Two-Minute Peripheral Motion Contrast Threshold Test Predicts Older Drivers' Collisions And Hazardous Driving in Simulator

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The Questions

Does Peripheral Motion Contrast Threshold (PMCT) increase with age?

Do 2-minute (Rapid) PMCT tests correlate with the 10-minute PMCT test?

How effective are RPMCT and PMCT at predicting hazardous driving behaviours in a driving simulator?

Background

- PMCT scores significantly correlate with simulator driving performance in older drivers, but the PMCT test requires 10 minutes to administer – too long for field deployment.
- The Rapid PMCT, our improved version of the previous test, has previously been shown to yield results that correlate with the PMCT, and requires less than two minutes to administer.

Summary

Older drivers' contrast thresholds for low spatial frequency drifting Gabor stimuli at 15 degrees eccentricity, as measured with a previously validated 10-minute forced-choice test and a 2-minute increasing contrast detection test (implemented on an iMac and a PC), significantly predict collisions, near collisions, and hazardous lane excursions, during a simulated drive with surprising hazard encounters and highway merging tasks. The 2-minute tests also correlate with each other and with the 10-minute test. The 2-minute tests are potentially suitable for use in an operational driver assessment setting.

Method:

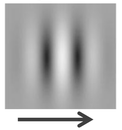
Participants (tested with their normal visual correction) :

25 younger volunteers (19-58 years, *M* = 25.4, *SD* = 8.6) (vision test only)

26 older paid participants (65-83 years, *M* = 69.7, *SD* = 4.7)

Stimulus: A drifting Gabor stimulus with spatial frequency of 0.4 cycles per degree, centripetal drift rate of 13.75˚/second (5.5 Hz), SD of Contrast Envelope 1.33˚, and background luminance of 53.9 candelas per meter^2.

These stimulus characteristics were chosen to optimally stimulate the magnocellular pathway.



Procedure

Participants were tested with both the **PMCT** and the **RPMCT**.
The order in which the two tests were administered was counterbalanced.
Participants completed three driving scenarios on a STISIM driving simulator.

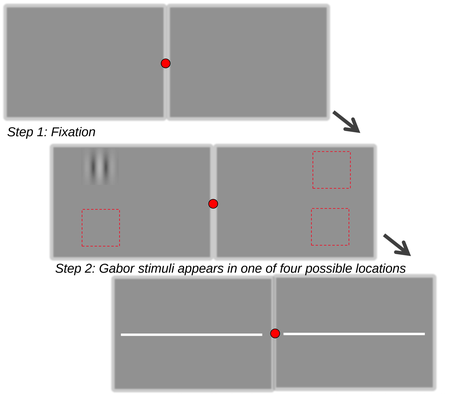
Peripheral Motion Contrast Threshold (PMCT) (10 minutes).

Gabor stimuli were presented in half-sine 1.5 sec temporal intervals at one of four locations 15˚ from a red LED fixation point .

PMCT used the method of descending limits to measure contrast threshold for these targets.

Randomly interleaved blocks began at well above threshold contrast.

Contrast decreased 2 dB between trials in first four blocks, and by 1 dB in last four blocks.

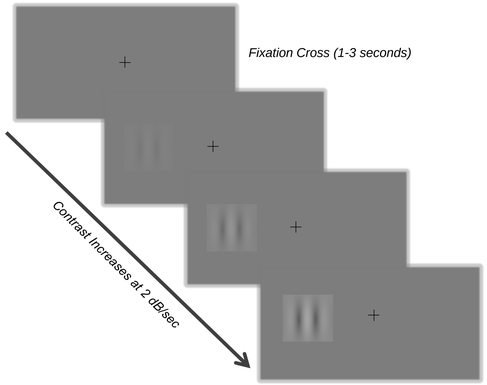


Rapid Peripheral Motion Contrast Threshold (RPMCT) (2 minutes).

RPMCT presented participants with the same gabor stimulus positioned 15˚ to either the left or right of a fixation cross.

Ten trials (five per side) were randomly interleaved.

Contrast started at -48 dB and increased at a rate of 2 dB/second until participant indicated side of presentation.



STISIM Driving Simulator

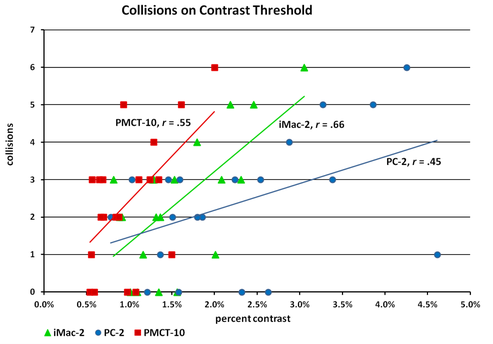
- Scenarios (60-75 minutes total): familiarization, city with surprising event, highway merging.
- Simulator: high-fidelity STISIM 3.02.13 simulator by Systems Technology Inc.
- Operates on four Dell Dimension 9200 computers (2.4 GHz Intel Core 2 Duo processor, 3 GB RAM per computer)
- Simulations projected by 3 BENQ W1060 projectors onto 3 panels 160cm in front of driver, center panel 138cm x 91cm, side panels 123cm x 91cm.

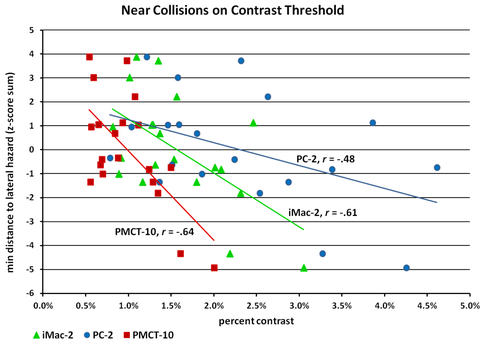
Results

Age-related decrement in peripheral motion processing (between younger and older groups):
PMCT-10, t = -4.661, p < .0001; PC-2, t = -4.877, p < .0001; iMac-2: t = -4.998, p < .0001.

Pearson r correlation coefficients across motion processing tests (all p < .00001)**:**
PMCT-10 and PC-2, r = .78; PMCT-10 and iMac-2, r = .84; PC-2 and iMac-2, r = .89

Correlation, probability (1-tailed)	2-min iMac	2-min PC	10-min PMCT
Number of collisions	+.66, p = .0008	+.45, p =.024	+.55, p =.006
Min distance of approach to hazards	-.47, p =.019	-.39, p =.047	-.55 , p =.006
Min distance of approach to lateral hazards	-.61, p =.002	-.48, p =.016	-.64, p =.001
Total hazardous lane deviation time	+.41, p =.036	+.24, (ns)	+.41 , p =.036





Conclusions

The 2-minute peripheral motion processing test agrees well with the 10-minute forced-choice peripheral motion processing test.

Peripheral motion processing undergoes an age-related decrement.

As older drivers' PMCT and RPMCT scores rise, they become more prone to crash, and to make dangerous lane deviations in simulated driving scenarios. That is, near peripheral motion processing is a critical visual function for driving which predicts older drivers' relatively less safe simulator driving performance.

This study suggests that RPMCT will be useful in predicting collision risk among older drivers.

RPMCT is easy to administer, easy to take, and requires only 2 minutes to implement, making it an excellent candidate for a field-deployable driving assessment tool.

Future studies will determine the relationship between RPMCT scores and older drivers' on-road performance and accident records.

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