Journal of Physical Education and Sport ® (JPES),Vol 21 (Supplement issue 1), Art 85 pp 696 – 701, Feb.2021
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Starting a sport as outdoor education in infancy: orienteering, visual spatial memory for empowering school learning

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Published online: February 28, 2021
(Accepted for publication February 22, 2021)
DOI:10.7752/jpes.2021.s1085

Abstract
Description of the problem and aims. This study aims at investigating the relationship between an Orienteering training program and the enhancement of short-term visuo-spatial memory in a school setting. The hypothesis is based on the idea that there is a relationship between motor learning stimulated by the practice of Orienteering in an outdoor area and visuo-spatial working memory. Several studies have already highlighted the relationship between active motor play in school-aged children and cognitive development (Truelove et ali. 2017). The ability to map and plan is already present in the first year of life of a child and it will influence the cognitive-motor organization of the adult individual (Halliday et al. 2018). Orienteering stimulates and improves memory skills and motivation (Etnier& Chang, 2009; Prakash et ali., 2015). Orienteering had already been shown to enhance learning processes (Notarnicola et ali., 2012) all the more stimulated by the outdoor environment (Acar and wings., 2015). Methodology :Two groups were examined: an experimental group, that attended orienteering lessons for 16 weeks, and a control group that, instead, performed indoor exercises such as jogging and gymnastics. The Corsi block-tapping tasks, in both the forward and backward response modalities, as well as the Star-Butterfly test were used for both groups, each consisting of 20 children. Results In the experimental group, the scores in the Forward and Backward Corsi block -tapping tasks significantly increased from pre to post-test, compared to the control group; in the Star-Butterfly Test both time and mistakes decreased. Instead, in the control group, the Star-Butterfly scores remained unchanged from pre to post tests. Conclusions The study confirmed that a training period based on orienteering could improve the visuo- spatial working memory in the experimental sample group by enhancing the ability to recall short-term memory spans more accurately than before training. Instead, these skills remained unchanged in the control group.
Keywords: motor skills, spatial orientation, cognitive functions, attention, short-term memory.

Introduction

The purpose of this study is to monitor and identify the enhancement of the executive functions in a school setting, by stimulating orientation and spatial representation abilities in an outdoor environment. The hypothesis is based on the idea that there is a relationship between the motor learning stimulated by the practice of Orienteering and the visuo -spatial memory useful in the processes of reading and writing. Our aim is to analyse the relationship between active motor play in school-aged children and cognitive development in line with recent studies (Truelove et al. 2017). The ability to map and plan that is already present in the first year of life of a child, has a deep influence on play activities and it will influence the cognitive-motor organization of the adult individual (Halliday et al. 2018; Fumagalli et ali. 2020). Orienteering stimulates and improves memory abilities and motivation (Etnier& Chang, 2009; Prakash et al., 2015; Notarnicola et ali., 2012). This mapping and planning ability is developed in the first year of life and will influence the organization of the individual's future (Hazen &Durett, 1982). Orienteering enhances the mental processes that are activated when the subject realizes that there is a discrepancy between the "model present on a map" and "what we see in front of us" (Crampton, 1988). The first step in finding a solution is to become aware of the mistake. So the mental processes enabling the person to formulate a strategy and try to solve the problem, will be activated; this activity will call into play cognitive abilities, memories and previous experiences along with personal motivations (Russo et ali. 2019; Spiers & Maguire, 2008). Individual differences are very important to explain the different ways people can orient themselves in space: gender, past experiences, mathematical skills and ability to use maps are all predictors of "wayfinding" performance (Malinowski & Gillespie, 2001). Tasks can be improved by practice and training (Baenninger& Newcombe, 1989); this has broad implications for education (Invernizzi et ali., 2020). Some researchers (Bethell-Fox & Shepard, 1988) have showed that practice leads people to make fundamental changes in how they process spatial stimuli, enabling them to adapt to new stimuli and tasks .

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Previous studies showed that training in motor activity could develop and improve spatial skills when based on initial visual coding of stimuli (Notarnicola et ali., 2012)by rotating an object (typically in congruence with another), by comparing the objects to decide whether they are the same or different and finally responding. In order to practice various sports successfully, it is crucial to develop these multilateral skills (Mann et ali., 2007; Fischetti & Greco, 2017).

The purpose of this study is to assess any improvement in the experimental group that took part to the orienteering training, as well as to monitor the effects of this sport on children. It has already been showed that Orienteering improves spatial cognitive abilities in adult athletes (Guzmán et ali., 2008). The experimental group practicing orienteering, was compared to the control group practicing jogging and other activities with closed skills; as it is reported in the literature these latter activities require the involvement of physical rather than mental skills (Siddiqui et ali., 2010; Fischetti et ali., 2019).

Materials and Methods

A randomized longitudinal pre-test and post-test study was conducted in an elementary school, from October to March, for 24 weeks. Parents provided informed written consent for the participation of children. The children were divided into two groups, each consisting of 20 children 10 boys, 10 girls (M age = 9 years, SD = 0.7, interval = 8-10) The participants were randomly divided into two groups (experimental and control groups), and stratified by gender (male/female) and age (8 and 9 years, > 9 to 10 years). The research program was conducted in the green park adjacent to the school. The two groups attended the lessons for 6 months, three times a week for a total of 72 lessons, following the teaching programs offered in literature (Drury & Bonney, 2005).

For the experimental orienteering group (M age = 9 years, SD = 0.7), various activities were proposed, starting with brief theoretical explanations. The group was involved in fieldwork to learn how to use maps and interpret map contours. Through orienteering specific exercises focused on memory training were proposed such as running while reading a story and then asking participants to summarize the story at the end of the activity.
Instead the children of the control group (M age = 9 years, SD = 0.7) did not attend orienteering lessons as they followed an indoor-exercise course based on jogging and gymnastics. Three assessment tests of the span of visuo-spatial memory were administered to both groups: the Forward and Backward Corsi tasks and the Star-Butterfly test (Kessels et ali., 2000), validated in literature (Piccardi et al., 2008; Furley&Memmert, 2010). The Block-tapping Test was described by Corsi as a non-verbal test. The test material consists of nine black blocks (cubes) irregularly distributed and permanently fixed on a black board, as shown in Fig. 1.

The Corsi Block-tapping Tests, Forward and Backward, provide a method for measuring the duration of visuo-spatial memory, that is, the amount of information that the participant is able to store in the short-term working memory. In a given process, the examiner touches some of the blocks in a particular sequence and the participant is required to choose exactly the same sequence immediately afterwards. The first step is to determine the maximum number of blocks that the participant is able to touch in the correct order. The administration procedure requires the examiner to touch the blocks with a rod at a rate of one per second; the movement of the hand guiding the rod must be sequential; in other words, the examiner must pass from one block to another, in accordance with the timing of the submission. At the end of the series, the participant shall point one finger at the same blocks in sequence, repeating in exactly the same order as the sequence indicated by the examiner for the forward test and in the reverse order for the reverse test. The test is organized at different levels of complexity which increase with the number of blocks used.

The test was started at level 3 so the first sequence consisted of sequences of three blocks, and if the participant was successful with this, another sequence was added each time. The correct repetition of two out of three sequences in the same session allowed the transition to the next session, while the test was interrupted after two mistakes in the same session.

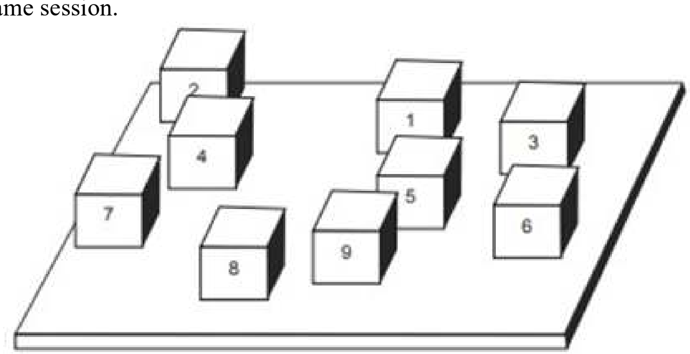

Fig. 1. Corsi test: sketch showing the approximate position of the nine black blocks (1.25-in. cubes) on a black board (8 × 10 in.). The blocks are numbered on the examiner's side for ease of recording, but the participant cannot see the numbers.

The Star-Butterfly test is instead a working memory exercise that requires the child to complete a path without the aid of a map. In practice, the child must read the map at the start of the course, memorize and repeat the operation for the second control point. The first points indicated in the test route must be searched for one at a time, while the last points of the test route must be memorised so that the child can search for them all together without going back to the start. The time needed to complete the path is expressed in seconds, and any mistakes made are also recorded. This exercise was not used in orienteering lessons. All tests described above were administered to all participants from the time of recruitment (pre-test) and after 6 months. (post-test). The results were expressed as means , standard deviations. The Student's t test for independent samples was used for pre- and post- test comparisons within the groups. The Chi-squared test was used for the comparison of the proportion of mistakes reported in the Star-Butterfly test The statistical significance was set at p.0.05.

Results

For the Forward and Backward Corsi tests, the pre-test scores of the experimental and control groups (level of complexity) were not statistically significantly different (Table 1).means , standard deviations. The Student's t test for independent samples was used for pre- and post- test comparisons within the groups. The Chi-squared test was used for the comparison of the proportion of mistakes reported in the Star-Butterfly test The statistical significance was set at p.0.05. complexity) were not statistically significantly different (Table 1)

TABLE 1

MEANS, STANDARD DEVIATIONS, AND RANGES OF TEST SCORES AT PRE- AND POST-TEST FOR THE EXPERIMENTAL AND CONTROL GROUPS, WITH STUDENT *t* TEST COMPARISONS

Test	Experimental Group ($n=20$)		Control Group ($n=20$)		t	p	Cohen's d
	M	SD	M	SD			
Pre-test							
Corsi test							
Forward	4.50	0.94	4.30	0.95	0.34	.73	0.21
Range	3–6		3–6				
Backward	4.30	0.73	4.35	0.81	0.20	.84	−0.06
Range	3–6		3–6				
Star-Butterfly Test							
Time	112.85	4.75	113.15	4.51	0.20	.84	−0.06
Range	103–125		105–126				
Post-test							
Corsi test							
Forward	5.15	0.99	4.55	0.83	2.00	.04	0.66
Range	4–7		3–6				
Backward	4.9	0.72	4.4	0.75	2.15	.04	0.68
Range	4–7		3–6				
Star-Butterfly Test							
Time	106.85	4.93	113.95	3.98	5.00	.001	−1.58
Range	98–118		102–121				

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On the Star-Butterfly test, the two groups' times and mistakes were not statistically different at pre-test (Tables 1 and 2). At post-test, groups' scores on the Forward and Backward Corsi Tasks, as well as on the Star-Butterfly test, were statistically significant(Table 1). The level of complexity in the Corsitest was higher within the experimental group. The time to complete the Star-Butterfly test was lower in the experimental group, and this group also made fewer mistakes. At the post -test, the experimental group achieved statistically significant results and better scores for all three tests compared to pre-test scores.

TABLE 2

MISTAKES IN STAR-BUTTERFLY TEST, AT PRE- AND POST-TEST FOR EXPERIMENTAL AND CONTROL GROUPS, WITH CHI-SQUARED COMPARISONS BETWEEN AND WITHIN GROUPS

	Experimental Group ($n=20$)	Control Group ($n=20$)	χ^2	p
Pre-test	4	4	0.00	1.00
Post-test	0	3	3.53	0.10
χ^2	5.00	0.22		
p	.04	.5		

No statistically significant difference was observed in the control group between the scores obtained before and after the test for none of the three tests (Table 3, p > 0. 05).

TABLE 3
COMPARISON OF CORSI AND STAR-BUTTERFLY TESTS PRE- AND POST-TEST, IN EXPERIMENTAL AND CONTROL GROUPS

Test	t	p	Cohen's d
Experimental group			
Corsi test Forward	1.50	0.14	−0.67
Corsi test Backward	1.80	0.08	−0.82
Star-Butterfly Test	2.77	0.01	1.23
Control group			
Corsi test Forward	0.62	0.53	−0.28
Corsi test Backward	0.14	0.88	−0.06
Star-Butterfly Test	0.42	0.67	−0.18

Discussion

In many sports, the development of spatial orientation skills is influenced by the situation at play (Mann et ali., 2007). This is the basis of the tactical action, defined as a technical action carried out in space at the right time and with the right links (Vaeyens et ali., 2007). Moreover the perception of time is influenced by the characteristics of the available space. Some researchers believe that athletes possess superior visual systems that allow them to recognize information better than their peers (Vaeyens et ali. 2007). Other authors argue that elite athletes are able to use available information more efficiently and effectively than novices (Kibele, 2006). Depending on the features of stability and predictability of the environment, sports activities are classified as open- or closed- skill type (Brady, 1995). In sports of open- skill type, the environment is variable and unpredictable. The athlete generally needs to be able to react to changing circumstances and, for this reason, the skill required is described as the ability to adapt to external events (Fontani et ali., 2006; Sgrò et ali. 2020). Typical examples are sports based on technical movements constantly modified and adapted to changing environmental requirements although influenced by the teaching strategies of the teacher (Sgrò, F. et al., 2020). In contrast, in closed -skill sports, movement is performed in a stable or largely predictable manner (Spittle & Morris, 2007; D'elia et ali. 2019).

Moreover, movement patterns can be planned in advance and automatic processing is so fast that it occurs beyond the conscious control of the athlete (Spittle & Morris, 2007). Orienteering combines automatic athletic and analytical skills. It requires information of various kinds that often undergoes rapid changes to be selected and collected in order to make a decision. The studies published up to now have focused mainly on the analysis of the differences among physical properties in those practicing orienteering, in order to monitor the variables related to the type of athletic training. However, only recently research has showed that orienteers could acquire a better mental representation of space (Guzmán, et al., 2008). Since orienteering is a sports discipline of open skill type, the ability to choose the fastest or most convenient route for getting from one point to another and achieving a goal plays is essential to win. Which route is more convenient needs to be assessed each time on the basis of some elements such as: the specific environmental situation (obstacles, inaccessible areas, slopes) and individual or group resources. The psychological skills required in orienteering include the abilities to read a map correctly and to plan and make rapid decisions, summarized as wayfinding, while the qualities required include concentration, perseverance and fatigue endurance. The Jogging and gymnastics used in the control group, are closed skill sports that involve taking up a slow, pleasant running pace along a chosen distance; varying rhythms can be adopted (Williams et al., 2000). The main goal of this sport is to increase the athlete's muscle tone but without the stress of true running, which is much faster. It is usually carried out in public parks, but can be done in all types of terrain. Jogging has become very popular because this aerobic exercise is good for the heart and lungs and can be practiced by anyone who is in a good state of health(Siddiqui, et al., 2010).

The first end-point of the present study was to assess whether practicing sport can improve the cognitive abilities of young people. In a previous meta-analysis of exercise and cognition in children, Sibley and Etnier (2003) found evidence that physical activity resulted in improvements in cognitive performance, with effect sizes higher in children than in adults and even higher during middle school years. The results of our study, obtained with the two - way Corsi test and the Star-Butterfly Test, show that after a beginner's training course, the children of the orienteering group were able to remember and repeat sequences of events with greater accuracy than before starting the training, at pre-test. Instead, in the control group that did jogging, and activities with closed skills, no significant differences emerged in the comparison between pre-test and post-test scores for the three tests after their training course. The absence of statistically significant improvement in the control group is consistent with the evidence that in motor activities with closed skills, complex cognitive processes such as rapid information intake, decision-making processes, and interpersonal interactions are largely absent (Tenenbaum, 2003).It has already been reported that different types of physical activity may have different influences on cognitive performance in children (Sibley &Etnier, 2003). The current results are explained by the different types of cognitive-motor demands in the two types of sports, emphasizing the importance of selecting uitable sports activities for children depending on the results to be obtained.

Conclusions

The results of our study have been quite encouraging as our hypothesis has been supported by evidence. Nevertheless there are some limitations : first of all the low number of samples used, although many studies on exercise and cognition in a school setting are often characterized by a low methodological rigour in controlling and describing the intensity of exercise interventions (Tomporowski, 2003; Schembri et ali. 2019). With a larger sample it would be possible to recruit children of different ages and thus verify the influence of Orienteering training courses at different stages of psycho-physical development.

Moreover, long-term follow-up could demonstrate whether the acquired skills are maintained and even further developed over time by keeping on training. Future work could examine the best timing and duration of orienteering training during childhood that could enable children to acquire critical spatial orientation, visual memory skills and maintain them in adulthood. In conclusion, physical activity has been linked to mental well-being based on improved cognitive ability. In this work, the study hypothesis was that practicing orienteering, in open spaces, during childhood could improve the cognitive skills of mental representation of space and short-term memory. The results show that by constantly stimulating visuo-spatial memory, orienteering sport is highly important as a means of optimizing the overall development of the individual. For this reason, it could be beneficially included in primary school curricula and would provide several stimuli that could further enrich school experience. Therefore, Orienteering is not only a play and a sporting activity, but also an inter-disciplinary activity and mental training that may serve to restore a better relationship between man and the environment.

Reference

Acar, I. H., Rudasill, K. M., Molfese, V., Torquati, J., &Prokasky, A. (2015). Temperament and preschool children's peer interactions. Early Education and Development, 26(4), 479-495. Baenninger, M., & Newcombe, N. (1989) The role of experience in spatial test performance: a meta-analysis. Sex Roles, 20, 327-344.

Bethell -Fox, C. E., & Shepard, R. N. (1988) Mental rotation: effects of stimulus complexity and familiarity. Journal of Experimental Psychology: Human Perception and Performance, 14, 12-23.

Brady, F. (1995) Sports skill classification, gender, and perceptual style. Perceptual and Motor Skills, 81, 611-620.

Crampton, J. W. (1988) The cognitive processes of being lost. Scientific Journal of Orienteering, 4, 34-46.

D'elia, F., Izzo, R., Senatore, B. (2019) Self-physical and emotional perception in rhythmic gymnastics for drop out, Journal of Human Sport and Exercise, 14, S1071-S1079

Drury, J. K., & Bonney, B. F. (2005) The backcountry classroom: lessons, tools, and activities for teaching outdoor leaders. (2nd ed.) Guilford, CT: Falcon. expertise in sport: a meta-analysis. Journal of Sport and Exercise Psychology, 29, 457

Etnier, J. L., & Chang, Y. K. (2009). The effect of physical activity on executive function: a brief commentary on definitions, measurement issues, and the current state of the literature. Journal of Sport and Exercise Psychology, 31(4), 469-483.

Fischetti, F., & Greco, G. (2017). Multilateral methods in Physical Education improve physical capacity and motor skills performance of the youth. Journal of Physical Education and Sport, 17(3), 2160-2168.

Fischetti, F., Cataldi, S., & Greco, G. (2019) A combined plyometric and resistance training program improves fitness performance in 12 to 14-years-old boys, Sport Sciences for Health, 15 (3), pp. 615-621

Greco, G., Cataldi, S., Fischetti, F. (2019) Effectiveness of a short after-school intervention on physical fitness in school-aged children extracurricular multilateral training improves physical fitness in children, Ricerche di Pedagogia e Didattica, 14 (1), pp. 143-164.

Fontani, G., Lodi, L., Felici, A., Migliorini, S., &Corradeschi, F. (2006) Attention in athletes of high and low experience engaged in different open skill sports. Perceptual and Motor Skills, 102, 791-805.

Fumagalli, G.F., Tortella, P., Coppola, R., &Sgrò, F. (2020). Physical or emotional scaffolding in a difficult motor task: What is better with 5-year-old children? Journal of Human Sport and Exercise, 15(4proc), S1437-S1445.

Furley, P., &Memmert, D. (2010) Differences in spatial working memory as a function of team sports xpertise: the Corsi Block-tapping Task in sport psychological assessment. Perceptual and Motor Skills, 110, 801-808.

Guzmán, J. F., Pablos, A. M., &Pablos, C. (2008) Perceptual-cognitive skills and performance in orienteering. Perceptual and Motor Skills, 107, 159-164.

Invernizzi, P.L., Signorini, G., Colella, D., Raiola, G., Bosio, A., Scurati, R. (2020)Assessing rolling abilities in primary school children: Physical education specialists vs. generalists, International Journal of Environmental Research and Public Health, 17 (23), art. no. 8803, pp. 1-19.

Halliday, S. E., Calkins, S. D., &Leerkes, E. M. (2018). Measuring preschool learning engagement in the laboratory. Journal of experimental child psychology, 167, 93-116.

Hazen, N., &Durett, M. E. (1982) Relationship of security of attachment to exploration and cognitive mapping abilities in 2-year-olds. Developmental Psychology, 18, 751-759.

Kessels, R. P. C., van Zandvoort, M. J. E., Postma, A., Kappelle, L. J., & de Haan, E. H. F. (2000) The Corsi Block-tapping Task: standardization and normative data. Applied Neuropsychology, 7, 252-258.

Kibele, A. (2006) Non-consciously controlled decision making for fast motor reactions in sports: a priming approach for motor responses to non-consciously perceived movement features. Psychology of Sport and Exercise, 7, 591-610.

Malinowski, J. C., & Gillespie, W. T. (2001) Individual differences in performance on a large-scale, real-world wayfinding task. Journal of Environmental Psychology, 21, 73-82.

Mann, D. T., Williams, A. M., Ward, P., & Janelle, C. M. (2007) Perceptual-cognitive expertise in sport: a meta-analysis. Journal of Sport and Exercise Psychology, 29, 457- 478.

Notarnicola, A., Vicenti, G., Tafuri, S., Fischetti, F., Laricchia, L., Guastamacchia, R., & Moretti, B. (2012). Improved mental representation of space in beginner orienteers. Perceptual and motor skills, 114(1), 250-260.

Piccardi, L., Iaria, G., Ricci, M., Bianchini, F., Zompanti, L., &Guariglia, C. (2008) Walking in the Corsi test: which type of memory do you need. Neuroscience Letters, 432, 127-131.

Prakash, R. S., Voss, M. W., Erickson, K. I., & Kramer, A. F. (2015). Physical activity and cognitive vitality. Annual review of psychology, 66, 769-797.

Russo, G., Nigro, F., Raiola, G., Ceciliani, A. (2019) The role of the extra physical activity on memory storage and psychosocial features, Journal of Human Sport and Exercise, 14 (Proc4), pp. S948-S956.

Schembri, R., Quinto, A., Aiello, F., Pignato, S., &Sgrò, F. (2019). The relationship between the practice of physical activity and sport and the level of motor competence in primary school children. Journal of Physical Education and Sport, 19 (Suppl. Issue 5), 1994-1998.

Sibley, B. A., &Etnier, J. L. (2003) The relationship between physical activity and cognition in children: a meta-analysis. Pediatric Exercise Science, 15, 243-256.

Siddiqui, N. I., Nessa, A., & Hossain, M. A. (2010) Regular physical exercise: way to healthy life. Mymensingh Medical Journal, 19, 154-158.

Sgrò, F., Coppola, R., Tortella, P., & Lipoma, M. (2020). Tactical Games Model as curriculum approach at elementary school: Effects on in-game volleyball technical improvements. Journal of Human Sport and Exercise, 15(4proc), S1178-S1186

Sgrô, F., Barca, M., Schembri, R., & Lipoma, M. (2020). Assessing the effect of different teaching strategies on students' affective learning outcomes during volleyball lessons. Journal of Physical Education and Sport, 20, 2136-2142.

Spiers, H. J., & Maguire, E. A. (2008) The dynamic nature of cognition during wayfinding. Journal of Environmental Psychology, 28, 232-249.

Spittle, M.,&Morris, T. (2007) Internal and external imagery perspective measurement and use in imagining open and closed sports skills: an exploratory study. Perceptual and Motor Skills, 104, 387-404.

Tenenbaum, G. (2003) Expert athletes: an integrated approach to decision making. In Thomas, L. (2006) Tazidisemaineiepibiose. Science Illustrated, 18, 32-37.

Tomporowski, P. D. (2003) Cognitive and behavioural responses to acute exercise in youths: a review. Pediatric Exercise Science, 15, 348-359.

Truelove, S., Vanderloo, L. M., & Tucker, P. (2017). Defining and measuring active play among young children: a systematic review. Journal of physical activity and health, 14(2), 155-166.

Vaeyens, R., Lenoir, M., Williams, A. M, &Philippaerts, R. M. (2007) Mechanism underpinning successful decision making in skilled youth soccer players: an analysis of visual search behaviors. Journal of Motor Behavior, 39, 395-408.

Williams, A. M., Davis, K., & Williams, J. G. (2000) Visual perception and action in sport. London: E. & F.N. Spon. Pp. 96-142.