STAYING OUT OF RANGE: INCREASING ATTACKING DISTANCE IN FENCING

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ABSTRACT

To avoid being hit, fencers typically adopt an out of range position, which was hypothesized to be governed by body- and action-scaled affordances. This theory was measured in elite and national level junior (u20) fencers. Associations between "reachability" of lunging and step-lunging attacks, was assessed against height, arm-span, leg-span, body mass and lower-body power, and then compared across level. Reachability was determined as the distance covered by fencers during these attacks and was reported as actual and estimated distances. Elite fencers are better at estimating their lunging and step-lunge distance compared to national ranked junior fencers (-0.9 *vs.* 7.3 % and 5.4 *vs.* 10.9 % respectively). Surprisingly, elite fencers' actual and estimated distances for these was less than the junior fencers' (222.6 *vs.* 251.5 cm and 299.3 *vs.* 360.2 cm respectively), and significantly so in the former. Finally only arm (r = .81) and leg span (r = .71) were significantly correlated to estimated lunging distance and this was only in elite fencers. Findings suggest that better fencers can accurately predict their attack range and that reachability appears to be positively influenced by arm and leg-span; these may feed in to talent identification. Given that distances were less in elite fencers, findings suggests that timing and distance estimation are key skills to master, and that the mastery of these in offensive actions can mitigate to a large extent, the physical benefits of an opponent's greater height.

INTRODUCTION

Fencing is a combat sport, where in simple terms, the goal is to hit the opponent while avoiding being hit. In this regard, it is similar to other striking sports such as boxing and taekwondo for example. As sport scientists we must appreciate this dynamic and determine which the athlete and their coach favors. This may be staying within close proximity of the opponent allowing for striking in the shortest time, or staying out of range of an opponent's strike, but inversely affecting the delivery time of striking. Albeit indirectly, this was previously examined by Turner *et al.*,[1] where it was found that fencers who were more powerful in their lower body, seemed to favor using this advantage to move further away from their opponent and take up a greater out of range position. This was as opposed to maintaining distance and transferring this enhanced propulsive ability to striking in a shorter time. Therefore a fundamental tenet to performance in fencing, and possibly combat sports in general, is facilitating an increase in attacking distance. As such, sport scientists must determine the physical characteristics that govern this.

Also fundamental to performance is the ability of fencers to judge distance, or as described by Chen and Liu,[2] "reachability". These investigators found that compared to non-fencers, a group of collegiate fencers were more accurate at predicting this. In this study, participants' estimated striking distances were compared to their actual striking distance, and while the estimate was always in excess of the actual, this bias was less in fencers (mean ratio of 1.04 *vs.* 1.09 respectively). This finding was attributed to their experience and potentially explained through the theory of affordances.[3] The affordance theory, and in particular body- and action-scaled affordances, suggests that an individual self optimises for a particular task based on their anthropometry e.g., leg-length (body-scaled) or on capabilities such as strength (action-scaled). For example, when a ball is thrown overhead, the affordance concepts aims to explain how an athlete knows not only when to jump, but even if to attempt to catch the ball in the first place; the decision to jump or not, will be based on their height, propulsive power and the actions of the opponent or the conditions of the environment.

The aim of this paper is to compare the estimation of attacking range in relation to performance level, and analyse the influence that physical capabilities has on it. Given the frequency with which lunging and step-lunges are used,[4, 5, 6] determinants of range in these attacks will be examined. Similar to Chen and Liu,[2] estimated and actual attacking distances will be compared to assess their judgment of reachability, but this will be done in elite and national ranked junior (u20) fencers. It is hypothesized that all measured physical characteristics will explain some variance in range, and that elite fencers will more accurately estimate this across both types of attack, as well as doing so from greater range.

METHODS

Experimental design

Given the high frequency with which lunges and step-lunges are preformed in competitive bouts, these are the dependent variables. The independent variable is performance level (elite *vs.* national) and also (during correlational analysis) height, arm-span, leg-span, body mass and lower-body power, which have equally been shown to relate to lunge velocity.[6] To extend the work of Chen and Liu,[2] elite and national ranked junior (u20) fencers will be used, in addition to examining step-lunges. Groups will be compared for precision of actual *vs.* estimated attack distance. This sample enables the generalization of results to high level fencing, and may explain, in part, differences between levels of fencer; this may be important information to fencing coaches and guide training drills. Correlational analysis of independent variables with dependent variables will determine the magnitude of each physical characteristic. In the case of lower body power, this may justify the use of strength and conditioning programming. In the case of anthropometrics, this may inform coaches of particular statures that favor out of range positions and thus feed in to talent identification where this is considered fundamental.

Subjects

Subjects were elite (n = 8) and national level junior (n = 17) fencers aged 22.6 ± 2.5 and 17.7 ± 2.2 years of age respectively; physical characteristics are identified in Table 1. Institutional review board approval was granted, in the spirit of the Helsinki Declaration, and subjects or guardians where relevant provided written informed consent before taking part in the research. In order for fencers to participate in this study, they had to be considered free from injury and illness and of good fitness.

Anthropometric data

Body mass was measured to the nearest 0.1 kg with a pre-calibrated electronic weighing scale (Seca Alpha 770, Birmingham, UK). Stature was measured to the nearest 0.1 cm with a stadiometer (Seca 220, Birmingham, UK). The measurement was taken as the maximum distance from the floor to the highest point (vertex) on the skull. Leg-span was measured as the linear distance between the medial malleolus of each leg during a split in the frontal plane,[7] and arm span was measured as the linear distance between the middle finger tips, with the arms out to the side and parallel to the ground. All scores were recorded to the nearest 0.1 cm, using flexible tape, and measured by the same investigator.

Lower-body Power

The standing broad jump (SBJ) was used to define this variable as it is considered a better indicator of lunging performance than vertical jumping ability;[6] it is thus more pertinent to fencing. The SBJ was measured using a flexible tape measure, placed along the ground. Fencers had to jump as far forward as possible, keeping their hands on their hips. If the fencers fell forward at landing, causing their feet to change position, the jump was disqualified. Scores were recorded to the nearest 0.1 cm, and in line with the heel of the foot furthest back. For tests of lower-body power, three trials were conducted for the determination of reliability, with the highest score used for subsequent analysis.

Estimated *vs.* actual lunging distance

A target area consisting of a round pad with a diameter of 24 cm was set up and the fencer could adjust the height of the target.[6] Fencers had to position themselves in the *en guard* position, as if they were to cut (sabre) or hit (épée or foil) the target using a lunge and then a step-lunge. Following this, fencers were able to take practice attempts to provide a more precise position. In all conditions, the distance from the tip of the front shoe to the base of the target was recorded. Using a target ensures the appropriate depth of offensive action, as attacks must land with at least the minimum penetration *i.e.*, the minimum bend of the sword blade required to depress the tip of the blade for the point weapons, or striking with the furthest part of the blade for sabre. This again builds on the work of Chen and Liu[2] where it would seem that any strike, however deep, was recorded. When estimating distance, three measures from each attack type were recorded, with the average score from each used. This was to determine the reliability of the test, which was further facilitated by alternating between stationary and step-lunges after each trial.

Statistical Analysis

Measures of normality were assessed using the Kolmonogrov-Smirnov statistic. To determine the reliability of the SBJ and estimated distances, single (SBJ) and average (distance) measures intraclass correlations (two-way random with absolute agreement) between trials were conducted. Pearson's Product Moment Correlation analysis was used to identify relationships between variables. Independent samples *t*-tests were used to examine differences between groups (elite *vs.* junior) across each measured variable with Levene's test used to assess the equality of variances. These statistical analyses was conducted using Statistical Package for Social Sciences (SPSS) version 21, with the level of significance set as $p < .05$. The strength of association (r) was graded as follows: .0 - .19 as very weak, .2 - .39 as weak, .4 - .59 as moderate, .6 - .79 as strong, and .8 - 1 as very strong correlations.[8] Accuracy of range, or rather the lunge and step-lunge ratio, was calculated as follows: (actual distance – estimated distance)/actual distance. Accuracy was presented as a percentage.

RESULTS

Data was normally distributed, equal variance was assumed, and ICCs demonstrated a high level of rank-order repeatability between trials: SBJ = .94, estimated lunge distance = .96, and estimated step-lunge distance = .95. Table 1 shows the test scores for each level, where significant differences were noted in mass, $t(23) = -2.21$, $p = .037$, actual lunge distance, $t(23) = 2.15$, $p = .042$, actual step-lunge distance, $t(23) = -2.27$, $p = .033$ and lunge ratio, $t(23) = -2.62$, $p = .015$. Significant moderate and strong correlations were only noted in the elite group during estimated lunging (Table 2). These were for leg span ($r = .71$) and arm span ($r = .81$) respectively.

Table 1 and 2 about here

DISCUSSION

This is the first study to specifically address the physical characteristics associated with staying out of range in fencing, and investigate estimated *vs.* actual offensive distances at the elite level. Our hypothesis was only partially correct. Elite fencers are indeed better at estimating their lunging and step-lunge distance compared to national ranked junior fencers (-0.9 *vs.* 7.3 % and 5.4 *vs.* 10.9 % respectively), but elite fencers actual and estimated distance was less (222.6 *vs.* 251.5 cm and 299.3 *vs.* 360.2 cm respectively). Finally, only arm and leg-span were significantly correlated to estimated lunging distance and this was only in elite fencers.

The better prediction of distance made by elite fencers is not surprising and supports the findings of Chen and Liu.[2] In the current study, it was shown that elite fencers are very precise, particularly from a lunging range where there was < 1% difference between actual and estimated distances; this in part may explain their heightened competition performance compared to lower level fencers. It is interesting to speculate if this is a skill that is developed with experience only in competition, or one that can be expedited through purposeful practice in the training environment. Given that this appears to be a distinguishing feature of elite level fencers, it is a finding that should be explored further within a coaching context. In contrast to Chen and Liu,[2] there seems to be an underestimation of actual attacking distance. In essence this suggests that fencers are standing closer to their opponent than required. The difference is not large in elite athletes (and again may explain their superiority) but is in national level fencers. Such errors in judgment may leave them more likely to be hit. We must acknowledge the static position from which fencers initiated their attack; fencing is a dynamic sport, and attacks would normally and habitually be delivered on the move.

Perhaps the most surprising finding, and contrary to the hypothesis, is that the junior (and thus lower level) fencers' actual and estimated distances for lunging and step-lunges were greater than that of the elite fencers. Furthermore, these differences were significant for both tests of actual distance. Naturally it would be prudent to deem that these fencers are using excessive ranges, as oppose to the elite fencers under performing, especially as they had lower values for anthropometric and lower body power testing. Again, information here is best served via further analysis from a coaching perspective. It may highlight their desire to stay out of range, only progressively reducing this distance in line with technical and cognitive improvements and thus increased confidence in fencing ability.

Greater relationships between the measured physical characteristics and actual distances were anticipated. In junior fencers, the lack of association appears plausible given their exaggeration of distances. In elite fencers however, and especially given the precision of lunging, the subconscious assessment of these (i.e., body-scaled and action-scaled affordances) was expected to be more indicative of range. That said our sample was small and thus unable to significantly detect the lower range of coefficients that would be classed as "strong" associations (i.e., r = .6 - .79). For example, our finding of what would be a strong relationship with height and moderate relationship with SBJ to estimated lunging is similar to Turner et al.,[6] and Tsolakis *et al.*,[9] but must be ruled as a casual association herein. Furthermore, it was previously hypothesized that smaller fencers compensate for a reduced lunging range by becoming more powerful, and so more maneuverable.[6] This acts to even out the advantage of the taller fencer and may also explain the lack of associations found herein. Also, anecdotally, smaller fencers tend to be more reliant on timing and accuracy of attack or counter-offence, rather than going for greater range. Of course it may simply be that the fundamental variable to striking range was not identified. Currently however, data may be used to support arm and leg-span assessment as part of talent identification; leg-span training may be in part improved via developing good adductor flexibility. While we certainly recognize that our sample size and thus statistical power represent limitations to this study, it was not possible to increase participant numbers without diluting the level of fencer involved.

In conclusion, the evidence here supports the concept that better fencers understand their attack range over both lunge and step-lunge distances when faced with a static target. Given that distances were actually less too, it may be that knowledge of one's attack range is what actually relates to the successful application of tactics. This may therefore lead us to the concept that it is not absolutely how far a fencer can lunge or attack, but that they know how far that distance is, and the speed (thus time) they can do it. This would seem to be a skill that can be coached. This supports one of the central tenets of coaching fencing, i.e., timing and distance are key skills to master, and that the mastery of these in offensive actions can mitigate to a large extent, the physical benefits of an opponent's greater height.[10] Nevertheless, increasing striking distance, or if alternate terminology is preferred, being able to maintain a greater out of range position, is still considered important to performance, and is the advantage referred to when describing an opponent as a "taller fencer". However, because fencers have typically "played" themselves fit, this quality has generally been left to develop naturally and governed by anthropometry. As physical preparation coaches become more influential in the development of fencers, reachability may become a more sought after attribute with some training dedicated to this. It would certainly be of interest to revisit the area of affordances should this happen. Furthermore, investigating this theory under fatigue would be equally revealing. Such a scenario would represent the inevitable moments experienced by fencers, as they progress to the knockout stages of fencing competitions, and are faced with progressively closer contests.

PRACTICAL APPLICATIONS

Fencers need to understand and accurately determine their attack range or reachability at both lunge and step-lunge distances; this seems to be an important factor to performance and is indicative of fencing level. If an attack is too deep, it will land the fencer dangerously close to their opponent and give a serious risk of the attacker being hit with a counter-action before they can deliver their own offense. Too short an attack means, quite simply, that they miss the target completely, and again, leave themselves exposed to a counter-attack. Reachability appears to be positively influenced by arm and leg-span and thus may influence talent identification.

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Table 1. Anthropometry, standing broad jump (SBJ), and lunging distances (*M* ± *SD*), and ratios of estimated to actual lunging distances in junior and elite level fencers.

Level	Height (cm)	Mass (kg)	Arm Span (cm)	Leg Span (cm)	SBJ (cm)	Estimated Lunge (cm)	Estimated Step-Lunge (cm)	Actual Lunge (cm)	Actual Step-Lunge (cm)	Lunge Ratio (%)	Step-Lunge Ratio (%)
Junior (*n* = 17)	182.2 ± 6.1	74.4 ± 8.0	187.4 ± 6.8	169.9 ± 11.3	211.2 ± 10.1	233.1 ± 31.3	321 ± 46.9	251.5 ± 30.9*	360.2 ± 68.4*	7.3*	10.9
Elite (*n* = 8)	182.5 ± 6.8	83.1 ± 11.2*	190.1 ± 9.4	181.1 ± 23.0	215.9 ± 15.1	224.6 ± 25.7	283.1 ± 38.2	222.6 ± 31.4	299.3 ± 49.6	-0.9	5.4

*** = Significantly greater at *p* < .05**

Table 2. Correlations of anthropometry and standing broad jump (SBJ), with estimated and actual lunging distances in junior and elite level fencers.

	Elite (*n* = 8)				Junior (*n* = 17)			
	Estimated Lunge	Estimated Step-Lunge	Actual Lunge	Actual Step-Lunge	Estimated Lunge	Estimated Step-Lunge	Actual Lunge	Actual Step-Lunge
Mass	0.47	0.02	0.33	0.00	-0.26	-0.14	-0.27	-0.14
Height	0.67	0.08	0.31	0.08	0.11	-0.11	-0.16	-0.22
Arm span	0.81*	0.40	0.63	0.38	0.18	-0.12	-0.08	-0.23
Leg Span	0.71*	0.46	0.59	0.43	0.13	0.08	0.01	-0.07
SBJ	0.51	0.49	0.23	0.39	0.18	-0.01	0.01	-0.05

*** = Significantly correlated at *p* < .05**