MÀSTER UNIVERSITARI EN OPTOMETRIA I CIÈNCIES DE LA VISIÓ

TREBALL FINAL DE MÀSTER

Dynamic Visual Acuity between Action Video Game Players (AVGPs) and Non-Action Video Game Players (NAVGPs).

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18 JULIOL 2022

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El Sr MARC ARGILÉS SANS, com a director del treball

CERTIFICA

Que el Sra. IMAN BELKADI AIT ALI ha realitzat sota la seva supervisió el treball titulat AGUDESA VISUAL DINAMICA EN JUGADORS I JUGADORES DE VIDEOJOCS D'ACCIÓ que es recull en aquesta memòria per optar al títol de màster en optometria i ciències de la visió.

I per a què consti, signo/em aquest certificat.

Sr Marc Argilés Sans
Director del treball

Terrassa, 18 de Juliol de 2022

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MÀSTER UNIVERSITARI EN OPTOMETRIA I CIÈNCIES DE LA VISIÓ

AGUDESA VISUAL DINAMICA EN JUGADORS I JUGADORES DE VIDEOJOCS D'ACCIÓ

RESUM

Introducció: L'efecte dels videojocs d'acció en el processament perceptiu i cognitiu del cervell s'està convertint en una interessant eina per a les habilitats visuals. En concret, els videojocs d'acció (AVG) han demostrat millorar processos atencionals, cognitius i perceptius. L'agudesa visual dinàmica (AVD) és una mesura de l'agudesa visual en presencia d'un moviment relatiu entre l'observador i l'objecte observat, que es pot avaluar en diferents velocitats i direccions.

Objectius: L'objectiu d'aquest estudi va ser comparar el rendiment de la AVD entre jugadors/es de videojocs d'acció (AVG) i jugadors/es de videojocs no d'acció (NAVG) en adolescents.

Mètodes: 47 participants (N=47), d'entre 17 i 25 anys van participar en l'estudi, dels quals n=22 van entrar en el grup AVG i 25 en NAVG. Es va mesurar la AVD en 2 velocitats (2m/s i 1m/s) i en 3 contrastos diferents d'estímul (100%, 50% i 10%), obtenint 6 mesures diferents d'AVD.

Resultats: No es van observar diferències estadísticament significatives entre els grups amb el els valors de la AVD avaluada a 2 m/s i al 100% i 50% de contrast, P=.829, P=.514, respectivament, però si amb el 10 %, P=.020. Amb la velocitat de 1 m/s no es va observar diferències estadísticament significatives al 100% i 50 %, P=.542, P=.953, però si al 10%, P=.031. Les diferències no van ser clínicament significatives,

Conclusions: Segons els resultats obtinguts i la metodologia emprada, aquest estudi conclou que la AVD no es veu modificada en base a l'experiència en jugar a videojocs d'acció.

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AGUDEZA VISUAL DINÁMICA EN JUGADORES Y JUGADORAS DE VIDEOJUEGOS DE ACCIÓN

RESUMEN

Introducción: El efecto de los videojuegos de acción en el procesamiento perceptivo y cognitivo del cerebro se está convirtiendo en una interesante herramienta para las habilidades visuales. En concreto, los videojuegos de acción (AVG) han demostrado mejorar procesos atencionales, cognitivos y perceptivos. La agudeza visual dinámica (AVD) es una medida de la agudeza visual en presencia de un movimiento relativo entre el observador y el objetivo observado, que se puede evaluar en diferentes velocidades y direcciones.

Objetivos: El objetivo de este estudio fue comparar el rendimiento de la AVD entre jugadores/as de videojuegos de acción (AVG) y jugadores/as no de acción (NAVG) en adolescentes.

Métodos: 47 participantes (N=47) de entre 17 y 25 años han participado en este estudio, de los cuales n=22 entraron en el grupo AVG y 25 en NAVG. Se midió la AVD en 2 velocidades (2 m/s y 1 m/s) y en 3 contrastes diferentes de estímulos (100%, 50% y 10%), obteniendo 6 medidas diferentes de AVD.

Resultados: No se observaron diferencias estadísticamente significativas entre los grupos con los valores de la AVD evaluada a 2 m/s y al 100% y 50% de contraste, *P*=.829, *P*=.514, respectivamente, pero si con el 10%, P=.020. Con la velocidad de 1m/s no se observaron diferencias estadísticamente significativas al 100% y 50%, *P*=.542, *P*=.953, pero si al 10%, *P*=.031. Las diferencias no fueron clínicamente significativas.

Conclusiones: Según los resultados obtenidos y la metodología emprada, este estudio concluye que la AVD no se ve modificada en base a la experiencia en jugar a videojuegos de acción.

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DYNAMIC VISUAL ACUITY BETWEEN ACTION VIDEO GAME PLAYERS (AVGPS) AND NON-ACTION VIDEO GAME PLAYERS (NAVGPS)

ABSTRACT

Introduction: The effect of action video games on perceptual and cognitive processing of the neck is becoming an interesting idea for visual skills. Specifically, action video games (AVGs) have been shown to improve attentional, cognitive and perceptual processes. Dynamic visual acuity (DVA) is a measure of visual acuity in the presence of related motion between the observer and the observed object, which can be assessed at different speeds and directions.

Aim: The aim of this study was to compare the DVA performance between action video game players (AVG) and non-action video game players (NAVG) in adolescents.

Methods: 47 participants (N=47), aged 17-25 years participated in the study, of which n=22 were in the AVG group and 25 in NAVG. DVA was measured at 2 speeds (2 m/s and 1 m/s) and at 3 different stimulus contrasts (100%, 50% and 10%), obtaining 6 different measures of DVA.

Results: No statistically significant differences were observed between groups with DVA values assessed at 2 m/s and at 100% and 50% contrast, *P*=.829, *P*=.514, respectively, but with 10%, *P*=.020. With the 1 m/s speed, no statistically significant differences were observed at 100% and 50%, *P*=.542, *P*=.953, but at 10%, *P*=.031. The differences were not clinically significant.

Conclusions: According to the results obtained and the methodology employed, this study concludes that DVA was not modified based on experience in playing action video games.

Aquest treball està presentat en format article, segons les instruccions escrites en la guia d'autors de la revista "Optometry and Vision Science"

Ranking: 40/61 in Ophthalmology (5-year impact factor)
Impact Factor: 2.106

Title: Dynamic Visual Acuity between Action Video Game Players (AVGPs) and Non-Action Video Game Players (NAVGPs).

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ABSTRACT

Introduction: The effect of action video games on perceptual and cognitive processing of the neck is becoming an interesting idea for visual skills. Specifically, action video games (AVGs) have been shown to improve attentional, cognitive, and perceptual processes. Dynamic visual acuity (DVA) is a measure of visual acuity in the presence of related motion between the observer and the observed object, which can be assessed at different speeds and directions.

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Conclusions: According to the results obtained and the methodology employed, this study concludes that DVA was not modified based on experience in playing action video games. Unlike other investigations, this study took account the professional sport's experience from all the participants, excluding professional athletes, and seems important to control this variable when measuring DVA.

KEYWORDS: Dynamic visual acuity, Action video games players**,** video games**.**

INTRODUCTION

In the past years a lot of research have been focused on the effect of action videogame playing in perceptive and cognitive brain processing, (1-5) and become an interesting tool to raise some visual abilities (6-8), even though not all genres have the same properties. In fact, action video games (AVGs) had shown to improve visual attentional skills, (9-11) and various studies had taken advantage of this to enhance some visual functions in amblyopia (12-15). AVGs can be characterized by a) fast pace-time events, b) need to distribute their attention across the peripheral visual field, c) require focusing their attention on different locations, d) need to use the divided attention upon demand, and e) prevent automatization in task-gamers (16).

Then, all video games that include these characteristics could be suitable to be used as AVG, and then to be selected as experimental treatment in interventional studies, for instance Call of Duty, or Medal of Honor. (1-9) Nevertheless, non-action video games (NAVGs) are classically "slow-pace" videogames and used as a control group. Videogames used in research are The Sims or Tetris (17-18) and are frequently considered placebo games.

Dynamic Visual Acuity (DVA) is a measure of visual acuity in the presence of relative motion between the observer and the object being observed, which can be assessed in different velocities and directions (19). This measure seems to be important for the assessment of different ocular diseases, (20) even for integrity of vestibular system, (21) due to his nature relationship. Different studies have shown increased DVA in professional athletes, specifically in sports as water polo (22), MMA fighters (23), or baseball players (24). Some recent study shows better DVA in video game players (25) although this study did not differentiate AVG from NAVG players. The aim of this study was to observe if the DVA is different between AVG and NAVG player's experience.

METHODOLOGY

Baseline participant recruiting

Participants between 17 and 25 years old were recruited for this study. All the participants need to require >20/20 of monocular static visual acuity, measured with Palomar Rings Opotype at 5 meters with their their best-corrected visual acuity (BCVA), less than 40" of stereoacuity with the habitual correction (glasses and/or contact lenses) using the Randot Dot test, near point of convergence (NPC) less than 10 cm (26,27), and amplitude of accommodation (AA) normal by age, using Hofstetter equation, AAmín = [15 – 0.25 x age] – 2.00, (28) . NPC and AA were measured using a RAF Rule (Royal Aire Force Rule). Amblyopia or strabismus were excluded from this study.

Dynamic Visual Acuity (DVA) assessment

DynVa 3.0 software was used for DVA measures, which was validated in previous studies (29,30). All the measures were taken at 2.00 meters of distance from a monitor of 21" (Monitor MSI Pro MP221, 22", 1366x758, 60Hz. Screen-velocity of the optotype was computed from the next formula (**1**):

$$Velocity\ \left(\frac{m}{s}\right) = FR\ x\ Size\ x\ Step \qquad \mathbf{1}$$

"FR" as the frequency rate of the screen in Hz, "Size" as the pixel dot and "Step" as the number of pixels displaced each time during the test. And the velocity of optotype displaced for the retina in visual angle and computed with the formula (**2**):

$$Velocity\ \left(\frac{º}{s}\right) = \frac{Velocity}{Viewing\ distance} \qquad \mathbf{2}$$

We used the dynVA 3.0 "speed series", formed by a sequence of tests characterized by the displacement speed of the optotype remaining constant during 1 test, while its size increases. For every test of the sequence, the optotype has a constant and pre-defined speed. The initial optotype size was the minimum (s=2 pixels) and increased during the test. If the maximum size (s=10 pixels) was reached before the subject has given a response, the displacement stops, and the response was automatically taken as incorrect (-1). When the subject answered correctly the software saved the data (identity, responses, DVA and elapsed time) and initiated another optotype display. DynVa 3.0 uses a rotating "Palomar Ring" as a stimulus (**Figure 1**). We selected a velocity of 2 m/s and 1 m/s. Also, DynVA 3.0 can measure the DVA with different contrasts using Michaelson formula (**3**):

$$m = \frac{Lmax - Lmin}{Lmax + Lmin} \qquad \textbf{3}$$

We used a luxometer (Mavolux,Gossen) to measure luminance background (screen) and luminance on the optotype. Then, we were able to compute the contrast of the stimulus (m), which is proposed to measure in the highest, the medium and the lowest condition. In the three cases the stimulus will be swinging horizontally in both directions. We selected 100% of contrast, 50% and 10% of contrast in this study (**Figure 1**).

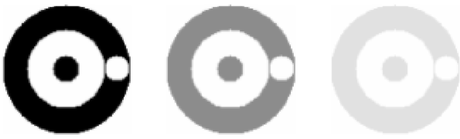

Figure 1. Palomar optotype rings used to measure the dynamic visual acuity. It is shown, from left to right, the different contrast stimulus (100%, 50% and 10%).

Participants had a specific keyboard to answer the 9 directions which the circle might be in each velocity and contrast set up. A staircase of 5 correct answers was applied for each velocity and contrast. Each DVA was measured 5 times obtaining the median and standard deviation. All the measures took about 30 minutes to complete for each participant.

Videogames Experience

For the videogame experience, we used the Videogame Questionnaire, created, and validated from Bavelier's Lab (31,32). Participants responses were divided in action video game (AVG) and non-action video game experience (NAVG). This questionnaire was assessed after DVA measurements.

Federate Sports Experience

As some studies have shown that some professional sports could influence the DVA performance (22,23,24,25,33-38), we created a questionnaire, similar as Bavelier's Lab, asking about the experience (hours in training) in a professional level (federated), both in the present year and the past year. Participants with more than 5/h of federate sport training in sports such water polo, basketball, soccer, tennis or ping-pong were excluded from the study. This questionnaire was assessed after DVA measurements to control the Hawthorne effect (39).

Ethics Committee

This study had the approbation of the Ethics Committee from Mutua de Terrassa, ref 04/2022. All the data were followed based on Helsinki protocols.

RESULTS

A total of 47 participants (N=47) were included to the study, n=22 in the AVG group and n=25 in the NAVG group, 47,9% were males and 50% females. Mean age and standard deviation (SD) for all the participants were 20,68 (2,06), 95% confidence intervals (CI), (95% CI: 20,07-21,28), range from 17 to 25 years old. All the participants were right-handed. Mean (SD) and 95% of confidence intervals (95% CI) for every dynamic visual acuity measurement is detailed in **Table 1**.

Table 1. Descriptive results for the 6 measurements in dynamic visual acuity (DVA) between participants. Mean and standard deviation (SD) with the 95% of confidence interval (below) are summarized. P-values are shown at the last row.

	Dynamic Visual Acuity (DVA)					
Velocity Contrast	**2 m/s** **100%**	**1 m/s** **100 %**	**2 m/s** **50 %**	**1 m/s** **50 %**	**2 m/s** **10 %**	**1 m/s** **10 %**
AVG n=22	0.129 (0.15)	0.149 (0.24)	0.133 (0.21)	0.150 (0.24)	0.050 (0.02)	0.063 (0.02)
	(0.123-0.136)	(0.139-0.161)	(0.124-0.142)	(0.139-0.162)	(0.040-0.060)	(0.054-0.071)
NAVG n=25	0.131 (0.14)	0.145 (0.23)	0.136 (0.11)	0.151 (0.24)	0.064 (0.02)	0.075 (0.02)
	(0.125-0.136)	(0.136-0.155)	(0.131-0.141)	(0.141-0.161)	(0.055-0.073)	(0.068-0.081)
***P*-value**	.829	.542	.514	.953	**.031***	**.020***

A one-factor ANOVA (with two groups) reveled that all the data followed the assumption of sphericity (Levene's test>.05). We did not find a statistical difference in the dynamic visual acuity with 2 m/s and 100%, F(1,46) =0.04, P=.829, 1m/s and 50% of contrast, F(1,46)=0.37,P=.542, 2m/s and 50% of contrast, F(1,46)=0.43, P=0.514, and 1m/s with 50% of contrast, F(1,46)=0.00, P=.953. We did fins a statistical difference between groups with 10% of contrast, both with 2 m/s, F(1,46)=5.858, *P*=.020 and 1 m/s, *F*(1,46)= 4.97, *P*=.031. The average and SD in the AVG group in the lowest contrast measurement was 0.063 (0.02) and 0.050 (0.02) for 2 m/s and 1m/s respectively. In the NAVG group was 0.075 (0.02) and 0.064 (0.02) for 2 m/s and 1 m/s, respectively. Mean DVA difference between groups for 2 m/s and 10% were 0.012, and 0.014 for 1 m/s and 10% contrast. In **Figure 2** are shown the results in bar plots for every measurement of the dynamic visual acuity between groups.

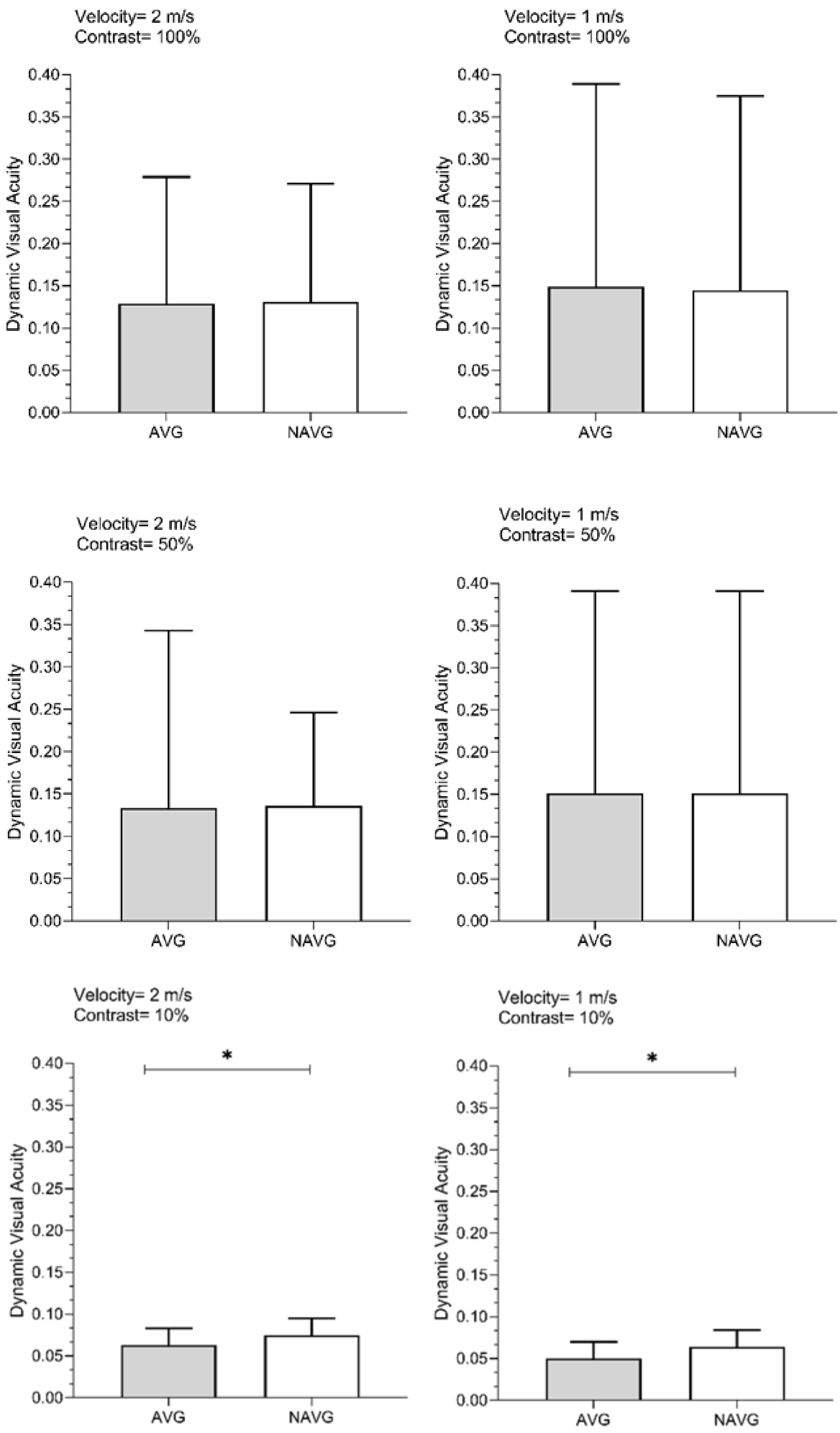

Figure 2. Bar plots with standard deviation (SD) in every measurement of the dynamic visual acuity (DVA) between AVG and NAVG. Velocity and contrast of the stimulus used to measure DVA are shown in every plot.

DISCUSSION

The mean objective of this study was to determine the effect of playing action videogames in de DVA. To our knowledge, this visual ability has been never investigated so far. We did not find a statistical significative difference in the performance of DVA measurement for velocities of 2 m/s and 1 m/s in two different contrast (100% and 50%). We did find a statistical difference using the 10% of contrast in 2 m/s, *P*=0.02 and 1 m/s, *P*=.031, but the mean difference was not clinically significant as the DVA measurements was in Decimal scale. Mean DVA difference between groups for 2 m/s and 10% were 0.012, and 0.014 for 1 m/s and 10% contrast. This unexpected result is in contrast with some studies which show AVG improves the contrast sensitivity function (CSF), especially in intermediate and higher spatial frequencies (40,41). This unexpected result may be due to the fact that in this investigation it has been taken in consideration the sport history of each participant as an independent variable. Some previous investigations have been shown that specific sports, especially those using fast-velocity balls, have an influence in DVA measurements (22,23,24,25,33-38). This study used 2m/s and 1 m/s (1º/s and 0,5º/s) to evaluate DVA. During research on DVA, it has been shown that this function is reduced as the speed of stimulus displacement increases, and that, depending on the experimental methods and conditions, the limiting speed of acuity deterioration varies.

In a study of the evaluation of dynamic visual acuity and the stability of its measurements they found a significant interaction between velocity and contrast (*p<0,043*) (41). It has been seen that the contrast variable is directly proportional to the DVA value, since the higher contrast, the higher DVA obtained. On the other hand, there is also an inverse relation that shows that as the velocity increases, the DVA decreases. DVA measurements in this study follows this rule.

Compared with our study, where we used a much higher speed value, it is consistent with the fact of obtaining DVA improvement at lower speed. In contrast, we also find that the highest DVA value is obtained at maximum contrast (100%) and decreases at minimum contrast (10%) (**Table 1**).

Focusing on the effect in the visual system, it has been seen that action video games generate an improvement in spatial and temporal resolution (29), probably due to the characteristics of the game itself, which are related to the ability to ignore distractions, processing speed, peripheral processing control, tracking of moving stimuli, among others, all of which are modified when playing (7,16, 31, 38).

It is seen that there is an increase in the precise visual-motor control due to the need to point to small moving objects, and in addition to this, a better attentional recovery time is achieved. That is to say that improvements are obtained mainly in aspects of visual attention and visual processing. Actual research it is focused on the possible use of action video games as visual rehabilitation in cases of visual processing deficits because of CNS problems such as amblyopia (11,15,43).

It should be considered that in our study we do not have a statistically ideal sample (N<60), and in addition, we excluded from the sample those participants who play a federated sport more than 5 hours per week, a fact that may have influenced the results, comparing to other similar studies. On the other hand, the type of device on which the participants play (PC/TV screen or mobile phone) was also not considered and may has an influence in it. Another interesting point is that there is a heterogeneity between every video game and considering a group of AVG which could play a wide range of videogames, with distinct perceptive and cognitive domains, could affect the results. (30). This hypothesis needs future studies to confirm if DVA is different between each video game.

CONCLUSIONS

It seems, based on these results, that DVA is not affected by AVG and NAVG player's experience. This study took account the professional sport's experience from all the participants and seems important to control this variable when measuring DVA. Future studies evaluating DVA with more participants and comparing with another level of experience in videogames (eSports) or different videogames could be interesting.

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