The purpose of this preliminary study was to investigate possible differences among a group of fencers and a group of swimmers, in the visual memory task and the spatial anticipation task. 15 national level fencers (aged between 16 to 23 years) and 15 swimmers of a competitive swimming club (aged between 15 to 22 years), were studied. The Brixton Spatial Anticipation Test (BSAT) was used as a measure of executive functioning. The second test was the Visual Patterns Test (VPT), which measured visual short-term memory. The Digit Span subtest of the Wechsler Adult Intelligence Scale - III (WAIS) was also included as an estimate of general intelligence.

There was a significant difference between fencers & swimmers in the BSAT, (F = 5.261, p = 0.030), while the analysis of the VPT test scores showed no significant differences among groups (F = 0.325 p = 0.573). In conclusion, fencers showed no better performance on visual memory, while they were superior in rule detection, comparing to swimmers. The long training fencing program, may greatly affects the speed of constitute information process as attributes of the decision making speed in national level fencers.

**Key Words:** Brixton Spatial Anticipation Test, Visual Patterns Test, fencers, swimmers.
INTRODUCTION

The relationship between sport performance and high cognitive functioning (e.g. attention and decision strategies) has been highlighted by sport experts (22) although a full neurocognitive assessment of professional athletes has not been yet adopted as part of their routine screening (29). The use of neurocognitive assessment has been recommended after sport-related brain injuries for clinical reasons (14) while recently has been reported that neuropsychological testing is ‘mandatory’ in the National Football League in the United States (10).

Given that routine baseline neurocognitive testing of professional athletes is a relative recent practice, very few normative studies exist and even less information is available concerning the sport of fencing.

Fencing is a complex, dynamic as well as technical and tactical, multidimensional sport. Factors like training hours, age, experience, sex, as well as the appropriate tactics the athlete engages in during a fight are partly responsible for fencing success (4). Yet, good fencing performance is determined by advanced perceptual and cognitive abilities, like attention, perceptual skills, decision making, and visuospatial memory (19). Therefore, fencers before initiate an offensive or defensive action have to select and analyze incoming visual cues coming from the motions and actions of the adversary (26).

The importance of visual information analysis for the fencer was studied by Bard et al (3), who found that experienced and distinguished fencers have shorter fixation times than novices. Elite fencers are advised to perform exercises for improving visual memory, as it is considered to help them benefit from visual cues provided by the opponent during a game (19). The opponent’s motion, provide visual cues which function as triggering stimuli for previous visual memories, assisting the fencer to remember the style of play and anticipate some movements to follow (20).

A few cognitive studies focused on various aspects of fencing such as eye hand coordination (2), left handed versus right handed athletes (16), figure ground perception (30), and psychomotor reactions under different situations and effort (15, 5, 6).

On the other hand visual memory, rule detection and rule following strategies in fencing are less studied. Recent findings from Di Russo et al (13), who looked at rule detection and rule following from the aspect of stimulus discrimination and motor response selection, as well as inhibition processes, suggested concurrent activation of brain areas associated with visual stimulus discrimination, and inhibition of motor reaction. This activation is of critical importance for the fencers, since it allows for a quick shift from their planned action to a different one when an unexpected action is initiated on behalf of
the opponent. In addition, fencers are required to mask their intentional moves and part of their success is related to the distinguish process between the feints and the relevant informational cues (7). Consequently, involvement of visuospatial memory, rule detection and rule following are activated processes, necessary for the interpretation of the adversary’s next action and the detection of the rule by which the opponent’s play is characterized (19).

Moreover, Nougier et al (23), analyzed at the same time the automatic and the voluntary modes of orienting attention and found that a group of fencers, who frequently faced attentional demanding situations showed significant but smaller attentional effects than a group of swimmers who served as a control group. Consequently, there seems to be a difference among sports on the basis of cognitive demands they pose to the athlete (13).

The purpose of this preliminary study was to investigate possible differences in the visual memory task (VPT) and the spatial anticipation task (BSAT), between a group of fencers and a group of swimmers. It was expected that fencers practicing in an interactive and open skilled activity could perform better than swimmers in the abovementioned selected cognitive tests (23).

METHOD

Participants

The experimental group consisted of fifteen national level fencers, aged between 16 to 23 years (Mean = 19.4, Sd = 2.6). Seven fencers were females and eight were males. All participants were right handed. The tests of two fencers were excluded as the participants were diagnosed for dyslexia. The control group consisted of fifteen swimmers, aged between 15 to 22 years (Mean = 17.4, Sd = 2.3), that consistently trained in their clubs. Both groups were engaged in similar daily training (2 hours, 5 times/week). Six swimmers were females and nine were males. All swimmers were right handed. An additional criterion for both groups was that none practiced any other sport. This was necessary as quite often fencing athletes as well as swimmers involve in modern pentathlon a sport that includes swimming, running, fencing shooting and horse back riding. All participants took part in a volunteered basis. A briefing session was administered in advance. Informed consent forms were given and signed. A debriefing was given after the tests. Fencers were chosen because they practised an individual interactive open skill activity in which the attentional system is intensively solicited, while the swimmers who compete against time do not need to process a lot of information and to develop important attentional capacities (23).
Procedures

Testing took place in meeting rooms situated either in the Olympic complex of Athens where the fencers train, or in meeting rooms of the swimming clubs whose athletes participated. The whole procedure lasted approximately 45 minutes. An AB counterbalanced design was used.

Materials

The Brixton Spatial Anticipation Test (BSAT) was used as a measure of executive functioning (9). BSAT resembles the task of the fencer detection of the opponent’s actions and the ability to shift to a new rule when the opponent changes his/her line of thinking.

The examiner presented an image that had ten circles on, one being coloured blue. There are 55 pages in which the coloured circle changes location in accordance to a rule. On each page the participant was called to predict where the coloured circle will move in the next page. The participant had to a) each time detect the rule, and b) follow the rule in order to make the correct prediction. The score was measured on the correct number of responses given (25).

The second test was the Visual Patterns Test (VPT), (12) which measured visual short-term memory. The VPT does not involve verbal coding so it was appropriate for our study (8). VPT consisted of 36 cards with a grid drown on them formed by black and white squares. The cards were presented to the participant for three seconds. After viewing the grid the participant had to regenerate the pattern on a separate sheet. The test stopped when the participant could not reproduce the exact pattern in three consecutive trials.

Digit Span subtest of the Wechsler Adult Intelligence Scale-III (WAIS), was also included as an estimate of general intelligence (27). This test was used as a preliminary requirement in order to reject low values of general intelligence.

In the specific task the participant was asked to repeat sequences of numbers that were presented orally at a rhythm of one digit per second. The participant had to remember all the numbers in the same order they occurred. Similarly they were given the digit backward test where numbers had to be recalled in the reverse order. The digit span is a highly reliable measure of working memory functioning although on its own it is not a sufficient index of general intelligence (28).

RESULTS

Descriptive statistics are presented in Table 1.
Table 1. Mean and standard deviations for the fencers (n = 15), and the swimmers (n = 15) in the selected neurocognitive tests

<table>
<thead>
<tr>
<th>Tests</th>
<th>Fencers X</th>
<th>Fencers Sd</th>
<th>Swimmers X</th>
<th>Swimmers Sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>WAIS Digit Forward</td>
<td>6.46</td>
<td>0.83</td>
<td>6.46</td>
<td>1.06</td>
</tr>
<tr>
<td>WAIS Digit Backwards</td>
<td>5.06</td>
<td>1.16</td>
<td>5.13</td>
<td>1.12</td>
</tr>
<tr>
<td>Visual Patterns Test</td>
<td>10.06</td>
<td>1.33</td>
<td>9.73</td>
<td>1.83</td>
</tr>
<tr>
<td>Brixton Spatial Anticipation Test</td>
<td>43.00</td>
<td>2.13</td>
<td>40.66</td>
<td>3.30</td>
</tr>
</tbody>
</table>

WAIS: Wechsler Adult Intelligence Scale-III test.

The results are presented as means and standard deviations. Differences between groups were tested by one-way ANOVA for single factors. Significance was set at the probability level of \( \alpha = 0.05 \). There was a significant difference between fencers & swimmers in the Brixton Spatial Anticipation test, \( F = 5.261, p = 0.030 \). The analysis of the VPT test scores were not significant \( F = 0.325, p = 0.573 \). Similarly, there were not any significant differences between the groups for the Digit Span forward \( F = 0.000, p = 1.000 \) and for the Digit Span backward tests \( F = 0.025, p = 0.874 \).

DISCUSSION

The present study is the first aimed to test the hypothesis that national level fencers possibly score better than swimmers in a spatial rule detection task and in short-term visual memory task respectively. Our results indicated that the fencers had a better performance in the Brixton test than the swimmers. On the other hand their performance on the visual memory test (VPT) was not different.

Improvements in spatial performance are task specific (24). The participants of the present study used different motor patterns to store information and to learn new tasks. More specifically, in learning new fencing actions and developing common motor patterns, the most important variable is selectivity of the perception process. The processing of external information should be time-conscious (before choosing and executing an action or in some situations, remembering a pattern of response and recalling and recreating it later) (5).
In contrast swimming has different competitive characteristics and does not require fast reactions or proper decision making (23). The motor responses required during swimming are less constructive skills and the visual memory is mainly focused on the right visual technical images, which are associated to more standardized kinetic patterns. All these cognitive differences underlying the sensorimotor adaptability mechanisms among fencing and swimming reflected in the results of the present study, and could probably explain the different scores in the selected rule detection test. Given the relative baseline neurocognitive testing of professional athletes is a relatively recent procedure, very few studies of this population exists.

The performance on the VPT was not different between the groups of the present study. It is surprising that relatively few studies have explored differences in visual memory as a function of sports expertise between sports (21). Fencers in this study have comparable visual memory to swimmers which is in agreement with the previous relative studies (1, 21). On the other hand, Nougier et al (23), found that a group of fencers facing high attentional-demanding situations improve the processing of visual outputs, optimizing their use of attentional processes, comparing to a group of swimmers.

In some cognitive sport activities, the human visual system extracts and retains complex visual information from multiple occurring displays (17). Cognitive processes should be analyzed from the standpoint of speed of processing information from the environment. Some sports regarded as sensorimotor (golf, bowling) as well as endurance (track and field), do not require fast processing of external signals. On the other hand in some combat sports such in fencing and team games the speed of processing information is often crucial (5). Perceptual skills enable athletes to respond only to important signals and to ignore disrupting ones which lower the effectiveness of functional performance (Klein, 1994). Furthermore, a fencer has to elaborate visual stimuli as cues in order to predict the opponent's next actions, while simultaneously misleading him (11, 19, 26). Sport research and practice show that the stimuli identification efficiency of patterns recreation is related to long-term experiences in different complex situations of fencing. However, the effectiveness of the information processing speed in fencing is related to development of cognitive mechanisms such as analysis signals, concentration of ability and divisibility of attention as well (6).

Experts and novice athletes differ in many aspects of their performance; nevertheless extensive research suggests that they do not differ in general visual abilities (21). On the other hand the speed of complex information processing (motor memory, concentration, and choice of motor programs) was found to be significantly slower in novice fencers in comparison to advanced fencers (11, 13). Although it was expected that the experienced fencers of the present study possibly score better than swimmers in visual memory capaci-
ty, the lack of significant differences suggest that advantages for fencers on one cognitive area may have minimal transfer to other similar tasks. Although similar visual memory found between fencers and swimmers, significant differences were observed in the decision making test, which confirms that systematic training on such tasks could in general result in improving skill specific performance (21).

CONCLUSION

In conclusion, fencers showed no better performance on visual memory, while they were superior in rule detection, comparing to swimmers. The results of the present study are probably attributed to the tests selections which were not robust enough to produce stable group differences. On the other hand the sample was relatively small and composed of both men and women, since this study was the first that aimed to explore these cognitive areas in fencers and swimmers. Future longitudinal studies could use such psychophysical methods, to obtain more precise measures of various aspects in the visual memory and rule detection in different sports, which would be very useful to trainers and sport psychologists as additional tools in designing training programmes, aimed to improve athletic performance.

REFERENCES


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