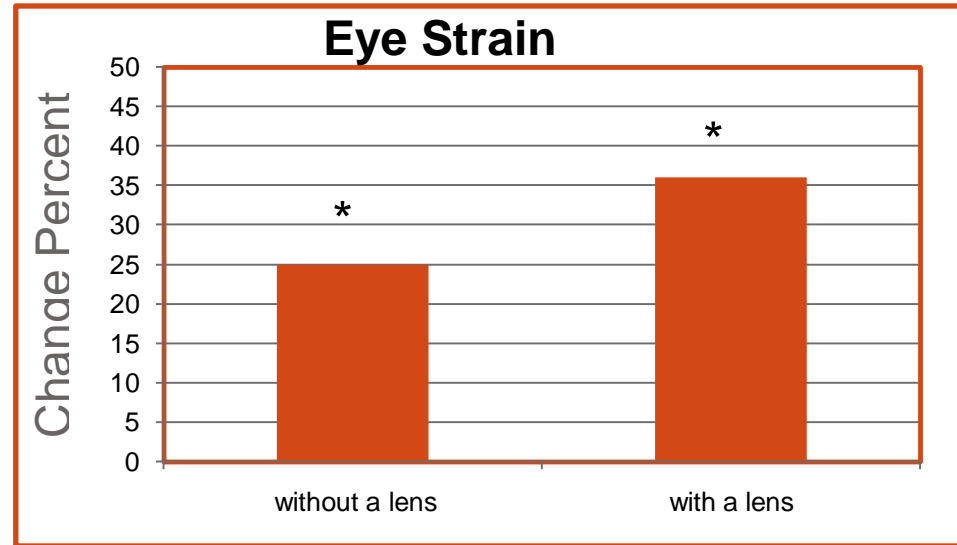


Questionnaire Results

Subjects' rating of questions about nausea and dizziness were higher after the non lens condition than after the lens condition



- Subjects complained about eye strain in both conditions.
- The stereoscopic task did not affect their ratings of headache and vision difficulties like: Teary eyes and a feeling of glare or flickering.



conclusions

- The decrease in CFF with collimation is smaller than without collimation.
Decrease in CFF is known to be an indicator of fatigue and to be correlated with subjective report of fatigue.
- In our study, subjects' subjective responses indicated less simulator sickness in the collimation condition than in no lens condition.
BUT we did not find differences in other measures of visual fatigue.
- Lessening the accommodation - vergence dissociation attenuates simulator sickness symptoms.
- We should carry out a non stereoscopic task condition to learn about the lenses' effect.
- We should prolong the task in order to try get significant results in the change TA and NPV.