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Visually Impaired Subjects Have More Difficulty in Quantify Distances Comparing to Subjects with Normal Vision

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Abstract

Purpose: We investigate the ability of adults with and without visual impairment estimate distances between stimuli in real environment.

Methods: We evaluated 12 subjects aged between 20 and 40 years in which 6 subjects with normal vision (mean age=31.0, SD=6.5), and 6 subjects with visual impairment (mean age=27.7, SD=7.8). Two styrofoam balls of 10cm in diameter were used, painted in black and a line of white velcro of 3.5 meters was fixed in the floor of a hallway without lateral references. Psychophysical scaling was evaluated by magnitude estimation and the exponent of the Stevens' law was calculated.

Results: The calculated exponent for the controls was 1.13 for near judgment and 1.11 for far distances. The low vision group showed exponent values of 1.01 for near and 0.96 for far distances judgment. There was a statistical difference for 120cm of distance between balls for near (F_{10}=88.21, p<0.001) and a tendency to difference for 200cm (F_{10}=3.81, p=0.079) between groups.

Conclusions: Our scaling procedure shows that despite the reduction in the distance judged by the low vision subjects, their internal representation of space is preserved. Similar exponent values indicates that their suprathreshold impression of the distance follow the same rules of the normal subject.

Keywords: distance perception; visual impairment; real distance judgment; magnitude estimation; perceptual rehabilitation; clinical psychophysics

Introduction

Our vision is guided by the egocentric references in which we've a better delicacy in distance judgment than for exocentric vision (1). Although our locomotion in space is grounded on the capability to estimate distances between objects in our visual space, many studies directly address this issue. Therefore, they also used the dimension of stereoscopic depth perception that isn't nearly related with long distances judgments (2- 5). The effectiveness of egocentric distance estimation improves due to the binocular difference using the angle of confluence of the two eyes over distances of two to six measures (7). Constant feedbacks of small deportations of the retina image are using to continually, acclimate the distance between effects when we move in space (8).

shells are also important cues in judging distances. Subjects can estimate face parcels using measures similar as textures, the average brilliance, and discrepancy between light and shadow corridor of the image (9).

In our diurnal life, the perceived size of objects plays an important part in helping people to move in the natural terrain through ongoing evaluation of the sizes of objects and spaces (10). When an object is presented in a visual angle of about 2 ° or lower we tend to overrate the size of objects at angles lesser than 2 ° we've a slight tendency to underrate the size. According to those authors, subjects with low vision have increased wrong judgments on the estimated size than people with normal vision. The value is a factor that also affects the estimated sizes, in which the more impregnated the color, the near it seems while further neutral colors feel more distant (10).

Another intriguing point related to our content is the fact of our perceptual distances isn't linearly related to the physical (objective) distances. So, the space judgment during mobility is a literacy function (11).

In this line, other studies report that the error in our spatial judgments increase as the distance increases (12- 14).

Considering distance judgment in subjects with visual impairment, indeed smaller studies were performed. Correlation between a tone-report questionnaires regarding spatial position suggest that some subjects with visual impairment have difficulty with real- world spatial tasks (15).

These difficulties could be prognosticated by their Vernier perceptivity results. Another important study is the one of Leat and Lovie- Kitchin (16). These authors measured visual perceptivity, discrepancy perceptivity and visual field attention and compared also with the real-life mobility quality. Their results shown a low to moderate correlation (r = 0.38) between mobility performance and discrepancy perceptivity. The authors concluded that attention and the presence of distractors are important factors in mobility performance.

Therefore, the purpose of this study is to probe how grown-ps subjects with and without visual impairment estimate spatial distances between simple stimulants on a real terrain, addressing the pride-exocentric judgments in searching of possible impacts of visual impairment in that spatial function.

Accoutrements and styles

We estimated 12 adult subjects progressed between 20 and 40 times in which 6 subjects with normal vision (mean age = 31.0, SD = 6.5), and 6 subjects with visual impairment (mean age = 27.7, SD = 7.8). Rejection criteria were systemic pathologies associated with the visual impairment and the using of central nervous system effect medicines. Demographic data are presented in (Table 1).

ID	Age	Gender	VA OD	VA OS	Ophthamological Diagnosis
Controls					
1	32	F	20/20	20/20	Normal
2	38	F	20/20	20/20	Normal
3	23	M	20/20	20/20	Normal
4	32	F	20/20	20/20	Normal
5	29	M	20/20	20/20	Normal
6	25	F	20/20	20/20	Normal
Low Vision					
1	23	M	20/160	20/200	High myopia and congenital strabismus
2	29	F	20/150	20/80	Congenital nistagmus, glaucoma and cataracts
3	33	F	20/160	20/150	Binocular macular scar by toxoplasmosis
4	30	F	20/200	20/150	Binocular macular scar by toxoplasmosis
5	25	M	20/200	20/120	Binocular congenital glauoma
6	32	F	20/120	20/200	Congenital binocular cataracts

Table 1: Demographic data of the Control and Low Vision Subjects.

The trial was performed at the Department of Low Vision and Visual Rehabilitation of Federal University of São Paulo (UNIFESP), Brazil.

This is a cross and experimental study and was carried out in the period from June to October after the blessing of the Ethics and Research of UNIFESP (#04.023- 061), and follows the principles of the protestation of Helsinki. All subjects inked the concurrence form.

Accoutrements and Procedure

Two styrofoam balls of 10 cm in periphery each, painted in black, were the stimulants used to calculate the distance judgment. A line of white Velcro (3M Dual Lock Reclosable Fasteners,St. Paul, MN, USA) of3.5 measures that was fixed in the bottom of a hallway without side references was used to fixate the balls.

These balls were fixed on the Velcro (velvet) in similar manner that one ball was deposited in front of the other. The distances between the balls varied in 10 cm way considering two experimental conditions

1. for exocentric judgment of distances – a reference ball was fixed at 1 cadence from the subjects while the other ball varied; 2. for egocentric judgment of distances – the reference ball remains fixed at 3 measures from the subject while the target ball varied. The position of the target ball was aimlessly chosen between 30 cm to 200 cm from the reference ball.

Each party was instructed by the experimenter about the procedure and guidelines of the trial, but wasn't informed about the white velcro line length and no information was gave about the step size of the distances. Subjects were deposited on a unheroic line reference on the frontal line of velcro.

Actors had their eyes closed in those moments when the ball was changing in distance. The task comported of as soon as (s) he opened their eyes, they've to look at the ball and incontinently judge the estimated distance.

Where, S is the judged (private) magnitude, k is a constant regarding to the condition, I is the physical intensity – in our case, the spatial distance between the balls and n is the exponent that characterizes those relations.

Statistical analysis

A full descriptive statistical analysis was performed using the Statistica(Statsoft v12, Tulsa, USA). Comparison between the groups was performed using One- Way ANOVA considering group and distance. Differences were calculated by Tukey post hoc test. Paired Pupil T- test was used to cipher differences within groups. Wilk's lambda that measures the unique donation of a separate variable to the demarcation between groups was also calculated.

Results

The distances were successfully attained for all subjects of both groups. The control group showed an exponent of1.13 (with a Pearson correlation measure of r = 0.992) for the exocentric judgment and an exponent of1.11 (r = 0.996) for the egocentric judgment of distance. also, the low vision group had an exponent of1.01 (r = 0.991) for the exocentric judgment and an exponent of0.96 (r = 0.984) for the egocentric judgment.

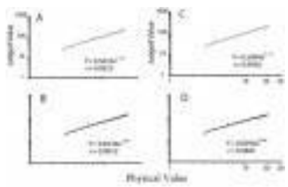

Figure 1: Stevens' exponent measures of the real object distance judgments attained for the control(A-C) and low vision subjects (B- D).

The difference set up between the controls and the low vision subjects for exocentric (0.12) and for egocentric judgments (0.15) suggest a compressive perceptual deformation in distance judgments, independently, of3.2 and4.1 times for low vision subjects.

Comparing the breadth of the private estimation performed by the low vision group with the control group, there was a statistical difference for 120 cm of distance between balls (F10 = 88.21, p<0.001) and a tendency to difference for 200 cm (F10 = 3.81, p = 0.079) for egocentric judgments. The Wilk's lambda measured for Clinical Psychology exploration and Reports ;120 cm was W = 0.06 (Chi- Sqr = 18.38; p = 0.004) which had a corrected difference between groups of F = 29.63; p = 0.002. No difference was set up for 40 cm for egocentric and for all 40, 120 and 200 cm for exocentric judgments.

Figure 2: Real distance judged by controls and low vision subjects indicating a significant difference distance perceived between the two groups. Advanced judgments differences were attained for egocentric conditions.

We also compared the distances judgment to egocentric and exocentric conditions within groups. Controls showed analogous private estimations for both conditions. Low vision subjects had analogous private estimations to egocentric (40 cm) and exocentric (200 cm) conditions, with a statistical worse judgment for egocentric compared to exocentric conditions at middle distance – 120 cm (T = -3.97, p = 0.011).

Discussion

We set up veritably emotional and meaningful results showing impairment in distance judgment in a small group of low vision grown-ups.

The first main result was a measurable reduction of the exponent of the Stevens ´ law judgment (18) in the low vision subjects, meaning an underestimation of the perceived distances between the reference and the target ball.

This is a new intriguing finding since the spatial distance judgment was different comparing with normal subjects. When we look to the values judged by the low vision subject there was a significant deformation in their perception. still, the small reduction in the exponent of the psychophysical scaling explosively suggests that their internal representation of space is saved.

The analogous exponent values indicates that their suprathreshold print of the distance follow the same perceptual rules than the normal subject. Unnaturally, this is extremely applicable information about the perceptual construction in visual impairment subjects. Indeed, with the reduction in their function for visual demarcation of spatial rudiments measured by visual perceptivity their perceptual association of space wasn't proportionally affected by the disturbed input.

The alternate main result came from the comparison of perceived distances considering the distance from the subject of the reference ball. We aiming explore if those different distances of the reference could be related with possible differences in perceived distance of the target ball. Our results showed a significant reduction in distance judgment for the low vision group for middle distances – 120 cm – and only for the egocentric condition. No differences were set up for veritably near or for distant conditions and for all the exocentric judgment. Considering these two results we argue that subjects with low vision had impairment in distance judgment reducing their private perception in comparison with normal subjects and it could be reflecting some experimental damages due to the visual disability. A analogous result was attained in a study assessing the tone- reported difficulties endured by visually bloodied subjects in real- world tasks taking distance judgments (15). A spatial localization doubter was applied by those authors to visual impairment subjects and their result suggests that subjects with visual impairment had difficulties in distance judgment and it was identified with the Vernier perceptivity. Our results showing differences in distance perception are in line with that study since both set up impairments in hyperacuities (Vernier and distance judgment).

Clinical applicability of our results could be however in means of recuperation programs. All of those former studies failed in supplement mobility performance with introductory visual functions as visual perceptivity or spatial discrepancy perceptivity for luminance (16). Grounded in our findings we suggest that the clinical measures should include further perceptual (high position) functions as figure integration and real distance perception than those classical visual tasks as visual perceptivity and discrepancy perceptivity.

Our data also shows that the egocentric judgment was more disabled than the exocentric judgments which are also in line with the experimental damages of visual impairment. According to some studies, numerous different functions parade pride - exocentric asymmetry. Both visual perception of elevation and verticality show a strong egocentric bias (19). analogous bias to egocentric judgments has been reported in spatially distributed targets (20) and for large field distances measures (21).

New perceptivity about the distance perception could be attained from our data. Although there were differences in the distance judged by low vision subjects the analogous exponent measured by power law means that they lost the visual capability to quantify precisely the distance between themselves and the objects but they maintain the internal magnitude for those perceived distances.

Low vision could be affecting further central distances since we weren't suitable to find differences in near and far distances to egocentric judgment. For near distances, fresh cues could be helping the distance between features in the medium. For far distances, our capability to judge is typically bloodied and the visual impairment couldn't be so applicable. also, we set up a tendency to a deficiency in judgment for far distances to egocentric judgment. The number of subjects in our study not allows us to considerate that tendency probative.

In both groups subjects had a trend to underrate the far distances and overrate the near distances between the two balls. The group of normal vision was more accurate than the group with low vision, still, the estimation wasn't accurate. Sharrack etal., (22) shown that indeed croakers and cases of a sanitarium are fairly squishy to estimate distance between spaces in the sanitarium. In our study, we observed that for small distances between the two balls there was an expansion judgment in the estimations and for large distances there was the oppose effect, a contraction.

Assaying what we named" internal consonance" for control and low-vision case judgments, we set up a analogous result indeed in those cases that the estimations bulks showed quantifiable imprecisions. Contrary results were set up by Lappe etal.,(23) in which subjects were asked to estimate the distance traveled in a virtual terrain. In that study, the subjects were sat inside a cell which was designed at the front an image of a virtual corridor and they had to press a button when they felt that the distance perceived was agree with the criteria distance.

Dynamic events also don't help subjects to ameliorate their distance judgment. Subjects in a virtual terrain performing a walk task showed that the perception of walked distances weren't identified with their preliminarily distance judged (24). These authors also set up an underestimation of distance to egocentric judgment, a result that's in line with ours.

Conclusion

Visually disabled subjects have further difficulty in quantify distances comparing to subjects with normal vision. In real life conditions, those deformations in distance estimation could induce accidents during their diurnal conditioning as walking between cabinetwork and other obstacles. We also set up that despite their low visual function, the" internal consonance" regarding the spatial terrain wasn't significantly affected. This is a precious information since it suggests that the perceptual association of space is saved indeed if grounded on a different (volume of) visual input. Rehabilitation programs for subjects with low vision must take into account this" internal consonance" of spatial connections, suggesting that the mobility and locomotion training should be concentrated on this property saved visual perception. Our thesis is that since the subject can learn to correct the quantifiable perceived distances, internal consonance saved must accompany this change, making the recuperation process more effective.

Conflict of Interest

The authors declare that they have no competing interests.

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