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Influence of sports practice in the useful field of vision in a simulated driving test

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Introduction

Is it possible that team sport athletes can transfer some visual search strategies, such as the "anchor-strategy", consisting of fixating our staring between two events/objects, in order to capture, without eye/head movements, relevant information of both (e.g., Bard & Fleury [9]; Beek [10]; Kato & Fukuda [11])?

Is it possible that a systematic practice of a very perceptual demanding activity, like "invasion" team sports, can facilitate the learning of another equally demanding activity, like driving, profiting from some sort of positive transfer?

Recently, some researchers (Kane et al. [7]; Hancock et al.[8]) concluded that there was an evident transfer from sport engagement to some features of driving, namely at a *tactical* level.

If that is true, could there be any advantage, beside others, of a systematic practice of sport activities in driving?

Literature review

Accident involvement

It is known that there is a very high rate of accident involvement in the early years of driving (e.g., McKnight & McKnight [12, 13]). It may occur because beginner drivers overestimate their capabilities (e.g., Gregersen [14]) and because of their lack of experience (e.g., Gregersen et al. [15]). Underwood et al. [16] state that novice drivers make a limited visual search of the involvement, as compared to expert ones. McKnight and McKnight [13] showed that the great majority of the non-fatal accidents, involving drivers aged 16 to 19 years old, are due to attention and visual search errors, non-adequate speed according to conditions, poor hazard and danger recognising, and emergency manoeuvres. They also state that high (in absolute terms) speed and risky behaviours had little significance. Rolls & Ingham, cit. in Underwood et al. [17], say that 20% of the 17 to 20 years old drivers are responsible for one accident per year, while that rate is of only 4,5% in drivers aged 31 to 40 years old, a situation that may be due to driving inexperience.

Transfer between sports practice and driving

If there is a relationship between prior practice of sports, specially team ones, and ability to drive, then it could offer an opportunity to reduce the risk of accident involvement in those early driving years, despite other factors such as, for instance, willing of taking risky behaviours.

According to our idea of similarity between team sports and driving, namely on perceptual and decision-making aspects, we hypothesized the existence of a *far transfer* (Schmidt [18]) between both activities.

We will focus our analysis on the possible transfer of peripheral vision attributes, namely the so-called UFOV - Useful Field of Vision. According to several researchers (Wood & Troutbeck [20]; Rizzo et al. [21]; Goode et al. [22]; West et al. [23]; Roth et al. [24]), the UFOV Test (Ball & Owsley [19]) is a very good predictor of the risk of being involved in driving accidents. Literature gives us several examples of better peripheral vision of people engaged in sports, as compared to those who are not (e.g., Cockerill [4]; Williams & Thirer, cit. in Davids [5]): would that be reflected in the results of the UFOV test and in our perceptual *driving* test?

Visual information processing

Is it possible that team sport athletes can transfer some visual search strategies, such as the “anchor-strategy”, consisting of fixating our staring between two events/objects, in order to capture, without eye/head movements, relevant information of both (e.g., Bard & Fleury [9]; Beek [10]; Kato & Fukuda [11])?

Rumar [25] states that late detection is one of the most referred causes by drivers to justify the accidents in which they got involved, a situation that might reflect some difficulty with their perceptual thresholds.

Sekuler et al. [26] concluded that the deterioration of the UFOV may begin as early as 20 years old, or even before that; we reinforce the idea that this deterioration is not a physiological straightening of the visual field but, otherwise, as Langham et al. [27] concluded, shrinkage due to cognitive and perceptual reasons, such as attention fails. Sekuler et al. [26] added that this problem is accentuated when the driving conditions require division of attention by central and peripheral tasks, aspects that are perfectly common to driving and team sports.

Crundall et al. [28] found that the more experienced drivers had bigger peripheral visual fields, expressed in the detection of more potential hazards. Ball & Owsley [19] stated that the peripheral vision seems to play a fundamental role in driving. Hughes & Land [29] found a quick change in the visual search strategies in novice drivers with increasing driving experience, enlarging their visual field of searching and changing the priority areas of fixation. Herslund & Jorgensen [30], referring to central and peripheral vision, state that when the fovea primary task is very demanding, there can be problems in the peripheral processing, such as in detecting walkers and cycling persons; they also refer that, when people are more experienced, they change their visual strategy and begin to look further in the traffic. This situation may imply consuming more time to detect nearer events!

Roenker et al. [31] found that elderly people can enhance their UFOV. Miura (cit. in Underwood et al., [17]) said that under stressing conditions, novices are less able to detect peripheral targets.

Method

Subjects

Our sample consisted of thirty young adult women who had no driving experience, ten elite basketball players (*m*=17,26 years, *sd*=0,96), ten no sport practitioners (m=19,11 years, *sd*=1,22) and ten elite swimming practioners (m=16,72 years, sd=1,47). The basketball players and the swimmers had, at least, three years sport experience

The subjects considered themselves in good health, had normal vision and were not wearing glasses or optical lenses. We used a simple procedure to ensure that the visual field of the subjects was large enough to detect our peripheral stimulus, without the additional load of a central task. They were told to focus on a point (finger of the investigator) in front of them, while following another finger of the investigator; all of them were able to see the finger at least until the left mirror eccentricity.

Devices and variables

The tests took place at the Motor Learning Laboratory of the Faculty of Human Movement. The subjects had to perform two different tasks, a simulated driving visual perception task and the UFOV test.

Simulated driving visual perception task

This task (Figure1) required the subject to detect central and peripheral stimulus. The central stimuli were the lightening of the (rear) brake lights of a black Rover 25, appearing randomly in time. This car, performing these brakes, was videotaped at the A8 Portuguese highway, in a period of low traffic (10 o'clock a.m., Saturday). The camera, Canon XL1, was fixed at the rear seat of a Clio. Both cars were driven at a speed of approximately 90 km/h. The Rover driver performed the braking actions randomly.

This videotaped ten minutes' movie was projected by a Sony DHR 1000 NP DV video projector, onto a screen located three meters and a half from the subject, covering thirty-four degrees of the horizontal and twenty-three of the vertical of his visual field.

The video projector stood four meters away from the screen, projecting horizontal rear images, since the subject was at the other side of the screen. This prevented the subject to project any shadow, namely with his head.

The images were twenty-eight degrees wide and seventeen high, from the subject perspective. The size of the projection was one meter and ninety-one centimetres wide and one meter and forty-five high. The projected size of the car, which varied slightly upon the distance between both cars, was of about thirty-seven centimetres, corresponding to six degrees, wide, and thirty-one centimetres high, corresponding to five degrees. The rear brake lights occupied, each, about half a degree of the subject visual field. These two lights were about thirty-one centimetres apart from each other and were projected ninety-four centimetres above the laboratory floor.

The minimum gap time between two of the eighty-three central stimuli was 3.05s, and the maximum 13.84s, with a mean value of 7.19s.

The peripheral stimuli consisted of cars which appeared at a situation that resembled an overtaking. These were seen at a fifty-five cm Philips television, located about seventy centimetres from the left eye of the subjects, at a horizontal visual angle of about forty-five degrees to the left of the central stimuli.

The vertical angle between eyes height and the rear mirror position was about ten degrees, for a person 175 cm tall.

The images that passed on this television monitor were videotaped in the same highway, with the camera focusing the external left mirror. We obtained a ten minutes' movie, with the presentation of ninety-two random stimuli. The minimum gap time between two of them was 3.24s, and the maximum 13.80s, with a mean value of 6.45s.

With a Sony RM-E700 video linear edition controller, we collected the time codes of the moments in which we could begin to see the incoming cars in the mirror, coming from its far right side.

As other stimuli could be seen in the tape, and in order to prevent some difficulties in identifying just one, we digitally made a black mask surrounding the mirror, so that, when the subjects watched the tape, the entire TV monitor, except for an area of the size of a common external rear mirror, was dark.

This mirror, on the TV monitor, was fifteen cm (eleven degrees) wide and ten cm (four degrees) high, with the biggest car stimulus, according to proximity when overtaking the investigator car, twelve cm (nine degrees) wide.

The testing room was lighted by a halogen lamp, so that, at about the subjects' eyes level, there was a illumination of about twenty-five lux.

Figure 1. Partial aspect of the devices used in the simulated driving visual perception task

UFOV Test

The UFOV Test (Ball and Owsley [19] is a computer-administered and computer-scored test of functional vision and visual attention, which can be predictive of the ability to perform many everyday activities, such as driving a vehicle.

This test (Figure 2) consists of three subtests or parts, which assess speed of visual processing under increasingly complex task demands. Subjects had to detect, identify (central stimuli) and localize (peripheral stimuli) briefly presented targets. In the first subtest, the subject identifies a target (car or truck) presented in a centrally located fixation box which is presented for varying lengths of time. In the second subtest, the subject identifies a central target (car or truck) but must also localize a simultaneously presented target displayed on the periphery (at about thirteen degrees of eccentricity from the central ones, at a distance of fifty-two cm from the monitor. The third subtest is identical to the second one, except that the peripheral target is embedded in distractors (forty-seven white triangles), which makes the subjects' task more difficult.

To ensure that all subjects had their eyes at about the same distance (fifty-two cm) from the seventeen inches computer-monitor, we improvised a chin-rest, consisting of a sponge disk located at the top of a video-camera tripod..

The testing room for this test was somehow darkened, with an illuminance of about eight lux at the subject's eyes level.

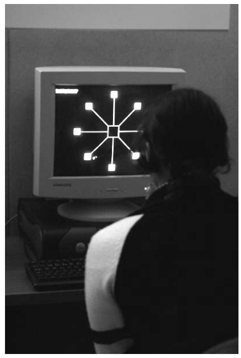


Figure 2. Partial aspect of the devices used in the UFOV test

Procedures

Simulated driving visual perception task

Subjects sat on a chair and had to react to stimuli. In front of them they had a wheel and two foot pads. When they detected a peripheral stimulus (car at the left external mirror) they had to press, with their left thumb, a button, stacked with Velcro to the wheel, at its *nine o'clock position*. This button, consisting of a pressure sensor device, when depressed displayed a yellow light at another device. When they detected a central stimulus (rear brake lightening) they had to release, as quickly as possible, the accelerator pad, pressed with their right foot, turning off, by doing this, a green light that was normally present by that pressure; after this, they tried to press the brake foot pad, turning on a red light.

We made a change on the accelerator pad, by preventing it from being pushed down, so that when subjects released it, there was an immediate sign (green light off), assuming that it was quite close to their reaction time. As the entire task was videotaped, we could see the direction of the subjects' gaze all the time, as well as the road and mirror scenes, by installing a mirror in front of the subject.

They underwent a two-minutes training session with fifteen central and peripheral stimuli to ensure that they understood the task and did not confuse the actions they had to perform (hand to peripheral, foot to central stimuli).

After this training period, the investigators switched on the video camera, the Acqnowledge software, and, after this, activated the central and peripheral movies, by, respectively, releasing the *pause* and pressing the *play* video buttons. Since we had a switch sensor attached to each of these buttons, we could insert an input to the software, so that we could know where, in the software, we had the *zero* moments of the two movies, to allow us to determine the subject's reaction times.

After ten minutes of projection, both movies finished, thus signaling the end of the task.

UFOV Test

Subjects sat on a chair, while the investigator displayed the UFOV test, along with an explanation of its functioning. The administration of the whole test took about fifteen minutes.

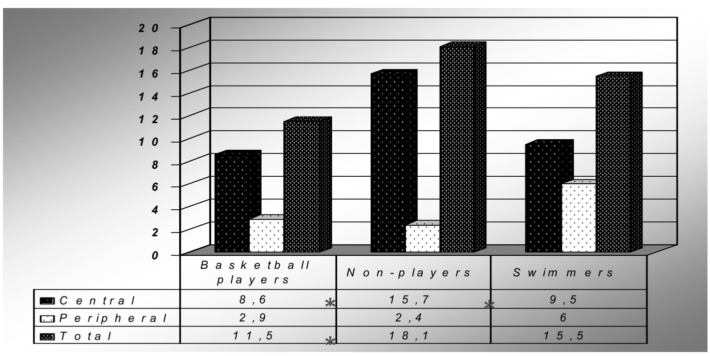
Results

To compare the results of the three groups (basketball women players and non-players) we used the non-parametric Kruskal-Wallis and Mann-Whitney tests, defining the level of significance at .05.

Simulated driving visual perception task

Non-detected stimuli

Figure 3 shows that basketball players and swimmers missed significantly less central stimuli than non-players. Basketball players also missed significantly less total stimuli.



***** Significant differences (p=0,05)

Figure 3. Mean numbers of central, peripheral and total stimuli not detected, (in a maximum of 175, being 83 central and 92 peripheral), in basketball players, swimmers and non-players.

UFOV Test

The data from subtests one (Processing speed), two (Divided attention), and three (Selective attention) revealed no significant differences between basketball players, swimmers and non-players, despite the better results of the first group, as shown in Table 1 (less ms represent better results).

Table 1. UFOV test mean results (ms), in basketball players, swimmers and non-players

	Subtest1	Subtest2	Subtest 3	Sum
• Basketball players	17.7	25,7	89.7	133
• Swimmers	18	62,7	97,3	178
• Non-players	18.04	33.0	91.01	142.1

Conclusion

In general terms we can say that the basketball women players studied exceeded the non-players and the swimmers in the simulated driving visual perception task, since they missed significantly less stimuli. This was particularly true for the (non) detection of the central stimuli. Non-players, despite instructions, mostly made the option of staring at the rear mirror, since it seemed to be the most difficult of the two tasks; by doing this, they missed much more central stimuli.

These results confirm, e.g., Cockerill [4] and Hancock et al. [8] findings.

The non-existence of significant differences between the 3 experimental groups, in the UFOV test, may have happened because eccentricities, at which peripherally stimuli appear, in this test, at about 13 degrees, are too narrow for group discrimination. The UFOV test is specially designed for older people.

In future works we intend to compare peripheral vision of players of different levels of expertise in team sports, to develop a peripheral vision enhancement program, to see if it works with people who have no sport experience, and to compare these same groups (team sports, individual sports and no-sports) in a driving simulator test, specially their capability in hazards detection.

References

[1] Helsen, W., and Pauwels, J. (1993), 'The relationship between expertise and visual information processing in sport', in J. L. Starkes, & F. Allard (Eds.) (Ed.), Cognitive issues in motor expertise (pp. 109-134). Amsterdam: North-Holland.

[2] Huys, R., and Beek, P. J. (2002), 'The coupling between point-of-gaze and ball movements in three-ball cascade juggling: the effects of expertise, pattern and tempo', Journal of Sports Sciences, 20(3), 171-186.
[3] Kioumourtzoglou, E., Kourtessis, T., Michalopoulou, M., and Derri, V. (1998), 'Differences in several perceptual abilities between experts and novices in basketball, volleyball and water-polo', Perceptual and Motor Skills, 86(3 Pt 1), 899-912.
[4] Cockerill, I. (1981), 'Peripheral vision and hockey', in I. Cockerill, and W. Gillivary (Eds.), Vision and Sport (pp. 54-63). Cheltenham, London: Stanley Thornes Publishers Ltd.
[5] Davids, K. (1984), 'The Role of Peripheral Vision in Ball Games: Some Theoretical and Practical Notions', Physical Education Review, 7(1), 26-40.
[6] Ando, S., Kida, N., and Oda, S. (2001), 'Central and peripheral visual reaction time of soccer players and nonathletes', Perceptual and Motor Skills, 92(3 Pt 1), 786-794.
[7] Kane, M., Pearce, K., Hancock, P., Scallen, S. and Heniff, C. (1999), Investigating differences in driver accident involvement: the influence of perceptual motor competence, competitive athletics, and gender. Minneapolis: Tucker Center for Research on Girls and Women in Sport, & University of Minnesota.
[8] Hancock, P., Kane, M., Scallen, S. and Albinson, C. (2002), 'Effects of gender and athletic participation on driving capability', International Journal of Occupational Saf Ergon., 8(2), 281-292.
[9] Bard, C. and Fleury, M. (1976), 'Analysis of Visual Search Activity During Sport Problem Situations', Journal of Human Movement Studies. 3, 214-222.
[10] Beek, P. J. (1989), Juggling Dynamics. Amsterdam: Free University Press.
[11] Kato, T. and Fukuda, T. (2002), 'Visual search strategies of baseball batters: eye movements during the preparatory phase of batting', Perceptual and Motor Skills, 94(2), 380-386.
[12] McKnight, A. J. and McKnight, A. S. (2000), 'The behavioral contributors to highway crashes of youthful drivers.' Annual Proceedings of the Association for the Advancement of Automotive Medicine 44: 321-333.
[13] McKnight, A. J. and McKnight, A. S. (2003), Young novice drivers: careless or clueless? Accident Analysis and Prevention, 35(6), 921-925.
[14] Gregersen, N. P. (1996), 'Young drivers' overestimation of their own skill – an experiment on the relation between training strategy and skill', Accident Analysis and Prevention, 28(2), 243-250.
[15] Gregersen, N. P., Berg, H., Engstrom, I., Nolén, S., Nyberg, A., and Rimmo, P. (2000), 'Sixteen years age limit for learner drivers in Sweden – an evaluation of safety effects', Accident Analysis and Prevention, 32, 25-35.
[16] Underwood, G., Crundall, D. and Chapman, P. (2002), 'Selective searching while driving: the role of experience in hazard detection and general surveillance', Ergonomics, 45(1), 1-12.
[17] Underwood, G., Chapman, P., Brocklehurst, N., Underwood, J. and Crundall, D. (2003), 'Visual attention while driving: sequences of eyes fixations made by experienced and novice drivers', Ergonomics, 46(6), 629-646.
[18] Schmidt, R. A. (1991), Motor Learning and Performance - from principles to practice. Champaign, Illinois: Human Kinetics.
[19] Ball, K. and Owsley, C. (1993), 'The useful field of view test: A new technique for evaluating age-related declines in visual function', Journal of the American Optometric Association, 64, 71-79.
[20] Wood, J. M. and Troutbeck, R. (1995), 'Elderly drivers and simulated visual impairment', Optometry and Vision Science, 72, 115-124.
[21] Rizzo, M., Reinach, S., McGehee, D. and Dawson, J. (1997), 'Simulated car crashes and crash predictors in drivers with Alzheimer disease', Archives of Neurology, 54, 545-551.
[22] Goode, K., Ball, K., Sloane, M., Roenker, D., Roth, D., Myers, R., and Owsley, C. (1998), 'Useful field of view and other neurocognitive indicators of crash risk in older adults', Journal of Clinical Psychology in Medical Settings, 5, 425-440.
[23] West, C. G., Gildengorin, G., Haegerstrom-Portnoy, G., Lott, L. A., Schneck, M. E. and Brabyn, J. A. (2003),'Vision and driving self-restriction in older adults', Journal of American Geriatric Society, 51(10), 1348-1355.

[24] Roth, D., Goode, K., Clay, O. and Ball, K. (2003), 'Association of physical activity and visual attention in older adults', Journal of Aging Health, 15(3), 534-547.
[25] Rumar, K. (1990), 'The basic driver error: late detection', Ergonomics, 33(10-11), 1281-1290.
[26] Sekuler, A., Bennett, P. and Mamelak, M. (2000), 'Effects of aging on the useful field of view', Experimental Aging Research, 26(2), 103-120.
[27] Langham, M., Hole, G., Edwards, J. and O´Neil, C. (2002), 'An analyses of "looked but failed to see" accidents involving parked police vehicles', Ergonomics, 45(3), 167-185.
[28] Crundall, D., Underwood, G. and Chapman, P. (1999), 'Driving experience and the functional field of view', Perception, 28(9), 1075-1087.
[29] Hughes, C., and Land, M. (2002), 'The development of eye-movement and fixation patterns in learner drivers', Perception, 31(Supplement), 181.
[30] Herslund, M. and Jorgensen, N. (2003), 'Looked-but-failed-to-see-errors in Traffic', Accident Analysis and Prevention, 35(6), 885-891.
[31] Roenker, D., Cissell, G., Ball, K., Wadley, V. and Edwards, J. (2003),'Speed-of-processing and driving simulator training result in improved driving performance', Human Factors, 45(2), 218-233.