Psychophysical approbation of an algorithm for coherent motion perception

R.Trukša *, E. Kassaliete, I. Lācis, K. Meļķe, A. Krastiņa
University of Latvia, Department of Optometry and Vision Science
Ķengaraga 8, Rīga, Latvia, LV-1063
European Conference of Visual Perception
Liverpool, August 23-27, 2015

Introduction

Definition: motion coherence describes minimal amount of dots that must move in common direction within test stimuli for correct identification of that direction (Chena et al, 2003). Coherence threshlod shows minimal amount dots moving in one direction in order to recognize it from random dot background (Braddick, 1995).

Problem: efficiency of motion perception is affected object properties (parameters of stimulus) and perceptual and physiological factors. Unfortunately independent researches yields diverse threshold values e.g. 5.6±0.4% (Ridder, Borsting, Banton, 2001); 15.34±4.71% (Milne et al, 2002); 25% (Slaghuis, Ryan, 1998). Dissonance among results may rise because lack of joint conception of motion perception stimuli design as well as from individual experience of test participants (Lee, Lu, 2010). Preliminary results suggest that perceptual learning do affect repeatability of test results as well as fatigue of participant (Douglas et al, 2006)

Purpose: Aim of the research is to aprobate coherent motion stimuli and evaluate whether psychopsical testing methods as method of constants and modified staircaise metholds lead similar results. During research was revaled how threshold values of coherent motion are influenced by test stimuli dot speed and frame rate.

Hypotesis: Coherent motion preception threshold decreases with increasing amount of information per unit of time. Both psychophysical testing metholds yields equivalent coherent motion preception threshold values.

Participants

Study participated three groups of people – 20 participants aged from 20-30 years, 10 18-36 years and 3 participants aged 22, 24, 26 years. Each group was given different task – compare phsychophsical metods, obtain coherent motion threshold values at different dot velocities, measure coherent motion threshold values with different amount of information.

Test stimuli

Each test stimuli contains 160 dots moving in 8 directions with 20 dots per direction and additional 40 or more dots for coherent motion. Dots are 4 pixels in diameter, colored black, emitting 1 cd/m^2. Test field is circular shaped 12 degrees of visual field, emitting 200 cd/ m^2, colored white. Experiments were carried with dominat eye at 50 cm distance from computer monitor. Coherent motion treshold values were measured by using two psychopysical methods (see figures 1,2). Data obtained by using method of constants was aproximated with Boltczmann sigmoidal function and threshold value calculated at 62.5% probability because 4AFC protocol was used.

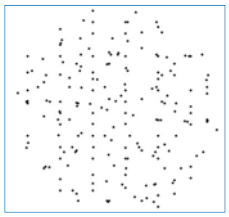


Fig.1 Test stimuli preview

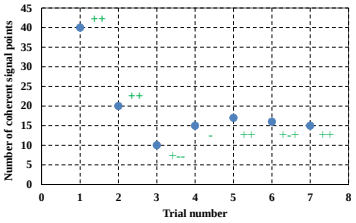
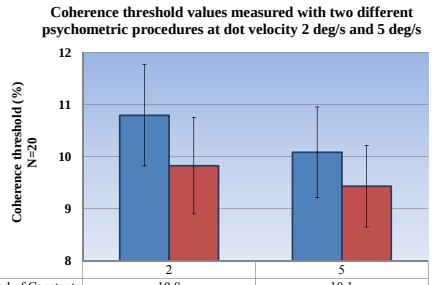
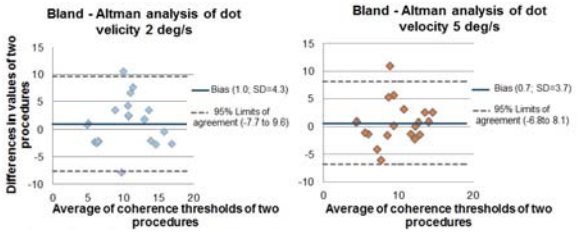


Fig.2 Algorithm of modified staircase method

Comparison of psychometric procedures

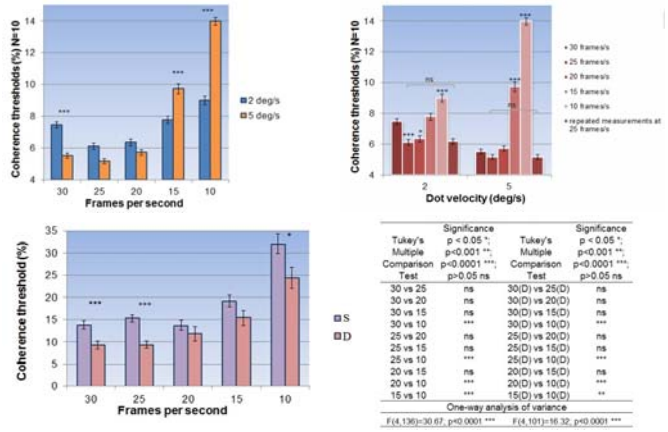


	2	5
Method of Constants	10,8	10,1
Staircase Method	9,8	9,4

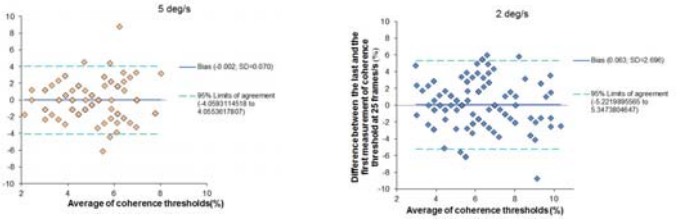


Lowest threshold values were obtained with eliptical shaped test field (radiuss 6.2degress at 50cm). Dot velocity vectors were kept constant at 2 or 5 deg/s. Dots with different motion directions were more or less evenly distributed over the test field. Coherence thresholds measured with adaptive staircase method shows the same values as with method of constants (p>0.05) at both dot velocities.

Dot velocity and frame rate effect on coherent motion thesholds.



Learning and fatigue effects



Conclusions

Two different phsychophisical testing approches (method of constant stimuli and modified straicase methods) leads to equivalent results. Main property of coherent motion is common feature motion direction, but other properties like motion speed, information amount is less significant. In case test stimuli contains more information per time unit (larger number of frame rate results detailed dot motion path), test subjects shows lower threshold values. During experiments it wasn't confirmed whether mental fatigue and learning affects coherent motion preception. It can be assumed that there is minimum amount of spartial and temporal information necessary in order to extract coherent motion from background noise.

References:

Chena, Y., Nakayama, D., Levya, S., Matthyssea, P. Processing of global, but not local, motion direction is deficient in schizophrenia. *Schizophrenia Research.* 2003, 6, 217 – 227.
Braddick, O. Visual perception: Seeing motion signals in noise. *Current Biology.* 1995, 5(1), 7 – 9.
Milne, E., Swettenham, J., Hansen, P., Campbell, R., Jeffries, H., & Plaisted, K. High motion coherence thresholds in children with autism. *Journal of Child Psychology and Psychiatry*. 2002, 43(2), 255–263.
Ridder, W. H., III, Borsting, E., & Banton, T. All developmental dyslexic subtypes display an elevated motion coherence threshold. *Optometry and Vision Science*. 2001, 78(7), 510–517.
Slaghuis, W. L., Ryan, J. F. Spatio-temporal contrast sensitivity, coherent motion, and visible persistence in developmental dyslexia. *Vision Research.* 1999, 39, 651-668.
Lee, A. L. F., Lu, H. A comparison of global motion perception using a multiple-aperture stimulus. *Journal of Vision.* 2010, 10(4):9, 1-16
Douglas, R., Neve, A., Quittenbaum, J., Alam, N., Prusky, G. Perception of visual motion coherence by rats and mice. *Vision Research.* 2006, N 46, p. 2842 – 2847.

Acknowledgment: This work has been supported by Nr.2013/0021/1DP/1.1.1.2.0/13/APIA/VIAA/001