CORE Metadata, citation and similar papers at core.ac.uk
Provided by Archivio istituzionale della ricerca - Università di Palermo

The official published version of this article can be found at
http://www.amsciepub.com/doi/abs/10.2466/05.22.27.PMS.112.3.915-925?prevSearch=giglia+g&searchHistoryKey=%5D.

This is a final authors' draft of the paper:

Giglia, G., Brighina, F., Zangla, D., Bianco, A., Chiavetta, E., Palma, A. & Fierro, B. Visuospatial Attention Lateralization In Volleyball Players And In Rowers. *Perceptual And Motor Skills*, 2011, 112, 3, 915-925. ©

VISUOSPATIAL ATTENTION LATERALIZATION IN VOLLEYBALL PLAYERS AND IN ROWERS[1,2]

G. GIGLIA
Department of Experimental Biomedicine and Clinical Neuroscience (BioNeC)
Via G. La Loggia,1 90100 University of Palermo
Palermo, Italy

F. BRIGHINA, D. ZANGLA, A. BIANCO, E. CHIAVETTA, A. PALMA,
Department of Sports Science (DISMOT)
University of Palermo, Palermo, Italy

B. FIERRO
Department of Experimental Biomedicine and Clinical Neuroscience (BioNeC)
Via G. La Loggia,1 90100 University of Palermo
Palermo, Italy

[1] Address correspondence to Filippo Brighina MD. Tel: +39 091 6555105. via G. La Loggia, 1. 90100 Palermo (ITALY) or e-mail (fbrighina@unipa.it).

[2] The authors thank Dr. Elide Lombardi for her excellent help in preparing the manuscript.

Summary.—In the present study, differences in visuospatial attention lateralization were evaluated in athletes engaged in open compared to closed skill sports and sedentary non-athletes. 23 volleyball players (open skill; Italian national level and regional level), 10 rowers (closed skill, Italian national level) and 23 sedentary participants responded to a computerized line-length judgment task. Five lines, differing in the length of their right and left segments, were randomly presented; the respondent made a forced-choice decision about the respective length of the two segments. Volleyball players responded significantly faster; those at the higher competitive level were also more accurate, making a statistically significantly lower number of leftward errors as compared with rowers and controls. If such responses are due to training rather than self-selection of ability, then the results may suggest the possibility of changing the distribution of visuospatial attention by training in open-skill sports.

Visuospatial attention is a cognitive function considered to represent an important determinant of success in open skill sports (McAuliffe, 2004). In such sports, the environment is constantly changing and movements have to be continually adapted, so they are also called "externally paced skills" (Singer, 1980). In competitions, the main source of this continuous variation is the opponents' behaviour and actions—above all, strategic feints meant to confuse or fool the other competitors. In many team sports, actions by teammates also must be taken into account. Task-relevant information, often complex and dynamically changing (i.e. ball, opponents, attack area, etc.), must be extracted quickly from the visual field while ignoring unimportant or distracting stimuli. The ability to process spatial information and perceive differences or asymmetries correctly in both hemi-visual fields allows athletes to perform successfully. In contrast, in "closed skill" sports, the environment remains substantially unchanged and there is less need for distribution of visuospatial attention.

Some studies have assessed the ability to allocate visual attention (McAuliffe, 2004; Casteillo & Umiltà, 1992; Nougier, Ripoll, & Stein, 1989). A recent study exploring visual search strategies in open-skill soccer players found that they were faster than non-athletes in switching attention from local to global focus and more rapid to "zoom-out" the focus of attention (Pesce, Tessitore, Casella, Pirritano, & Capranica, 2007); but no data are available on visuospatial attention anisotropy (i.e., directional non-uniformity)

Visuospatial attention can be assessed using the line-length judgment task, a version of Milner's modified Landmark task (Milner, Harvey, Roberts, & Forster, 1993). This task has been extensively used to assess visuospatial attention distribution in healthy respondents (McAuliffe, 2004) and in patients with visuospatial deficits (Bisiach, Ricci, Lualdi, & Colombo, 1998). People affected by right parietal damage and spatial neglect estimate or perceive the left segment shorter and the right one longer than their real size (Bisiach, *et al.*, 1998). These individuals show attentional-spatial biases that cause inattention to the left side of the space or the left side of the presented stimulus, regardless of its position in the environment. In contrast, the general population tends to overestimate the left hemispace: a phenomenon known as pseudoneglect (Bowers & Heilman, 1980) and interpreted as due to physiological hemispheric imbalance in visuospatial attention control (Kinsbourne, 1970). This finding has been more recently confirmed in a large meta-analysis study of bisection performance (Jewell & McCourt, 2000). On this basis, the line-bisection judgment task could allow evaluation of whether playing an open skill sport is associated with a more symmetrical allocation of spatial attention. This would imply a more accurate perception of sizes and distances in both sides of the space.

The aim of the present study was to evaluate the visuospatial attention distribution, i.e., distribution of visuospatial attention in both sides of the space in athletes practicing open and closed skill sports. Volleyball is a classic open skill sport, while rowing is a closed sport. A group of volleyball players from regional and national teams (different skill levels) and a group of national level rowers were recruited and compared to a control group of sedentary participants on a computerized line-bisection judgment task. Accuracy of responses and reaction time (RT) were analyzed. The hypothesis was that the open skill players were faster and more accurate in the visuospatial performance.

METHOD

Participants

Thirty-six male athletes belonging to three different categories participated in the study: 24 representatives of an "open skill" (12 Italian national-level volleyball players, 12 Italian regional-level players); 12 representing a "closed-skill" (national-level rowers); and 24 sedentary male students in the same age range who declared themselves "in a condition of habitual lack of physical activity"[1] Participants had no history of neurological disease, drug abuse, and were right-handed as evaluated by the Edinburgh Handedness Inventory. A total of 56 participants volunteered for the study (four dropped out).

Measures

All participants gave their informed consent to participate in the study, which was conducted in accordance with the Declaration of Helsinki. A semi-structured questionnaire was distributed to all participants to assess frequency of sport training.

Procedures

Each participant underwent the experimental procedure as follows: the participants were comfortably seated on a chair in front of a 15" laptop computer screen at the distance subjectively considered optimal for reading (*M* distance for all subjects= 57 cm, *SD*=5.4). No statistically significant difference in mean distance was present among groups. The participant's seat was positioned so that the eye level was at the middle of the display monitor centered on the

[1] Queensland Health, retrieved on Last Reviewed: 06 March 2009 from http://www.health.qld.gov.au/npag/glossary.asp

midplane. A computerized version of a modified Landmark task was used (Fierro, Brighina, Oliveri, Piazza, La Bua, Buffa, *et al*., 2000). Visual stimuli consisted of black 1 mm thick horizontal lines transected by a 1 mm thick and 1 cm long vertical bar, presented on a white background with the transector exactly coinciding with the centre of the screen. Five lines differing in the overall length and in their right and left segments were presented for 50 msec. on the computer screen: Line 1 was exactly bisected (right segment 0.75 mm, left segment 0.75 mm); Line 2 had the left segment elongated (right segment 0.70 mm, left segment 0.75 mm); Line 3 also had the left segment elongated (right segment 0.75 mm, left segment 0.80 mm); Line 4 had the right segment elongated (right segment 0.75 mm, left segment 0.70 mm); Line 5 had the right segment elongated (right segment 0.80 mm, left segment 0.75 mm). Three blocks of 18 trials were presented in random order (three repetitions for left or right elongated lines and six repetitions for exactly bisected line, so that an equal number of left-elongated, right-elongated and exactly bisected lines were presented), for a total of 54 lines. Two min. resting time was set between blocks.

Tachistoscopic stimulus presentation of 50 msec. duration was used to prevent visual scanning. Before stimulus presentation, the participant was required to fixate on a central target (a black asterisk) that disappeared after 250 msec. as soon as the visual stimulus was flashed. After the presentation of the stimulus the participants were instructed to make a forced-choice decision about the respective length of the two segments, pressing as soon as possible one of the three keys marked over an Italian computer QWERTY keyboard, corresponding to the response possibilities: ‘‘equal’’(key N), ‘‘longer right’’ (key M) or ‘‘longer left”(key B). The accuracy and reaction times (RTs) of the participants on each trial were recorded and collected. The software used for the aim was Psyscope X (Cohen, MacWhinney, Flatt, & Provost, 1993). Leftward error was when Lines 4 and 5 were judged equal or longer on the left or when Line 1 was judged longer on the left. Rightward error was when Lines 2 and 3 were judged equal or longer on the right or when Line 1 was judged longer on the right.

Analysis

One-way analysis of variance (ANOVA) was used to compare age and the total workload of training (calculated for each participant as hours per week per months per year) among categories of athletes. Differences in percentage of errors and RTs (msec.) across the three groups of athletes and the control group were also analyzed by means of one-way ANOVA. Two separate one-way ANOVAs were performed for percentage of leftward and rightward wrong responses. Based on a pilot experiment, RTs higher than 1000 msec. were excluded from the analysis as response errors. The relationship between total workload of training and performance (% of correct responses) was evaluated. Accuracy and suitability of the data for linearity and normality were checked before analysis. No transformation data was made. Outliers and missing data were less than 3%.

RESULTS

One-way ANOVA for mean age showed a significant effect ($F_{3,51}$=9.04, $p < .01$; Cohen's f^2= .53). The *post hoc* Fisher LSD showed that the mean age did not differ in all groups but the rowers were significantly younger (p<.01; Cohen's d= 1.65) compared to the other groups . One way ANOVA for mean total workload of training in the three groups of athletes showed a significant main effect ($F_{2,29}$=32.1, $p < .01$; Cohen's f^2 = 2.). The *post hoc* Fisher LSD test showed that mean total workload of training was significantly higher (p< .01) in national-level volleyball players and rowers compared to regional-level volleyball players (Cohen's d = 3.55) (Table 1).

Reaction Times

One-way ANOVA for RTs in four different groups of participants (national-level volleyball players, regional-level volleyball players, national-level rowers, controls) showed a significant main effect ($F_{3,1901}$=9.89, p <.01; Cohen's f^2 = .015). The Fisher LSD *post hoc* analysis showed that national-level and regional-level volleyball groups had faster RTs than controls and rowers: national-level volleyball groups versus controls (p < .05; Cohen's d= .12); national-level volleyball groups versus rowers (p <.01; Cohen's d = .30); regional-level volleyball groups versus controls (p < .01, Cohen's d = .); regional-level volleyball groups versus rowers (p <.01; Cohen's d= .39); no significant differences were found between national-level and regional-level volleyball players (Fig.1).

Errors

The one-way ANOVA for the percentage of errors in the three groups of athletes and controls showed a significant main effect ($F_{3,53}$ =3.15, p <.05; Cohen's f^2= .18). The Fischer LSD *post hoc* analysis showed that national-level volleyball players group made a significantly lower number of errors compared to all other groups: national-level volleyball groups versus regional-level volleyball players (p <.05; Cohen's d= .86) national-level volleyball groups versus controls (p = < .05; Cohen's d = 1.); national-level volleyball groups versus rowers (p <.01; Cohen's d=.92). No other statistically significant differences were found among groups.

The two-way ANOVA comparing leftward versus rightward errors among groups with errors (leftward and rightward) as within subjects factors and Group as between subject factors did not show statistically significant main effects ($F_{3,53}$=0.42, p=.74; η^2=.023).

A separate analysis for right and left wrong responses was then performed. The ANOVA for the percentage of wrong responses to the left in the three groups of athletes and controls showed a statistically significant main effect ($F_{3,53}$=3.13, p <.05; Cohen's f^2= .18) (Fig. 2) . Fisher LSD *post hoc* analysis showed that national-level volleyball group made statistically significantly fewer errors to the left (i.e., less leftward bias) compared to all other participant groups: national-level versus regional-level volleyball groups (p <.05; Cohen's d= 2.); national-level volleyball group versus controls (p <.05; Cohen's d = 3.65); national-level volleyball group versus rowers (p <.01; Cohen's d = 3.9). No significant differences in the percentage of errors to the right among participant groups were found ($F_{3,53}$=1.40, p =.25; Cohen's f^2= .008)(Fig. 2).

The correlation between total workload of training and percentage of correct responses in the three groups of athletes was not statistically significant (r= .15, p=.40). Also the analysis including only the volleyball players (national-level versus regional-level volleyball groups) was not statistically significant (r=.37, p=.08).

DISCUSSION

Results indicated that open skill higher-trained athletes (national-level volleyball players) were more accurate in the line-bisection judgment task and made a lower number of leftward errors compared to all other groups. Since no difference in rightward bias across all groups was found, one might speculate that training at higher levels of open-skill sports—or gaining a commensurate amount of experience—can improve spatial judgment. However, considering the design of the study, one cannot exclude that the differences between groups are due to a combination of aptitude, motivation (self-selection), and training. There were no statistically significant differences in percentages of errors towards left or right found in the other three groups; only controls had a small (but not statistically significant) leftward bias. The demographic characteristics of participants and the modality of presentation of the line could explain the results (Jewell & McCourt, 2000). The peculiar, statistically significant improvement in the left hemifield in national-level volleyball players could be considered as a trend to counteract the physiological hemispheric imbalance in visuospatial attention control (Kinsbourne, 1970). One could argue that the greater attention to the left hemispace would result in more accurate, faster perception related to high-level training in the open skill athletes. This would need to be assessed specifically using a better design and a larger, more carefully chosen sample—and preferably a longitudinal design.

The same accuracy in the task was not found in the open-skill regional-level volleyball players; neither they nor the regional-level closed skill rowers differed from controls, indicating that the effect was related to the skill (or experience) level of the athletes rather than to the type of sport. In the results, reaction times (RTs) were shorter in the open skill player groups than in closed skill and sedentary groupe, suggesting that in higher-trained volleyball players the accuracy of responses was maintained in spite of the faster responses.

It is known that open skill athletes show a smaller "cueing effect" when compared to non-athletes. The spatial cuing paradigm, first described by Posner (1980), is considered an index of the ability to allocate attention. In this paradigm, the visual stimulus is preceded by a cue that can provide the correct (valid trials) or erroneous (invalid trials) information about the location of the stimulus. In general, RTs for valid trials are faster than the ones for invalid trials and the difference is called the "cuing effect." The studies of Casteillo and Umiltà (1992) and Nougier, *et al.* (1989) showed that athletes had approximately the same RTs as nonathletes on valid trials but had much faster RTs on invalid trials. Moreover, Enns and Richards (1992) found that this difference was larger for more highly trained open-skill athletes (hockey players of two skill levels). This phenomenon was interpreted as the ability of these athletes to ignore deceptive stimuli, such as occur during the perception of and response to feints. However, these results were not supported by others (McAuliffe, 2004) who found university-level female volleyball players had longer RTs on both valid and invalid trials. However, McAuliffe suggested the difference was due to an experimental paradigm that required involuntary, reflexive orientation of attention.

Although the mechanisms that lead to distribution of spatial attention in a line-bisection task are still unclear (Bowers & Heilman, 1980), it is known that it can be modified according to "modulating stimuli," such as height, position (Jewell & McCourt, 2000; McCourt, Garlinghouse, & Reuter-Lorenz, 2005), contrast (Bradshaw, Nathen, Nettleton, Wilson, & Pierson, 1987), and geometry of the line (McCourt, *et al.*, 2005). Therefore it has been speculated that systematic errors in perceiving the midpoint in the line judgment task are not linked to a perceptual phenomenon (pre-attentive), but to differences in the distribution of visuospatial attention (McCourt, *et al.*, 2005). It was speculated that training to ignore feints in the open-skill athletes might have improved their ability to rapidly allocate attention, resulting in decreased RTs. However, only higher level competitors among the open skill players had better performance in the spatial perception task, and presumably a better distribution of spatial attention. The correlation between performance (correct responses) and total workload in volleyball players was not significant, which seems to support the hypothesis of *a priori* aptitude rather than an effect of training on visuospatial accuracy. National-level rowers appear not to differ from controls, suggesting that the stable sport environment did not train their ability to distribute visuospatial attention, or that they are self-selected when entering and persisting in their sport and do not have superior ability in this area. The rowers were younger than the other two groups of athletes, but they performed at a higher competitive level and their total workload did not differ from that of national-level volleyball players. Indeed, rowing can be considered only a partially closed-skill sport, because even if in a relatively stable environment, athletes have to adapt their movements to different weather conditions and currents.

Apparently, this is the first study investigating the lateralization of visuospatial attention in athletes and it shows there are differences but only at the highest level of competition. It also seems to suggest a potential for changes in visuospatial attention with training in open-skill sports, although this speculation assumes the differences are due to training and not selection factors for who becomes a high level athlete in open or closed sports. The main limitation of the study consists in the fact that the condition of laboratory setting is very different from the open space in which the athletes actually operate, the samples are not random, and the design does not give information about longitudinal changes with training within subjects.

It is important to emphasize that the laboratory setting is very different from the open space in which the athletes actually perform sports. Physical stress and "time pressure" must be also taken into account in the real context of sport, during which the perceptive ability of players could be differently adapted. Moreover, the possibility that athletes belonging to higher performance categories—rather than the more experienced—were self-selected on the basis of their natural abilities can be considered.

REFERENCES

Bisiach, E., Ricci, R., Lualdi, M., & Colombo, M. R. (1998) Perceptual and response bias in unilateral neglect: two modified versions of the milner landmark task. *Brain and Cognition,* 37, 369-386

Bowers, D., & Heilman, K. M. (1980) Pseudoneglect: effects of hemispace on a tactile line bisection task. *Neuropsychologia,* 18, 491-498

Bradshaw, J. L., Nathen, G., Nettleton, N. C., Wilson, L., & Pierson, J. (1987) Why is there a left side underestimation in rod bisection. *Neuropsychologia,* 25, 735-738

Casteillo, U., & Umiltà, C. (1992) Orienting attention in volleyball players. *International Journal of Sport Psychology*, 23, 303-310.

Cohen, J. D., MacWhinney, B., Flatt, M., & Provost, J. (1993) PsyScope: a new graphic interactive environment for designing psychology experiments. *Behavioral Research Methods, Instruments, and Computers*, 25(2), 257-271.

Enns, J., & Richards, J. (1992) Visual attentional orienting in developing hockey players. *Journal of experimental child psychology,* 64, 225-275

Fierro, B., Brighina, F., Oliveri, M., Piazza, A., La Bua, V., Buffa, D., & Bisiach, E. (2000) Contralateral neglect induced by right posterior parietal rTMS in healthy subjects. *Neuroreport,* 15;11(7), 1519-1521.

Jewell, G., & McCourt, M. E. (2000) Pseudoneglect: A review and meta- analysis of performance factors in line bisection tasks. *Neuropsychologia,* 38, 93-110

Kinsbourne, M. (1970) The cerebral basis of lateral asymmetries in attention. *Acta Psychologica*, 33,193-201

McAuliffe, J. (2004) Differences in attentional set between athletes and nonathletes. *The Journal of General Psychology,* 131 (4), 426-37

McCourt, M., Garlinghouse, M., & Reuter-Lorenz, P. A. (2005) Unilateral visual cueing and asymmetric line geometry share a common attentional origin in the modulation of pseudoneglect. *Cortex,* 41(4), 499-511

Milner, A. D., Harvey, M., Roberts, R. C., & Forster, S. V. (1993) Line bisection error in visual neglect: misguided action or size distortion? *Neuropsychologia,* 31, 39-49.

Nougier, V., Ripoll, H., & Stein, J. F. (1989) Orienting of attention in highly skilled athletes. *International Journal of Sport Psychology*, 20, 205-223.

Pesce, C., Tessitore, A., Casella, R., Pirritano, M., & Capranica L. (2007) Focusing of visual attention at rest and during physical exercise in soccer players. *Journal of Sports Sciences*, Sep. 25(11), 1259-1270.

Posner M. I. (1980) Orienting of attention. *The Quarterly Journal of Experimental Psychology*, 32, 3-25

Singer, R. N. (1980) Cognitive processes, learner strategies, and skilled motor behaviors. *Canadian Journal of Applied Sport Sciences,* Mar. 5(1), 25-32.

Accepted

Category	*N*	*M* age, yr.		*M* weight, kg		*M* height, m		*M* BMI		*M* Workload hr/day		RT, ms		Errors, %	
		M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
National Volleyball Players	12	26.0	4.3	92.5	6.32	1.97	0.07	23.9	1.87	3.37	0.98	747.52	147	25.14	11
Regional Volleyball Players	11	25.6	3.4	82.9	8.67	1.85	0.05	24.3	1.78	1.14	0.32	733.04	160	38.74	19
National Rowers	10	19.2	4.0	81.7	12.66	1.87	0.07	23.2	2.53	3.05	0.50	791.27	141	44.94	15
Sedentary Controls	23	24.83	2.5	71.3	9.08	1.76	0.06	23	2.82	---		764.92	141	38.10	16

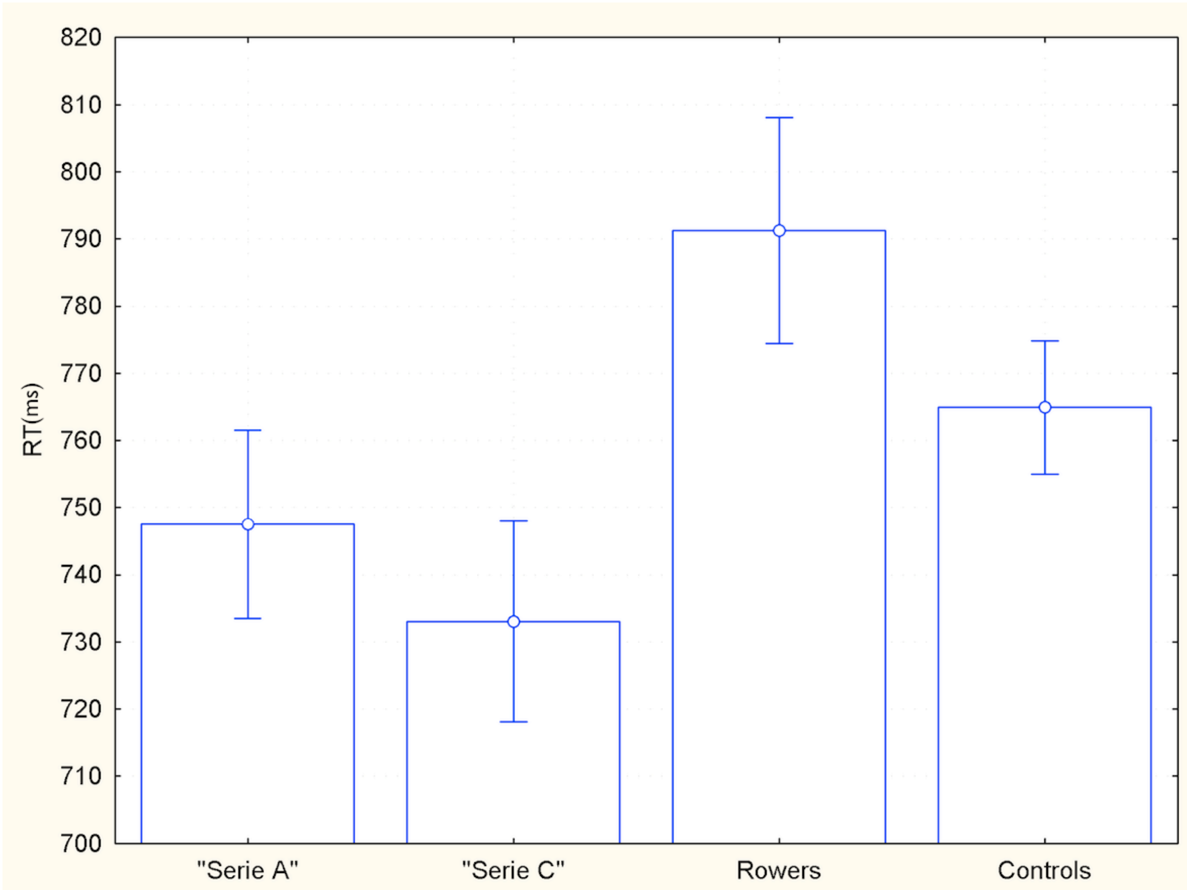

Fig. 1. Mean RTs in national and regional level volleyball players, rowers and controls. Vertical bars denote 95% confidence intervals.

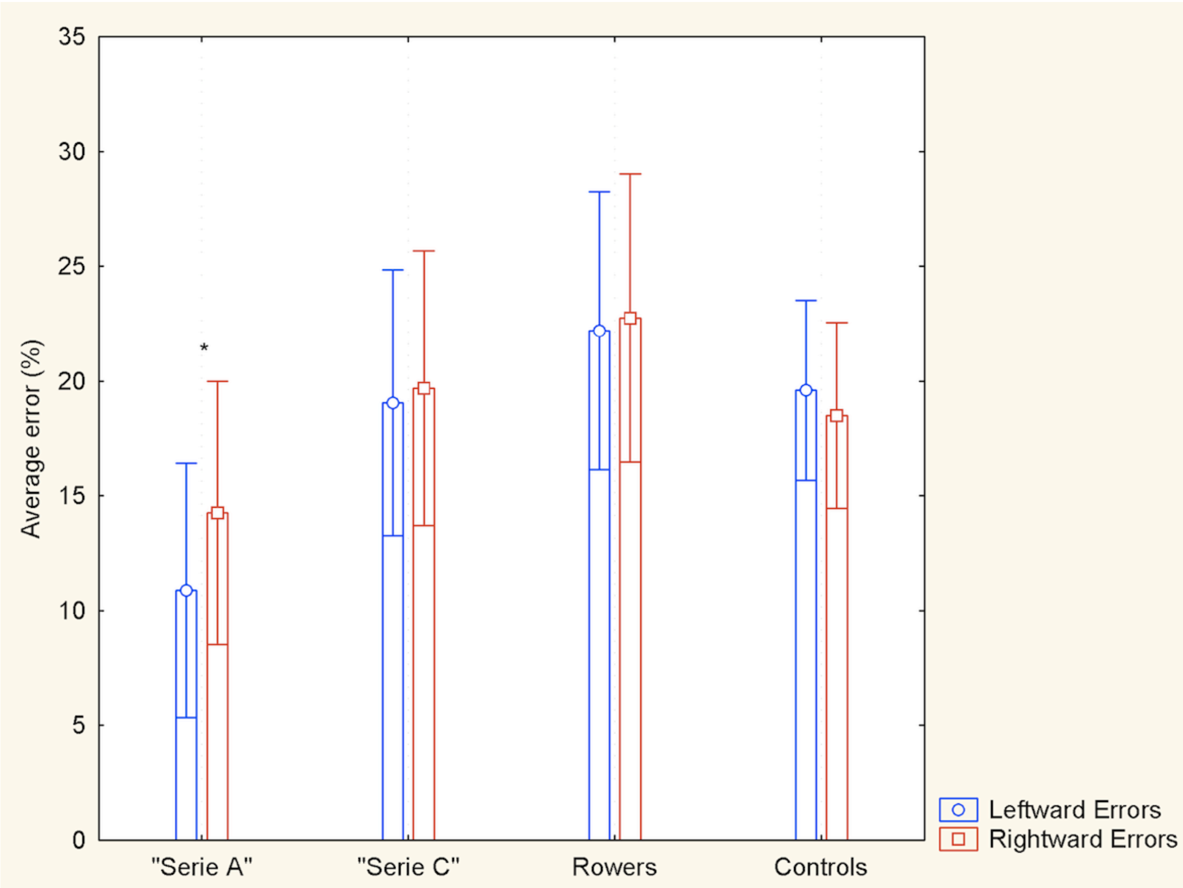

Fig. 2. Mean percentage of leftward and rightward errors in national and regional level volleyball players, rowers and controls. Vertical bars denote 95% confidence intervals. * p<.05