Original research

Dynamic Visual Acuity Between Frisbee Players and Non-Frisbee Players

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Abstract

Background: Dynamic visual acuity (DVA) is the ability to resolve a moving stimulus. Dynamic visual acuity is in general superior in athletes than non-athletes, which contribute to better visual abilities and translate to better performance. In this study, it is hypothesized that Frisbee players have better dynamic visual acuity due to greater perception of active images through perceptual learning from the constant tracking of Frisbee discs at a vertical and horizontal trajectory.

Materials and Methods: To measure dynamic visual acuity, participants were asked to indicate the orientation of a broken ring like a Landolt C while it traverses across a screen in the two trajectories with a computerized software (DinVA 3.0 software[8]).

Result: Frisbee players (n=17) showed no significant difference in mean DVA at both the meridians (V:0.377m/s+0.05; H:0.394m/s+0.05) compared to non-Frisbee players (n=33) (V:0.396m/s+0.09; H:0.405+0.08). Similarly, within group analysis showed non-Frisbee players had no significant difference (p=0.327) between vertical and horizontal DVA. However, there was a statistical significance (p=0.017) between the vertical and horizontal mean DVA in Frisbee players.

Conclusion: This concluded that there was no significant difference between the two groups but may suggest that Frisbee training does improve dynamic visual acuity but in the horizontal meridian due to a constant and improved tracking ability to predict horizontal stimulus.

Keywords: Dynamic Visual Acuity, Frisbee players, Static visual acuity, Landolt C

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Introduction

Vision provides functional information to conduct actions and motor behavior of a living being to react to its environment. Dynamic visual acuity (DVA) is briefly described as the ability to resolve a relatively moving stimulus[1]. They are part and parcel of our daily lives and seemingly essential for activities that require stimulation of precise and clear vision whilst in moving or dynamic environments. These activities include video games, driving, piloting, sports and scrolling on screens. Thus, suggesting that DVA is a more practical estimation of visual performance for everyday conditions rather than static visual acuity[2]. However, while static visual acuity (SVA) only targets to resolve a stationary stimulus, it is also one of the rudimentary visual functions and is involved in various other important visual functions.

These oculomotor abilities and system, consisting of rapid eye movements such as saccadic and pursuit movements[1] with saccadic eye movements thought to be a pivotal role in tracking moving targets at high speeds[3] while pursuit eye movements being a visual analysis of moving objects by stabilizing the retinal image on the fovea. With sports known to enhance the visual prowess of an individual, it was reported that athletes resulted in better DVA[4.] Hence, the interest came about to identify if DVA can be improved by the regular practice of the sport ultimate Frisbee. Hypothesizing that the ongoing practice of the athlete to respond to the constant rapid eye movements towards the flying disc in their frontal and peripheral vision allowed merits to sustain its visual ability.

DVA is relatively important in sports, especially when involving high speed movements. Such studies have reported increased DVA in athletes with correlation to the ability to track moving targets[5]. These sports that showed increased DVA in athletes include water polo[6], baseball[5], tennis and badminton[4] and softball[7]. Sports in general are known to have a certain effect on a person's visual ability and prevent the attenuation of cognitive processing speed as they age. Hence, the interest came about to identify if participating in playing the sport, ultimate Frisbee, has made any inclination towards that direction. In addition, there are a variety of research done in comparison of the effect of different sports on DVA of participants and non-participants of the sport. However, little is known about the effect and difference of DVA trajectory.

Therefore, a specific and fixed direction from a vertical and horizontal trajectory was chosen to identify whether there are any differences in participants of the sports Frisbee and non-participants. The aim of this study is to examine the effect of dynamic visual acuity on Frisbee players by measuring their performance against the performance of sedentary individuals control group at different eye movements, specifically vertical and horizontal movements.

Methodology

The measurement for DVA was performed using a 17.5inch Pavilion HP laptop with a desktop resolution of 1366 x 768, refresh rate of 60Hz in an 8-bit depth and a Standard Dynamic range (SDR) of colour space. The software (DinVA 3.0 software[8]) was projecting a moving Palomar Universal Optotype stimulus across the screen horizontally, vertically, and diagonally.

The subjects were students and lecturers from SEGi University as well as frisbee players from Carebears Ultimate Frisbee Club (CUFC). Consent form and a questionnaire was given to patients to fill to see if they are eligible to be an ultimate Frisbee player or a non-Frisbee player which is subjected by the inclusive and exclusive criteria. The experiment was done in a dimly lit room to be isolated from anyone else but only examiner and subject. The room lux is around 100-200 cd/m^2 and the screen lux to be around 60-80cd/m^2. The subjects were to be seated at 2 meters from the monitor with the viewing distance to be monitored constantly throughout.

At first, the static visual acuity (SVA) was to be taken to ensure visual acuity of 6/9 or better before proceeding. It was done with a computerized SVA software. The size of the letter optotypes are set to be compensated to the distance of 2 meters. The subjects are to read the letter optotypes on the screen and until he or she incorrectly identifies at least 4 letters in the line. The SVA results were recorded in LogMAR. An addition of a contrast sensitivity test and a developmental eye movement test was done to see if there were any significant binocular vision abnormalities.

During DVA testing, the subjects were given a practice trial of each direction once to familiarize with the structure of the software and the keyboard keys. The test was started with high speed (0.881 m/s) with the horizontal direction and pressing the “S" button will signal the start of the test. There will be a moving Palomar Universal Optotype which the ring gap will appear facing any direction at random, pressing the appropriate directional key will signal the next moving target. Each test was done with a trail of 3 times and the mean DVA results were recorded. After that, the setting was changed to the vertical direction with the same sequence.

The Shapiro-Wilk test with independent T test and paired-t test was used for the analysis using IBM SPSS software (version 25, SPSS Inc.)

Results

A total of fifty-five subjects participated in this research. The mean age for Frisbee players were 25.64 ± 7.5 years and the non-Frisbee players were 23.24 ± 5.5 years. There were 10 males (58.82%) and 7 females (41.18%) Frisbee players while the non-Frisbee players had 9 males (27.27%) and 24 females (72.72%). Data on the DVA were all normal hence a parametric test was used to further analyze the data.

The mean values of DVA for the Frisbee players and non-Frisbee players are shown in table 1. The mean difference showed that the overall DVA Horizontal was higher than the overall DVA Vertical score, while the overall DVA score of non-Frisbee players was higher than the Frisbee players.

There was a statistically significant difference between DVA Horizontal (0.398 ± 0.0509 m/s.) and DVA Vertical (0.337 ± 0.0545 m/s) among the Frisbee players, a higher score on the DVA Horizontal, $t(15) = 2.686$, $p < 0.05$. However, similar pattern was observed among the non-Frisbee players but statistically there was no significant difference. Comparison of DVA vertical and horizontal among both the groups show no statistical significant difference.

Table 1 Mean, standard deviation, and p value of the Dynamic Visual Acuity scores of the non-Frisbee players and Frisbee players

	Group	N	Mean	Std. Deviation	p value
Frisbee	DVA_V	17	0.337	0.0545	**<0.05***
	DVA_H	17	0.398	0.0509	
Non-Frisbee	DVA_V	33	0.396	0.0912	0.327
	DVA_H	33	0.405	0.0773	
DVA_V	Non-Frisbee players	33	0.396	0.0912	0.365
	Frisbee players	17	0.377	0.0528	
DVA_H	Non-Frisbee players	33	0.405	0.0773	0.546
	Frisbee players	17	0.394	0.0517	

* *Significant distribution*

Discussion

The main aim for this study was to investigate the possible changes in DVA of players and non-players in the specific sport Frisbee, and whether with different directions had any part to play on DVA. In which the vertical meridian being bottom-up movement and horizontal movement being right-to-left movement. First, it was observed that there were no significant differences in the results of DVA exhibited between the Frisbee and non-Frisbee players, but non-Frisbee players scored overall higher than the Frisbee players. Secondly, the Frisbee players exhibited superior horizontal mean DVA compared to their vertical mean DVA. Finally, the horizontal DVA was overall higher than the vertical DVA in both groups of the Frisbee and non-Frisbee players with no clinical significance.

There are a variety of research that compared the visual abilities showing athletes had a likened superiority compared to the non-athletes but showed no differences between non-athletes and beginners of their sport. This was observed by studying the comparison of facility of accommodation and saccadic eye movement (SEM) differences in volleyball players and non-players[9]. They took three groups of people consisting of a first group of 22 advanced national players with 12h/week with at least 5 years of experience, a second group of 21 intermediate players with 7h/week and the third group of 22 non-serious players who played leisurely with no training programme. A group of 20 non-players was assigned as the control group. They found that the visual abilities were significantly (p<0.001) better for the advance players compared to the beginner players and non-players while the intermittent players did not show any significant differences from the advanced players, same results go when comparing the beginner players to the non-players.

This could explain the unobserved clinical significance between Frisbee players and non-Frisbee players in the present study as the Frisbee players that participated in the study were fanatics of the sport and were not under any national or training programme. This could be compared to the beginner players and non-players comparison of the cited study that had no significant differences as they only participated at a level of leisure. The visual prowess of the Frisbee players did not receive the potential development to show any differences even though the participants of the present study had an experience of at least two years and had been having 6h/week of playing Frisbee.

Furthermore, research suggested that players who participate in other fast ball sports such as softball[7] showed higher mean DVA skills where the players were focused on following the ball pitched at a high speed. Similar to volleyball[9], with the players constantly tracking the ball to predict the spatial location and speed that is travelling to make good judgements and outcome due to the nature of the sport. Whereas Frisbee players are occupied by looking at players more rather than the Frisbee disc flying as it is a team sport with the nature of the game like American football. This is especially evident when players are playing "defense" with all their focus appointed to the other players to track their movements rather than the Frisbee disc.

The difference in visual skill between professional rugby and non-professional rugby players hypothesized on an athlete's ability to excel at their sport due to their superior visual abilities or through the continuous training that to develop the necessary skills that aided in performance[10]. It was concluded that it was through the contribution of the vigorous and constant practice to train their skills that enabled them to excel, and superior visual abilities may be insignificant.

Other studies further provided evidence of unobserved differences of mean DVA between athletes and non-athletes, similar to current study. There were 30 elite national water polo players, 13 sub-elite players and 30 sedentary students[6]. They used the computer soft software (DinVA 3.0)[8] which was made for DVA testing with different directional trajectories. They concluded that the sedentary students, sub-elite, and elite players showed no clinical significance of mean DVA scores between the three groups but revealed that a significant interaction of certain conditions of speed, contrast, and trajectory in which sub-elite and elite performed better than the sedentary students.

In the present study there were no significant interaction between the Frisbee and non-Frisbee group, however there was a significant difference between directions of DVA, the mean of horizontal DVA being superior to the mean of vertical DVA of Frisbee players. This occurrence can be assumed as the movement of a Frisbee disc, is mostly horizontal, being swung around from one point to another by the players and done consciously and purposefully. As there is a lack of study done on the effects of ocular-exercise on athletes, The effect of oculomotor exercises on DVA and the limit of stability in female basketball players was previously studied[11]. This study had thirty female athletes with a minimum of three years of basketball activity and where they had the intervention group to perform exercises while sitting for four weeks, 10 minutes each time in the morning and evening. This exercise can be explained as saccadic and pursuit trainings done with the change of gazes or head movements with a ball in hand while sitting down, with it done all in the horizontal trajectory. They concluded that there was a significant difference (p<0.001) in mean DVA and overall stability index in the intervention group after doing the exercise.

As a result of constant and fast horizontal head movements and saccadic gazes practiced by Frisbee players in training to successfully resolve their desired target whilst in game, it may contribute to the explanation of the observed significance. Furthermore, a similar study on the effectiveness of oculo-motor exercises and gaze stability exercises on postural stability and DVA in healthy young adults where the 28 intervention groups did gaze stability exercise for three weeks[12]. The before and after postural stability by standing quietly, standing with active rotation, and DVA were measure. They found that there were significant differences in the standing with active head rotation and the DVA in the intervention group. They theorized that the improvements of results were due to the improved neural adaptation of the vestibular nuclear complex, increased vestibule-spinal function and enhanced central pre-programming. This can further clarify on the speculation that the function of 'exercised' horizontal head movements can result in the brain to produce predictive programming to adapt.

The idea that constant external stimuli can develop improvements in the visual system is observed in the present study, which overall horizontal DVA is higher than the vertical DVA in both Frisbee and non-Frisbee players. One could hypothesize that it can be due to the nature of our environment and daily activities. Relating to peripheral visual cues and the tracking of the eye to objects in our environment such as moving transportation vehicle and reading which are mostly horizontal movements which can assume it to be the most frequently used amongst the other movements such as vertical and oblique movements.

This hypothesis can be further be made more concrete through the anatomical orientation in the brain where horizontal or vertical stimuli are better resolved rather than oblique, coining the term the "oblique effect". This effect is further studied by and states that both widths and numbers of cells of their orientation tuning differs as function of preferred orientation[13]. In which cells tend to be orientated in horizontal and vertical rather than oblique angles and that most cells that are triggered are horizontal orientations. Their study observed that horizontally tuned cells have a better non-linear component than those tuned to other orientations. This can be translated into the preference of better resolve of horizontal stimuli.

In summary, the results of the present study are in contrary with the previous studies of DVA being superior to those who participate in sport5[5,6,7], but does improve with constant activation through specific exercises. A possible limitation in the present study is the limited amount of training and experience in the Frisbee players that participated and that the characteristic of the DinVA test were not sensitive enough to detect any distinction to be noticed due to the nature of the test being a software configuration rather than a hardware configuration.

Conclusion

This study showed Frisbee training does improve DVA in the horizontal meridian. However, there are no differences in DVA between Frisbee players and non-Frisbee players.

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Reference

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