Can Stroboscopic Training Improve Time-to-Collision Judgments of Approaching Objects?

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Introduction

- To move safely through the environment people must make effective judgments about potential collisions.
- Once a potential collision is detected, it is important to estimate the time remaining until the collision would occur, known as time-to-collision (TTC).
- Accurate TTC information is reliably indicated by tau, a property of the optic array, when certain assumptions are met. Tau is the inverse of an object's relative rate of optical expansion.
- However, less reliable heuristic information such as relative optical size and expansion rate, and image velocity, can influence TTC judgments even when tau is available (DeLucia, 2013).
- It is important to determine the conditions under which training can improve TTC judgments of approaching objects.

Experiment

Purpose

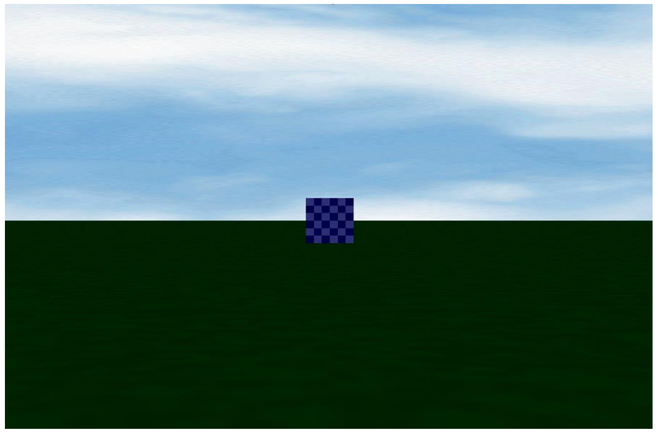
- Prior studies have shown that training with stroboscopic (intermittent) viewing improved performance on visual tasks, such as motion coherence thresholds, and performance on coincident anticipation tasks (Appelbaum, Schroeder, Cain, & Mitroff, 2011; Smith & Mitroff, 2012).
- We examined whether training with stroboscopic viewing can improve time-to-collision (TTC) judgments, which have importance in real-world tasks such as driving.

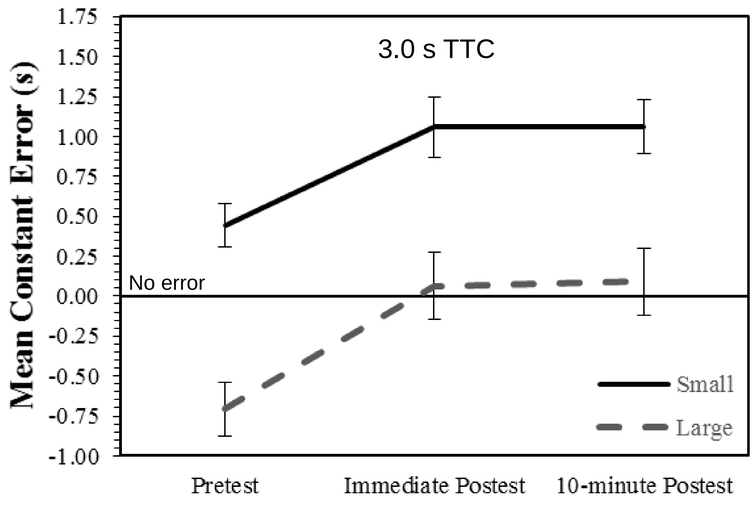
Displays

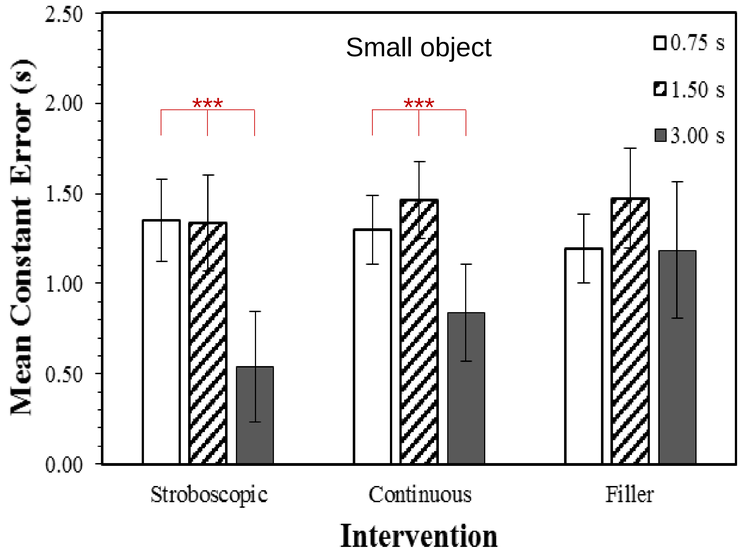
- A computer-simulated textured object approached the observer directly and disappeared. The object's size was either small or large. The distance when the object disappeared was either near or far.
- The TTC of the object when it disappeared was 0.75 s, 1.5 s, or 3.0 s.

Procedure

- Participants (N = 60) pressed a button when they thought the object would hit them.
- TTC judgments were calculated as the time between the object's disappearance and the participant's response.
- All participants completed four sessions: pretest, training, immediate posttest, and ten-minute posttest.
- Training consisted of stroboscopic (intermittent) viewing with the use of PLATO Visual Occlusion Spectacles (Milgram, 1987).







Training groups	
Stroboscopic vision of object	The goggles strobed at a frequency of 4 Hz.
Continuous vision of object	The goggles remained open for the entire approach.
Filler task (no object)	The goggles remained open while completing a crossword puzzle.

Results

- Constant error (CE) on each trial was calculated as (estimated TTC – Actual TTC).
- The stroboscopic training group did not significantly differ from the continuous vision or filler task groups.
- When TTC was 3.0 s, CE increased (performance degraded) across sessions for *small* objects ($p < .001$), but CE decreased (performance improved) across sessions for *large* objects ($p < .001$), $F(2, 114) = 3.47$, $p = .034$, $\eta_p^2 = .057$.
- For small objects, performance was better when TTC was 3.0 s than 0.75 s or 1.5 s for the stroboscopic condition ($p < .001$) and the continuous condition ($p < .001$). This was not the case for the filler condition ($p = .163$), $F(2,114) = 3.76$, $p = 0.007$, $\eta_p^2 = 0.117$.

Conclusions

- Generally, accuracy of TTC estimates decreased across sessions.
- However, training may improve TTC judgments of approaching objects when TTC is 3.0 s.
- These results have important implications for traffic safety and for driver training programs.
- Training programs designed to improve driver's abilities to judge longer TTCs may help to reduce accidents due to perceptual errors

References

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