A Study to Evaluate Peripheral Visual Perception

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Introduction

In everyday life we do not differentiate central and peripheral visual field, although there are two main visual pathways – M and P – that carry information within the cortex [1]. It is known that P visual pathway consists of midget cells whose properties allow us to see objects in detail in central visual field, whereas M visual pathway consists of *parasol* cells whose properties allow us see things in motion in peripheral visual field [2, 3]. These pathways might not always work properly, for example, dyslexia is thought to be linked to a M visual pathway dysfunction [4] and P visual pathway is impaired in autism spectrum disorder [5]. As far as there are several disorders connected to M, P visual pathways that can be improved until certain age [6], it is essential to differentiate which pathway is responsible for the problem as soon as possible. There have been several tests that are used to evaluate properties of visual pathways, although they are mainly invasive and usually there are tests that consist of a single spot or a letter while there are several moving stimulus in the peripheral visual field [7] that does not stay in the centre of attention for a long time. For example, Developmental Eye Movement Test is done naming all the letters from the blank and counting the score [8]. In this case they do not pay attention to the background that could affect the result. As far as there could be people whose peripheral vision sidetracks attention, these test results could be worsen with peripheral stimuli. For this reason, we decided to add different noise to make a test that would be interesting enough to keep the attention as long as possible and could help us evaluating peripheral vision properties. This is a pilot study.

Methods

We made a program using Microsoft Visual Basic 6.0 to evaluate individual's ability to perform near vision task:

- A set of ten letters in ten rows was used as a near vision object (see **Fig.1**).
- There was a different peripheral noise – no noise, small noise, greater noise – consisting from dots (0.4° each) (see **Fig.2.1**).
- Overall fourteen individuals (age 20-26 years) participated in the experiment in accordance with the tenets of the Declaration of Helsinki.
- An individual sat 60 cm from a projection screen (89.7° x 64.9°).
- An image was projected using Viewsonic PJ678 LCD Projector.
- An individual counted a specific letter from a set of letters that matches to the first one in the upper left row (see **Fig.1**) or named all the letters appearing every second (see **Fig2.3.**).

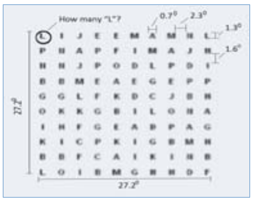


Fig.1. Properties of the set of letters

- Central peripheral noise was selected randomly, but each of them three times during the experimental part 1 and ten times during part 2.
- Additional peripheral stimuli appearing 44.1° from the center of a projection screen in experimental part 2 (see **Fig2.2**) and 40,4 in part 3 (see **Fig.2.3.**).
- One stimuli is presented at a time for 0.5 seconds during 3rd and 6th second in experiment's part 2 and after every 2.5th second in part 3.
- Experimental part 2 consists from no central noise and additional peripheral stimuli (see **Fig.2.2.**).
- Constant illumination in the room 797 ± 11 lx was used (measured with Conica Minolta T-10M).
- Statistical data analysis was made using MS Office Excel 2003ANOVA Two Way With Replication.

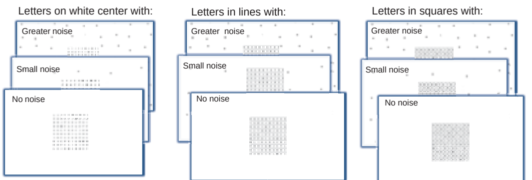
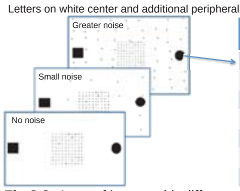


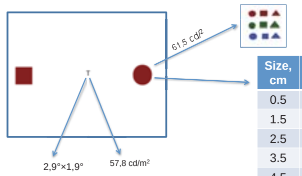
Fig.2.1. A set of letters with different properties incentral and peripheral visual field

Letters on white center and additional peripheral stimuli with:



Size, cm	Size, deg
1.0	0.5
1.9	0.9
2.9	1.4
3.8	1.8
4.9	2.4
5.9	2.8
6.8	3.3

Fig.2.2. A set of letters with different peripheral noise and additional peripheral stimuli



Size, cm	Size, deg
0.5	0.3
1.5	0.8
2.5	1.4
3.5	1.9
4.5	2.5

Fig.2.3. Near vision task with letters (changing every second) and additional red, green or blue peripheral stimuli

Results

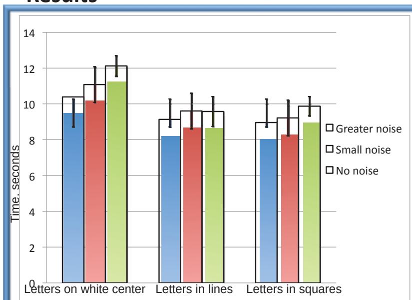


Fig.3. Average time needed to accomplish near vison task with different central and peripheral conditions for all the individuals in experimental part one. Standard errors are displayed. It takes less time to accomplish near vision task when adding central noise (p<0.01). What is more, it always takes more time to count letters with no central noise.

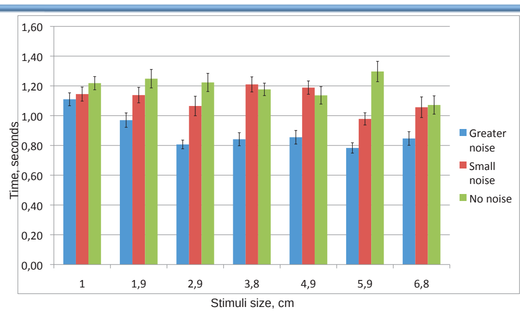


Fig.4. Average time per letter needed to accomplish near vision task with additional peripheral stimuli in experimental part two. Standard errors are displayed. It should be mentioned that peripheral noise significantly decreases time needed to accomplish near vision task with additional peripheral stimulus (p<0.01)

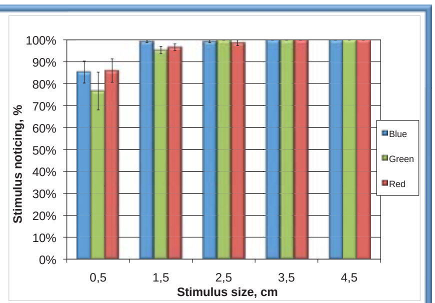


Fig.5. Percentnal correct responses for noticing red, green and blue stimulus in experimental part three (all individuals). Standard errors are displayed. Time needed to notice coloured peripheral stimulus is significantly influenced by peripheral stimulus size and colour (p<0.01).

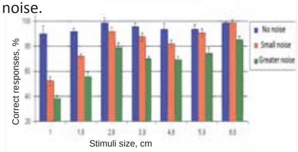
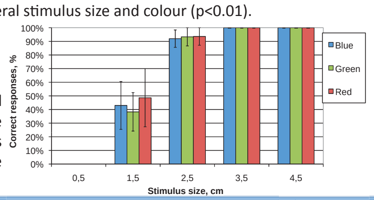


Fig.6. Noticing black peripheral stimulus. It is significantly harder to notice black peripheral stimulus when there is greater peripheral noise (p<0.05).

Fig.7. Naming coloured peripheral stimulus shape. As the stimulus size increases, ability to distinguish it's colour significantly increases for all the colours (p<0.01).



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Conclusions

1. Time needed to accomplish near vision task is significantly influenced by central noise (p<0.01).
2. Peripheral noise significantly decreases time needed to accomplish near vision task with additional peripheral stimuli (p<0.01)
3. Time needed to notice coloured peripheral stimulus is significantly influenced by peripheral stimulus size and colour (p<0.01).

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