ABSTRACT

Sport Activity, Aging and Cognition: An electrophysiological and behavioral study with veteran fencers

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AIMS

The effects of aging on cognitive functions have been extensively documented (e.g. Braver and Barch, 2002). Using electrophysiological methods, several studies have reported changes of cortical activity; in particular, in the go/no-go task, previous studies (e.g. Czigler and al. 1996; Vallesi et al., 2008) reported reduction and slowing-down of components related to cognitive processes (such as P300) associated with slow reaction times. Recently, the effect of physical activity in the elderly was investigated at an electrophysiological level (e.g., McDowell et al., 2003); however, to date, the effects of sport activity on elderly athletes have not yet been analyzed. This is the aim of the present study.

Event-related potentials (ERPs) of veteran fencers were compared to non-athletes of the same age, to young fencers, and young non-athletes. In particular, we examined four groups: ten veteran fencers (mean age 49.5, sd 2.9, 8 males), hereafter called Old Fencers (OF); 10 non-athletes age-matched to veteran fencers (mean age 48.1, sd 2.6, 6 males), hereafter called Old Non-Athletes (ONA); 10 young top-level fencers (mean age 24.1, sd 3.9, 8 males), hereafter called Young Fencers (YF), and 10 young non-athletes (mean age 24.8, sd 4.7, 6 males), hereafter called Young Non-Athletes (YNA). OF subjects had many years of fencing experience (mean 26.8 years, sd. 7.5). Written informed consent, approved by a local ethical committee, was obtained from all participants after the procedures had been fully explained to them.

EXPERIMENTAL PROCEDURE AND STIMULI

Participants comfortably sat in a dimly lit, sound-proof room and stimuli were displayed on a computer screen at a distance of 114 cm. Stimuli, composed of squares (4x4°) with vertical and horizontal bars forming four configurations, were displayed for 260 ms on a dark grey background. The presentation sequence was random; the stimuli had equal probability and stimulus onset asynchrony ranged from 1 to 2 s.

After a short practice session, subjects performed two tasks in separate runs: 1) Discriminative Response Task (DRT) - the task was to press a key as soon as possible when two (preselected) stimuli appeared on the screen (Go stimuli; p=0.5), and withheld the response when the other two stimuli appeared (No-go stimuli; p=0.5); 2) Simple Response Task (SRT) - the participants pressed a key quickly to all four stimuli. There were ten runs for the DRT and five runs for the SRT, each consisting of a sequence of 400 Go, No-go and SRT trials. Only trials followed by a correct response in the 100-900 ms window were considered. Each run lasted two minutes separated by a pause (total duration about 45 min). RTs of correct trials were analysed in the 100-900 ms window. Furthermore, we calculated the number of errors (Omissions in DRT and SRT; False Alarms in DRT, and Anticipations in SRT).

The EEG was recorded using a BrainVisionTM system with 64 electrodes placed according to the 10-10 system montage. ERPs were averaged separately for each condition (SRT, Go and No-go) in epochs that began 100 ms prior to the stimulus onset and lasted for 1100 ms. The amplitudes of the different ERP components were measured as peak values within specified windows with respect to the 100 ms pre-stimulus baseline. ERPs from the SRT and DRT runs were combined and sorted into three categories: (1) ERPs to SRT stimuli, (2) ERPs to Go stimuli and (3) ERPs to No-go stimuli. Peak amplitudes and latencies of major ERP components were calculated for each subject in the following time windows: P1 (80-150 ms), N1 (130-200 ms), N2 (200-350 ms) and P3 (250-600 ms). ANOVAs were carried out on ERPs latencies and amplitudes, and for RTs and errors having the Group (four levels) as the independent factor.
RESULTS

Behavioural data show that the ONA (221 ms) and OF (207 ms) were slower (p<0.01) than YF (189 ms) in SRT condition. In the DRT condition the ONA (455 ms) were slower (p<0.01) than OF (410 ms) and YF (374 ms). Differences between groups were also observed for errors. In particular, YF (14.5 %) had a higher percentage of anticipations (p<0.01) than the other three groups (YNA 3.9 %, OF 1.9 %, ONA 0.9 %) in SRT condition. Furthermore, in the DRT condition, YF (14.8 %) and OF (11.5 %) had higher percentages of false alarms (p<0.01) than YNA (6.3 %) and ONA (4.7 %), respectively. Other comparisons were not significant.

The general spatio-temporal structure of the ERPs was similar in the four groups showing the typical P1, N1, P2, N2 and P3 components as reported in previous studies (e.g. Di Russo et al., 2006). Differences between groups were also present. Statistical analyses showed that some of the components were delayed or reduced in ONA compared to OF. Furthermore, in all conditions, the P1 component was slower in ONA (126 ms) compared to the other groups (YF 109 ms, YNA 109 ms, OF 108 ms) (p<0.01).

As for the amplitudes, in the Go condition, the N1 component was enhanced in YF (-8,900 μV), OF (-7,408 μV) and YNA (-7,105 μV) compared to ONA (-3,685 μV) (p<0.05); likewise, in the No-Go condition, YF subjects (-8,600 μV) showed larger amplitudes compared to YNA subjects (-6,477 μV). A statistically significant difference in amplitude (p<.05) was also present between OF subjects (-7,037 μV) and ONA subjects (-3,385 μV). Finally, the N2 component was enhanced in fencers (p<0.05), and YF subjects (-8,051 μV) and OF subjects (-8,367 μV) showed higher amplitudes than YNA (-4,206 μV) and ONA subjects (-4,734 μV).

CONCLUSIONS

Behavioral and electrophysiological data support the view that persevering sport activity exerts a beneficial role in middle-age athletes. In the discriminative task, RTs of veteran fencers were faster than age-matched non-athletes, and were comparable to young fencers. The analysis of electrophysiological data showed that perceptual functions (indexed by the P1 component) were slower in middle-age subjects; however, continued the training in fencing activity keeps these functions as fast as in young people. As for amplitudes, the N1 component, reflecting attentional effect, was enhanced in fencers, suggesting that the fencing discipline improves visuo-spatial attention. Action selection/inhibition processing was attenuated in young and mid-aged non-athletes, but continuing fencing activity seems to maintain this function at high level.

Overall, the present study found protective effects on perceptual and cognitive functions in middle-aged athletes, supporting the view that sport practice can cancel age-related impairments of perceptual and cognitive functions. Fencing is a discipline that highly engages attentional and decisional processes. During their sport performance fencers face rapidly changing situations which demand responses involving high accuracy and fast execution. The effects observed may be due to a specific effect of the fencing discipline. Future research might clarify to what extent the protective effects described in the present study for fencing applies to different sport disciplines.

REFERENCES


