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ORIGINAL ARTICLE

Effect of dual-attention task on attack and defensive actions in fencing

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Abstract
The objectives of this study were to investigate the effect that the presence of two stimuli that require two different responses (dual-attention) has both, on offensive reaction-response time to a light stimulus, and on defensive response time when the stimulus is a real fencing attack. Twenty-five elite fencers and a fencing master were included in the study. The equipment included four force plates adapted to a scaffold that served as a fencing piste. Two force plates were placed, at the start position, under the fencer's feet and another two plates were placed under the master's feet. The results demonstrate that choice reaction time to visual stimuli increases in dual-task conditions with respect to simple reaction time, whereas the mean horizontal force tends to decrease in dual-task. However, when the stimulus was an opponent's movement, dual-task conditions did not have any effect on the time required to initiate a defensive action. The changes in reaction time when real movements were used as stimuli challenge the validity of the reaction time to visual stimuli paradigm as a predictor of performance in fencing. Also, the results obtained demonstrate that perceptual and attentional processes play a major role in fencer performance in real competition.

Keywords: *Biomechanics, motor control, dual-attention*

Highlights
- When the stimulus was an opponent's movement, dual-task conditions did not have any effect on the time required to initiate a defensive action.
- Fencers' ability to anticipate their opponent's intentions is crucial and should be achieved by intensive attacking different fencers with a similar level of expertise.
- Using RT to discrete visual stimuli (light signals) as a predictor of performance in fencing is questionable.

Introduction

Fencing requires a high perceptual and attentional capacity for fencers to be able to develop deceptive strategies that facilitate anticipation during attack while preparing a reaction to a potential defensive response (Borysiuk & Waskiewicz, 2008) this situation can be considered a dual-task action (Pashler, 1994). Reaction time (RT) is widely accepted a useful measure for assessing cognitive and perceptual processes (Seya & Mori, 2007) and is one of the criteria used to assess fencer performance (Borysiuk & Cynarski, 2010; Harmenberg, Ceci, Barvestad, Hjerpe, & Nyström, 1991; Roi & Bianchedi, 2008). RT in dual-task conditions is measured by calculating choice reaction time (CRT), which is the reaction time to two stimuli that require two different responses. Hick's law states that CRT increases logarithmically when the number of alternative reactions-stimuli doubles. However, Mowbray and Rhoades (1959) questioned the applicability of this law, as they demonstrated that the same RT can be achieved after intense training regardless of the number of stimuli presented; therefore, the effect of training is an exception to Hick's law (Schmidt & Lee, 2011).

The assumption that RT is a good predictor of performance in fencing is controversial, as it is challenged when the RTs of elite and inexperienced fencers are compared. On the one hand, some studies reveal that RT and CRT are lower among

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elite fencers as compared to inexperienced fencers (Borysiuk & Waskiewicz, 2008; Johne, Poliszczuk, Poliszczuk, & Dadrowska-Perzyna, 2013; Williams & Walmsley, 2000b). On the other hand, other studies have not found any differences in RT and CRT between elite and inexperienced fencers because of the effect that attentional processes and training have on RT (Gutiérrez-Dávila, Rojas, Antonio, & Navarro, 2013a; Mouelhi Guizani et al., 2006a, 2006b).

Also, it should be noted that in most of the studies cited a discrete signal (light signal) was used to calculate the RT or CRT, a externally paced act which is far from the conditions of real competition, where the visual stimulus is represented by the opponent's movement, (Singer, 2000). Therefore, as the stimuli presented in the studies differ so greatly from those of real competition, the effect observed of training on RT and CRT may be irrelevant. Further, these studies ignore the attentional processes that interact in real competition (Chan, Wong, Liu, Yu, & Yan, 2011) as well as fencers' neural capacity to detect and process information related to movement, which is performed through a complex cortical network (Steel, Ellem, & Baxter, 2015). One of the scarce studies comparing RT to a light signal vs. an opponent's movement (Harmenberg et al., 1991) confirmed that RT is only correlated with fencer performance when the stimulus is the opponent's movement in CRT situations.

It is of note that RT is affected by the interaction of different variables such as fencer's fitness, the type of stimulus, and the level of attention and training (Cañal-Bruland, Van der Kamp, & Van Kesteren, 2010; Chan et al., 2011; Seya & Mori, 2007). Attention is probably the most important factor affecting RT, since it is the main input processing mechanism. Attention acts on memory structures and response systems and activates and inhibits processes according to the goals to be achieved (Posner & Dehaene, 1994; Tudela, 2011). This inhibition mechanism can only be assessed by training with stimuli that are similar to those of real competition. The interaction among variables during real competition should be assessed using ecologic models, which requires the development of cognitive neuroscience. This would allow the study of tactical intent and response inhibition processing times, the latter being closely related to attentional networks (Del Percio et al., 2007; Di Russo, Taddei, Apnile, & Spinelli, 2006; Feng, Zhou, Zhang, & Tian, 2010; Taddei, Bultrini, Spinelli, & Di Russo, 2012).

With the purpose of adopting an ecologic approach in our study, we set two objectives: (a) Assessing the effect that dual-task (offensive/defensive) has on reaction-response times to a visual stimulus, that is, to determine differences between simple reaction time and CRT in elite fencers; and (b) to assess the effect that dual-task has on defensive response time to an opponent's real attack. According to the arguments exposed above, it was hypothesised that there will be significant differences between simple reaction time and dual-task reaction time to a light signal. Conversely, we did not expect to observe any statistically significant differences when the stimulus was a real attack. This would confirm that fencer performance can be improved by training perceptual and attentional abilities in conditions similar to those of real competition.

Methods

Participants

The study included 25 elite fencers from the Spanish National Épée Team, 15 men (age = 21.1 ± 4.9, years; height = 1.82 ± 0.06 m; mass = 78.3 ± 7.9 Kg) and 10 women (age = 21.4 ± 2.3, years; height = 1.73 ± 0.05 m; mass = 66.7 ± 9.2 Kg), and a professional fencing master. The protocols were submitted to, and approved by the Ethics Committee of the University, all participants provided informed consent.

Equipment and materials

The equipment included four Dinascan/IBV 0.6 × 0.37 m. force plates (Instituto de Biomecánica de Valencia, Spain) adapted to a scaffold that served as a fencing piste. Two plates were placed under the fencer's feet in on-guard position (A and B), whereas the other two plates were placed under the master's feet (C and D). The master was standing opposite to the fencer in on-guard position with the first toe of the back foot at a distance of 1.5 times the mean size of the two opponents (master and fencer) from the geometric centre of the fencer's platform. The two 500 Hz-plates under each opponent's feet measured the horizontal components of the reaction force.

A Casio EX – FH20 video camera recorded the sagittal plane of movements at a 210 Hz frequency. The plates were synchronised by an electronic signal that activated them simultaneously. At the same time, the electronic signal turned on a LED light installed within the field of view of the video camera, which allowed synchronising it with the plates. A LED light that was only visible for the opponent was respectively installed at the mask bib lame of the fencer and the master. The LED light was used as the stimulus to initiate the attack according to the option selected. Figure 1 shows a scheme of the measurement systems used.

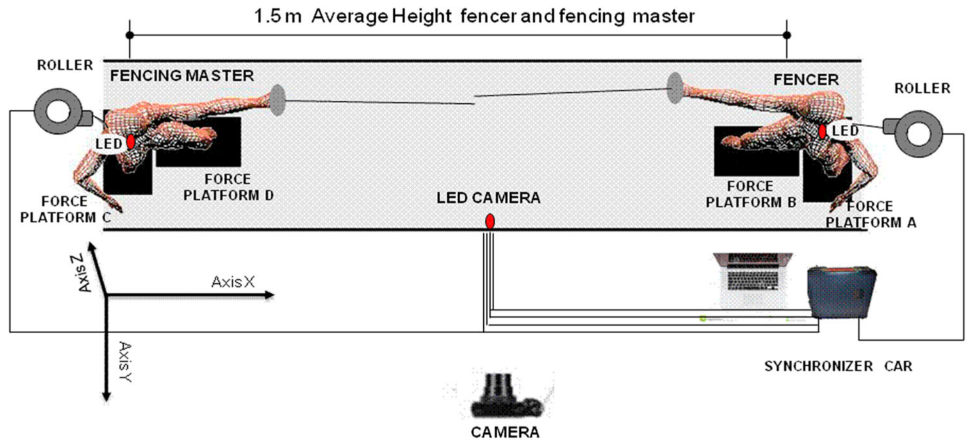

Figure 1. Outline of the materials and measurement systems used.

Procedures

After a general warm-up, the fencers received precise instructions for the tasks to be performed. Two blocks of ten trial actions each were performed in the experimental conditions described above, as follows: (a) a block of simple reaction time tasks (RT), and (b) a block of dual-tasks or CRT tasks. In all cases, the opponents were asked to stand motionless in on-guard position on the plates for a random time period until the LED on the opponent's mask bib lame turned on. Before initiating the measurement of each block of actions, the opponents performed several repetitions to become familiar with the experimental conditions. Task order was alternated in each block for each opponent.

For the simple reaction time (RT) block, the fencer was explained that when the LED light on the master's mask bib lame turned on, he had to perform a step-forward lunge and hit the master's plastron as fast as possible before the master dodged the hit by stepping backwards rapidly. Before initiating measurements, the fencer performed five valid trials. Subsequently, the master performed another five lunge trials when the LED light on the fencer's bib lame turned on. This time, it was the fencer who had to dodge the lunge by stepping backwards rapidly.

In the CRT situation, the opponents were explained that one of the LED lights would randomly turn on. Ten valid trials were performed. Next, depending on the LED light that turned on – the master's or the fencer's – the attacking fencer had to perform a step-forward lunge and try to hit their opponent's plastron as fast as possible. The defending fencer had to dodge the hit by increasing the distance between them by stepping backwards. The LED light on each opponent's bib lame turned on five times.

Data analysis

Reaction-response time components were measured in the two experimental situations where it was the fencer who performed the attack (*RRT-Attack)*: (a) Reaction time (*RT-Attack*) was defined as the time interval from the activation of the master's LED light (Start of measurement) and the Start of the attack ($t_{0(FENCER)}$); and (b) Motion-time (*MT-Attack*) defined as the time from $t_{0(FENCER)}$ until the time at which the back foot takes off or initiates an horizontal movement or the front foot strikes the floor ($t_{N(FENCER)}$). Of the five trials performed for each experimental situation, we only considered the trial where the *Attack-RT* matched the median of the five values measured.

When the fencer performed a defensive action, we measured the time to start the defensive action (DT-*Start of defence*), defined as the time interval from the start of master's attack ($t_{0\ (MASTER)}$) to the beginning of the fencer's defensive movement ($t_{0\ (DEFENCE)}$). The fencer's defensive movement time (*Defence-MT*) was defined as the time interval from $t_{0\ (DEFENCE)}$ to the completion of the master's attack action ($TN_{(MASTER)}$). Of the five trials performed in each experimental situation, we only considered the trial which DT matched the median of the five values measured. Figure 2 shows the notations for the time calculations described above and the horizontal force values obtained ($F_{R(X)}$) for one of the participants in the experimental situation CRT, where the fencer performed both, an attack (*a*) and a defensive action as a response to the master's attack (*b*).

Following the methods proposed by Gutiérrez-Dávila, Rojas, Caletti, Antonio, and Navarro (2013b), the initiation of the respective actions was defined as the time when the net force of the

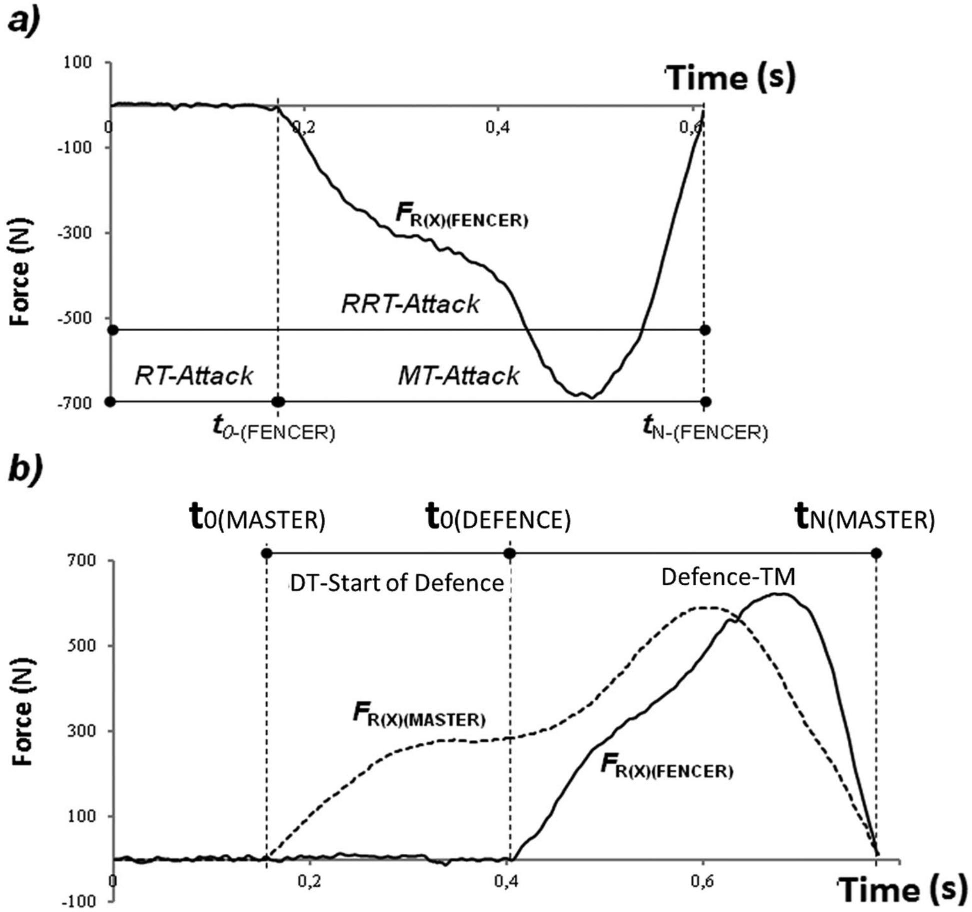

Figure 2. Time outline and horizontal force values obtained (FR(X)) for one of the participants in the experimental situation CRT, where the fencer performed both, an attack (a) and a defensive action as a response to master's attack (b).

horizontal component reached a value $\geq 1\%$ of the master's or the fencer's body weight, respectively.

The horizontal acceleration of the centre of mass (CM) was calculated as the horizontal net force yielded by the two plates (FX(A) and FX(B)) added to the fencer's or master's body mass. Progressive horizontal velocities ($\boldsymbol{v}_{(X)CM}$) and displacements ($\boldsymbol{s}_{(X)CM}$) were calculated from the horizontal acceleration-time values using trapezoidal integration. Using these data, we calculated the velocity and horizontal displacement of the fencer's CM at the end of the attack (*$Vx_{(CM)}$-MT-Attack and $Sx_{(CM)}$-MT-Attack,* respectively) for the two experimental situations and estimated their truncated value at the lowest time obtained for each situation (*$Vx_{(CM)}$-Truncated MT y $Sx_{(CM)}$-Truncated MT,* respectively).

For the situations where the fencer had to perform a defensive action, we calculated master's velocity and horizontal displacement of the CM at the initiation of the defensive movement (*$Vx_{(CM)\text{-}ATTACK}$-Start of defence $Sx_{(CM)\text{-}ATTACK}$-Start of Defence,* respectively), as well as the horizontal displacement of the master's and fencer's CM at completion of the master's attack (*$Sx_{(CM)}$-MT Attack and $Sx_{(CM)}$-MT Defence,* respectively) for the two experimental situations.

Statistical analysis

Data are expressed as mean (*M*) and standard deviation (SD) for each experimental situation. Analysis of variance of repeated measured (ANOVA) was performed to determine whether there were statistically significant differences in the means obtained for experimental situation. To confirm test reliability, we used the analysis of variance of repeated measures of all the trials performed in the two experimental situations (five trials per situation) using as dependent variables the fencer's reaction time in the situations where the fencer had to perform the attack (*RT-Attack*) and the delay for the situations where the fencer had to initiate the defensive action (DT-*Start of defence*). The intra-class correlation coefficient for these variables was 0.850 ($p < .001$) and 0.930 ($p < .001$) for *RT-Attack* and 0.904 ($p < .001$) and 0.801 ($p < .01$) for DT-*Start of defence*, in the two experimental

Table I. Descriptive (mean values with standard deviations) and inferential statistics for reaction-response times and kinematic variables for the two experimental situations (RT and CRT) for the trials where it was the fencer who performed the attack following the appearance of a visual stimulus.

Variables	RT	CRT	*F*
Reaction time of attack, RT-Attack (s)	0.169 ± 0.021	0.225 ± 0.053	32.36***
Motion-time of attack, MT-Attack(s)	0.475 ± 0.041	0.479 ± 0.040	0.66
Reaction-response time of attack, RRT-Attack (s)	0.644 ± 0.050	0.703 ± 0.068	25.45***
Horizontal velocity of the fencer's CM at the end of the attack, ($Vx_{(CM)}$-MT-Attack (m/s)	2.27 ± 0.24	2.20 ± 0.24	2.78
Horizontal displacement of the fencer's CM at the end of the attack, ($Sx_{(CM)}$-MT-Attack (m)	0.46 ± 0.06	0.44 ± 0.07	2.87
Horizontal velocity at truncated value at the lowest time, $Vx_{(CM)}$-truncated MT (m/s)	2.26 ± 0.23	2.16 ± 0.24	10.07**
Horizontal displacement at truncated value at the lowest time, $Sx_{(CM)}$-truncated MT (m)	0.44 ± 0.061	0.41 ± 0.071	14.84***
Touches-attack (%)	18.7 ± 0.25.6	29.3 ± 27.8	4.57

The values shown are the mean ± SD of the eleven reaction times measured.
***$p < .001$.
**$p < .01$.
*$p < .05$.

situations, simple reaction time and CRT, respectively. Results were analysed using the statistical analysis package SPSS v 20.0 for Social Sciences.

Results

Table I shows descriptive and inferential statistics for reaction-response times for the two experimental situations and for simple reaction times (RT) and dual-task times (CRT) for the trials where it was the fencer who initiated the attack following the activation of a light signal. The data indicate that the reaction time (*RT-Attack*) was significantly greater in the CRT situation ($p < .001$). However, no statistically significant differences are observed in the means of motion-times of the two experimental situations (MT-Attack). This means that differences in reaction-response times (*RRT-Attack*) were due to the *RT-Attack*.

Regarding the mean velocity and horizontal displacement of the fencer's CM at the end of the attack, no statistically significant differences were found between the two experimental situations, yet values tended to increase in the simple reaction time (RT) situation. When comparing velocity and horizontal displacement of CM at the same time, that is, when fencers' data are truncated at the lowest of the two motion-time values for each experimental situation (RT and CRT), the horizontal displacement of the CM (*$Vx_{(CM)}$-Truncated MT*) was significantly higher when the attack was performed in a RT situation (2.26 m/s vs. 2.16 m/s; $p < .01$). Further, the horizontal displacement of the fencer's CM (*$Sx_{(CM)}$-Truncated MT*) also increased significantly when the attack was performed in the RT situation (0.44 m vs 0.41 m; $p < .001$). Hence, the mean horizontal force was higher when the fencer performed the attack after a single response stimulus. Finally, Table I also displays the percentage of valid trials where the fencer could hit the master in his attack action (four for each fencer and experimental situation) (*Touches-Attack*). There were more valid trials in the CRT experimental situation, although differences were not statistically significant.

Table II shows reaction-response values for the two experimental situations (RT and CRT) for the trials where it was the fencer who performed the defensive action in response to a lunge (stimulus) of his opponent. The defending fencer's delay to initiate the defensive action (DT-*Start of defence*) tended to increase in dual-task situations (CRT), although differences between the means of the two experimental situations were not statistically significant. Something similar occurred concerning the motion-time used by the defending fencer to move away from his opponent (*Defence-MT*); however, values tended to increase for the simple reaction time situation (RT), although differences between mean values were not statistically significant either.

The kinematic values for the master's and fencer's CM show the same tendency as the time parameters described above. Thus, no statistically significant differences were observed in the means of the master's CM displacement and horizontal velocity at the start of the defensive action in the two experimental situations (*$Sx_{(CM)}$-$_{ATTACK}$-Start of Defence $Vx_{(CM)}$-$_{ATTACK}$-Start of Defence*, respectively), although values tended to increase in the CRT situation. Table II shows the central tendency values for the master's CM displacement at the start of the attack (*$Sx_{(CM)}$-MT-Attack)* and the fencer at Start of the defensive action *($Sx_{(CM)}$-MT Defence)* for the two experimental situations. Central tendency values are similar in the two situations. Finally, we also provide the percentage of valid trials where the fencer was hit by the master (five for each fencer

Table II. Descriptive (mean values with standard deviations) and inferential statistics for defensive reaction-response times and kinematic variables for the two experimental situations, simple reaction time (RT) and CRT for the trials where it was the fencer who performed the defensive action as a reaction to their opponent's lunge.

Variables	RT	CRT	*F*
Time to start the defence, DT-Start of Defence (s)	0.239 ± 0.020	0.245 ± 0.024	2.07
Defensive movement time, Defence-MT (s)	0.371 ± 0.034	0.355 ± 0.047	2.47
Master's horizontal displacement at the initiation of the defensive movement, $Sx_{(CM)}$-ATTACK-Start of Defence (m)	0.061 ± 0.015	0.066 ± 0.015	2.04
Master's horizontal velocity at the initiation of the defensive movement, $Vx_{(CM)}$-ATTACK-Start of Defence (m/s)	0.67 ± 0.11	0.70 ± 0.10	2.69
Horizontal displacement of the master's CM at completion of the master's attack, $Sx_{(CM)}$-MT-Attack (m)	0.61 ± 0.03	0.60 ± 0.04	1.19
Horizontal displacement of the fencer's CM at completion of the master's attack, $Sx_{(CM)}$-Defence-MT (m)	0.23 ± 0.043	0.23 ± 21.7	0.22
Touches-defence (%)	1.3 ± 6.7	14.7 ± 0.053	9.60**

Note: The values shown are the mean ± SD of the 11 reaction times measured.
***$p < .001$.
**$p < .01$.
*$p < .05$.

and experimental situation) (*Touches-Defence*). Although percentages were low, clear differences are observed between the means of the two experimental situations, since the percentage of touches was higher in the CRT situation ($p < .01$).

Discussion and implications

As expected, the reaction time to perform an attack after a visual stimulus increases when two stimuli associated with two responses are presented (CRT) as compared to the simple reaction time (RT), which is consistent with Hick's Law, taking into account that both situations are externally paced acts, due to the necessary experimental control (Singer, 2000). The results obtained in our study are in agreement with those reported by Gutiérrez-Dávila et al. (2013b), Gutiérrez-Dávila, Zingsem, Gutiérrez-Cruz, Giles, & Rojas (2014); Williams and Walmsley (2000a) and Mouelhi Guizani et al. (2006a) used and that is, CRT increases with respect to simple reaction time (RT). However, no significant differences were found in the mean attack motion-time values (*MT-Attack*) for the two experimental situations. This is consistent with the results obtained by Williams and Walmsley (2000a), since it evidences that response patterns show high consistency and demonstrates that, once the attack movement is initiated, only one muscle coordination control process is initiated. This may mean that dual-task has no effect on the forces exerted during motion.

Apparently, the results obtained confirm this hypothesis since no statistically significant differences were found in the mean velocity and horizontal displacement of the fencer's CM at the end of the attack (*$Vx_{(CM)}$-MT-Attack and $Sx_{(CM)}$-MT-Attack,* respectively) between the two experimental situations. However, it is worthy of note that the mean velocity and horizontal displacement of the fencer's CM at the end of the attack were slightly higher in the sRT situation, which may be explained by individual differences in the *MT-Attack* of each fencer and experimental situation. If we eliminate this effect by truncating *MT-Attack* values at its lowest value (*$Vx_{(CM)}$-Truncated MT and $Sx_{(CM)}$-Truncated MT,* respectively) clear differences are observed between the two experimental situations, since velocity and horizontal displacement of the CM are significantly higher in the sRT situation. This means that dual-response reduced the mean horizontal force exerted by the fencer during the attack. This might be explained by the double-response inhibition process that starts in CRT to prevent errors (Duque, Lew, Mazzocchio, Olivier, & Ivry, 2010; Gao, Wong-Lin, Holmes, Simen, & Cohen, 2009).

According to Duque et al. (2010), the CRT situation might cause the activation of the two potential responses (step-forward attack and defence by stepping backwards); this would require the generation of inhibitory signals for impulse control at molecular level, waiting for the input that makes one of the two responses prevail; then the second cortical inhibition mechanism would activate. Apart from explaining the increase in *RT-Attack* in CRT situations with respect to RT, this inhibition processes might reduce the rate of force development at the start of the movement; this is of special relevance considering that response in CRT situations requires different movement patterns and the inhibition mechanisms mentioned above are not activated in RT situations, as suggested by Schluter, Rushworth, Passingham, and Mills

(1998), who highlighted the major role that the premotor cortex plays in the selection of movements after a visual stimulus. Furthermore, following Bianco, Di Russo, Perri, and Berchicci (2017) and Zhang, Ding, Wang, Qi, and Luo (2015), using electrophysiological measures with high temporal resolution, during laboratory cognitive tasks, it is possible to draw conclusions about brain activity that might account for the behavioural performance. Accordingly, the expert fencers might develop a preparatory strategy, which involves high effort on both motor and cognitive preparation in order to maintain both efficient reactivity and accuracy during choice reaction tasks.

As to defensive response time parameters, when the fencer reacts to his/her opponent's attack movement, the results are very different (see Table II). Although the delay time until the start of the defensive action tended to increase in the CRT situation (DT-*Start of defence*), no significant differences were found between the means in the two situations. This confirms the hypothesis that in real situations the selective inhibition that activates in attentional processes might reduce differences in *DT-Start of defence* between the two experimental situations (Posner & Dehaene, 1994; Tudela, 2011). In agreement with Hijazi (2013), the human being has a selective neural capacity to detect and process relevant information, which can be improved by training with stimuli that are similar to those presented in real competition. Hence, this inhibition mechanism might be present in elite fencer in the two experimental situations, which would explain the minor differences observed in the mean values for *DT-Start of Defence* in the two experimental situations.

Further, the results obtained in this study confirm other general theories that question the applicability of Hick's Law due to the effects of training (Hale, 1968; Mowbray & Rhoades, 1959). The effect of training and the complexity of real stimuli were used by Williams and Walmsley (2000a) to explain the discrepancies observed regarding the invariability of CRT when the number of responses doubled from two to four. This suggests the major role that attention plays in dynamic situations of real competition. According to this hypothesis, the discrepancies observed in RT in fencing may be a result of trying to determine the relevance of RT by comparing elite fencers with young fencers or no fencers and using the paradigm of reaction time to visual stimuli by pressing keys (Borysiuk & Waskiewicz, 2008; Johne et al., 2013), moving a joystick (Delignières, Brisswalter, & Legros, 1994) or initiating a fencing action from a static position (Gutiérrez-Dávila et al., 2013a; Williams & Walmsley, 2000b). In these situations, the level of attentional practice and motor execution is probably similar in the two groups. Harmenberg et al. (1991) confirmed that RT is only correlated with fencer performance when the stimulus is the opponent's movement and in CRT situations.

The fact that there is a tendency to delay the Start of the defensive action in dual-response (CRT) might explain that velocity and horizontal displacement of the fencer's CM at that time also tends to increase in the CRT situations, although differences in the mean values for each experimental situation are not statistically significant. The displacement of the CM of the attacking fencer and the defending fencer indicate that the mean distance between the master's and the fencer's CM decreases by 0.38 ± 0.06 m and 0.37 ± 0.06 m for the RT and CRT situation, respectively. Previous studies with a protocol similar to ours confirm that the mean displacement of CM to hit a fixed target is 0.41 ± 0.07 m (Gutiérrez-Dávila et al., 2013a). According to these studies, the attacking fencer's CM remains at a mean distance of 0.03 and 0.04 m from the target for the RT and CRT situations, respectively. This confirms that the distance used in our study was appropriate, since it caused the desired stimulus in the defending fencer. It is of note the ability that elite fencers have to dodge the hit without moving away too much, which allows them to simultaneously react to their opponent's defensive action.

The fact that the proportion of touches is higher when the fencer attacks than when s/he performs a defensive action in the two experimental situations (*Touches-Attack* and *Touches-Defence*, respectively – see Tables I and II) – is due to the physical and technical differences among elite fencers (some of which are world champions) and the master. As expected, the percentage of touches was higher in the CRT situation, although differences between the two experimental situations only were significant in the mean number of touches on the fencer when s/he performed a defensive action, which is suggestive of the major role that attention and concentration play on dual-response tasks.

Conclusions

What primarily led us to perform this research study was the subjective observation that fencing masters rarely use the dual-task paradigm in their training lessons. After some reflections, we concluded that fencers' ability to anticipate their opponent's intentions – which is closely related to perceptual and attentional processes – is developed by attacking different fencers with a similar level of expertise. Nevertheless, including strategies associated with perceptual and attentional processes in fencing lessons would probably not improve fencers' ability to anticipate their opponent's actions. Also, it might have a negative impact on force and coordination in response movements and add extra uncertainty, which would interfere with the learning of tactical actions.

This study confirms the conclusion of Borysiuk (2006) that perceptive and attentional processes should be developed by training. In other words, improving fencers' ability to recognise the most revealing signs of an opponent's movement is crucial and should be achieved through intensive training in conditions similar to those of real competition.

The results lead us to question the usefulness of using RT to discrete visual stimuli (light signals) as a predictor of performance in fencing. Consequently, the results of the tests so far performed should be taken with caution. Further tests should be performed where moving stimuli similar to those of real competition are used and where the complexity of response can be increased.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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