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Comparison Of Running Times During Reactive Offensive And Defensive Agility Protocols

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COMPARISION OF RUNNING TIMES DURING REACTIVE OFFENSIVE AND DEFENSIVE AGILITY PROTOCOLS

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INTRODUCTION

In game situations the execution of a successful agility maneuver requires thought processing and problem solving in a constantly changing environment (6,15,19). Sheppard & Young (15) proposed that agility is: “a rapid whole body movement with a change of velocity or direction in response to a stimulus” (p. 922). This definition considers both the physical and cognitive parameters that contribute to a successful agility performance (7,8,15). Several studies have assessed cognitive function in agility tests by the inclusion of an external sensory stimulus to create a reactive movement in order to distinguish between elite and novice athlete’s change of direction performance by replicating the demands of the sporting environment by creating visual and spatial uncertainty (7,8,13,17).

Until recently, athletes have been required to respond to stimuli such as illuminated light bulbs (3,4) and video recordings of players movement patterns (6,13) exposing the subject to a 2-D generic stimulus, failing to accurately replicate sport-specific decision making and anticipatory abilities in a 3-D environment (15). Sheppard and colleagues (16) addressed this issue by developing a reactive agility test (RAT) using a real person (human stimulus) performing one of four movement patterns for subjects to react to in the same direction as the human stimulus. The use of a person as the stimulus allows athletes with anticipatory expertise to recognise specific body cues early in stimulus presentation and respond faster, thus being able to discriminate between elite and novice performance more accurately than other generic stimulus (14,16). However, Sheppard and colleagues (15) only recorded the total movement time (TMT) of athletes to complete the RAT. This does not allow one to isolate and measure specific movement times to gain further insight into athletes decision making (DM) ability during a sporting situation. Gabbett and colleagues (8) and Young & Willey (19) addressed this limitation by measuring reaction time (RT), response movement time (RMT) and total movement time (TMT) enabling a clear distinction between elite and novice athletes DMT. Currently RAT’s have only examined performance differences between elite and novice athletes, however it remains unknown whether RAT’s utilising a human stimulus can differentiate between male and female agility performance.

The discussed RAT’s have only measured the movement time of athletes in the form of a compatible stimulus from a defensive perspective. Often players are required to respond in the opposite direction to opponents in offensive situations or run towards an open space on the court. In sport responding in the same direction of play as an opponent or a pass, where the stimulus and response occur on the same side, produces compatible mapping, whereas, moving in the opposite direction to an opponent will result in incompatible mapping as the stimulus and response occur to opposite sides. Stimulus response (S-R) compatibility is determined by the spatial correlation between the stimulus and appropriate response (9) and is known to affect the rate of information processing and speed of the upcoming motor response. Several studies investigating the effects of S-R compatibility have concluded that RT is faster following a compatible stimulus (1,5,9), as the automatic response corresponds to the required response resulting in rapid motor activation, and faster DM ability (9). Thus, a clear advancement in methodological design would include measuring the movement times of male and female subjects during both offensive and defensive situations.

Therefore the purpose of the present study was to determine the differences in specific movement time variables; reaction time (RT), response movement time (RMT) and total movement time (TMT), between genders as well as offensive and defensive conditions during a RAT using a human stimulus.

METHODS

Experimental Approach

Subjects completed reactive offensive and defensive change of direction movements in response to a human stimulus to measure agility performance. Specific movement times (RT, RMT and TMT) were identified using a high-speed camera sampling at 240 Hz and timing light system to determine if a significant difference was observed between genders and offensive and defensive conditions.

Participants

Participants included male (n =12) and female (n = 12) sport science students, recruited from Edith Cowan University (22.43 ± 3.14 years; 174.31 ± 10.04 cm; 71.27 ± 14.99 kg). The participants were void of any lower limb injuries at the time of testing, had no previous history of major lower limb injury, and had no significant vision problems. The university ethics committee approved the study, and written consent was obtained from each participant before commencement of testing.

Procedures

The 4 movement patterns that were used in this study, as the stimulus for the subjects to respond have been previously utilised in agility tasks to create a reactive environment (8,16). Each movement pattern will be presented in a random order and will consist of:

1. Step forward with the left leg then right leg then change direction to the left
2. Step forward with the right leg then change direction to the left
3. Step forward with the right leg then left leg then change direction to the right
4. Step forward with the left leg then change direction to the right

A single human stimulus that was experienced in performing each of the 4 movement patterns provided the change of direction stimulus for all subjects. The human stimulus was informed of which movement pattern to perform, and in which direction to move in (left or right) before the commencement of each trial. Subjects began on a marked line 9 metres away from the human stimulus and were instructed to run in a straight line towards them (Figure 1). Once the subject reached a line marked at 3 metres from starting position, the human stimulus initiated one of the 4 movement patterns. Subjects were instructed to react to the movements of the human stimulus by cutting at a 45° angle, either in the same or opposite direction before sprinting 2 metres to the left or right as specified by the movement type. Subjects were instructed to move in the same direction as the human stimulus during a defensive trial or in the opposite direction during an offensive trial before the commencement of each agility assessment.

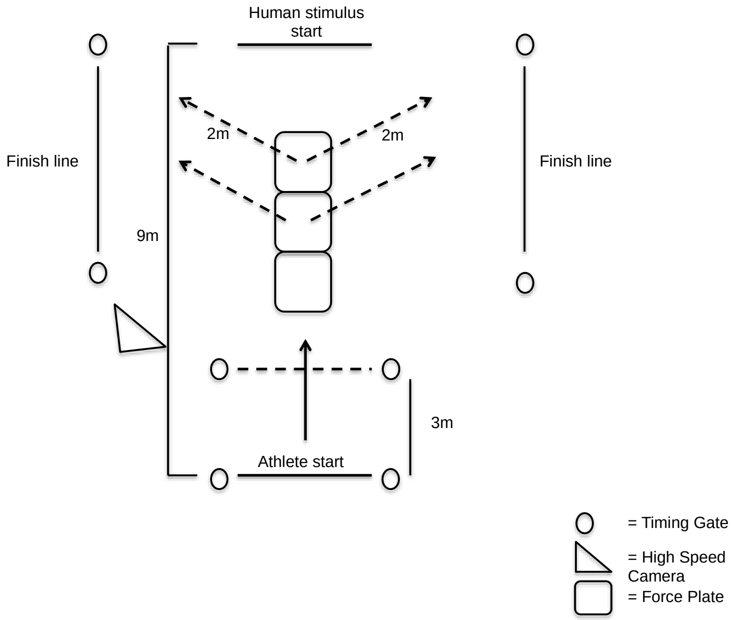

Figure 1: Reactive agility test (RAT) layout

Subjects completed 12 offensive and 12 defensive trials; 6 to the left and right, for each movement pattern totaling 24 trials. To ensure reliability between trials, the human stimulus was trained in all movement scenarios and wore similar clothing for each trial. Tape was placed on the ground to ensure step lengths of the human stimulus were consistent between trials, with reliability of the movement patterns performed by the human stimulus assessed in a previous study. During each agility protocol, for a trial to be deemed successful the subject must contact their whole foot on the force plate without targeting the plate, run at the set approach speed 4.5 m/s, cut at the required angle, perform a side-step cut only and respond in the correct movement direction as indicated at the beginning of each trial.

Specific movement times were identified throughout the RAT for each subject. TMT during the RAT was measured using a dual beam infra-red timing light system (Speedlight Timing System, Swift Performance Equipment). Timing commenced when the subject initiated movement through the first timing gate and finished when the subject ran through the last gate (Figure 1) either to the left or right after changing direction. RT and RMT within TMT were recorded using a digital high-speed video camera (Sony HDD Camcorder HDRXR550V, Sony Australia) and identified by counting the recorded frames in silicon coach (Version 6.1.5.1, SiliconCOACH Ltd). The camera was mounted above and behind the subject to enable clear identification of feet positioning of both the human stimulus and subject. RT was identified as the time between initial foot contact of the human stimulus for the side step change of direction, to the initial foot plant of the subject to change direction in response. RMT was identified as the time between initial foot contact of the subject to initiate the change of direction to running 2m at a 45° angle to the last timing gates.

Statistical Analysis

Comparisons for all independent variables (RT, RMT and TMT) between genders and offensive and defensive conditions were performed using an independent t-test with unequal variances. All data was processed using SPSS software (v17.0, Chicago, IL), with a significance set at $p < 0.05$.

RESULTS

Mean ± SD for RT, RMT and TMT comparisons between genders are shown in Figure 2 and comparisons between offensive and defensive conditions are shown in Figure 3. Males demonstrated a significantly faster RT ($p = 0.000$) and TMT ($p=0.000$) than females (Figure 2). The greatest difference in time was observed in RT with a difference of 0.39 sec between genders, followed by TMT and RMT; 0.258 sec and 0.113 sec, respectively. Males also demonstrated a greater percentage of negative RT results or anticipation time (48.05% negative, 51.94% positive) than female subjects (29% negative, 70.99% positive). There were no significant differences in RT ($p = 0.389$), RMT ($p=0.786$) and TMT ($p=0.904$) (Figure 3) between defensive and offensive conditions when the groups were combined. Across both offensive and defensive conditions, significant differences were observed for RT between males and females during the defensive and offensive condition ($p = 0.000$), (Figure 4).

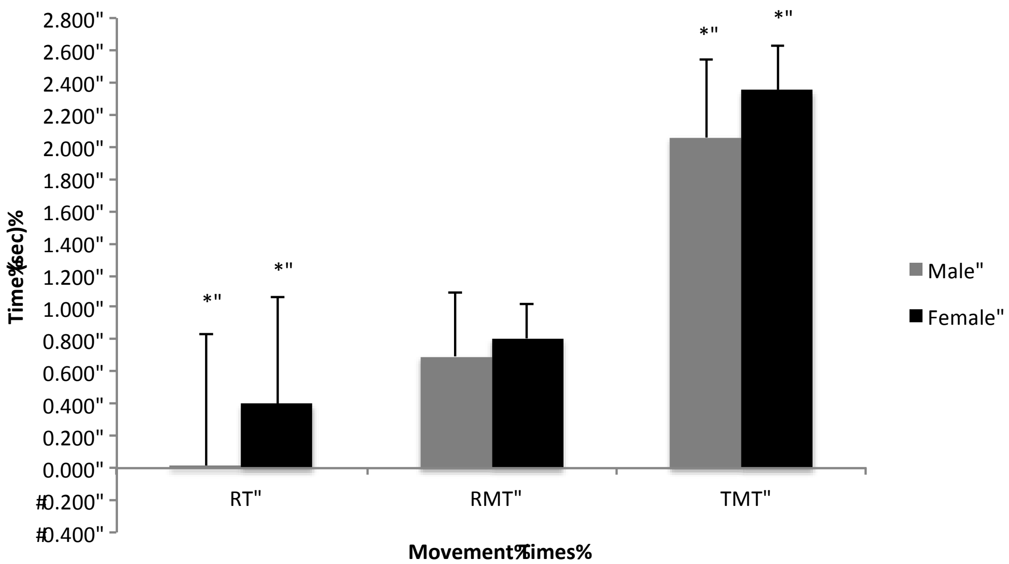

Figure 2: Gender differences in movement times
* Significant differences between means for males and females (p≤0.05)

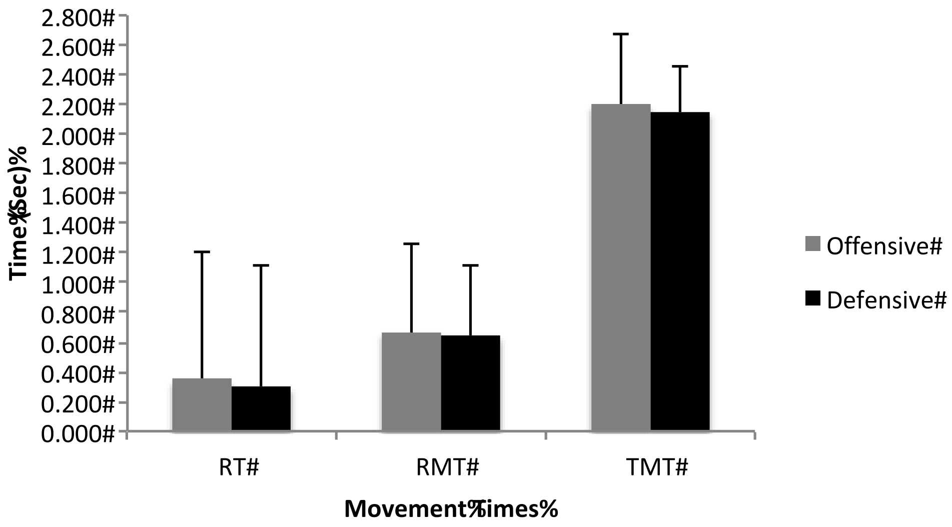

Figure 3: Differences in movement times between offensive and defensive conditions

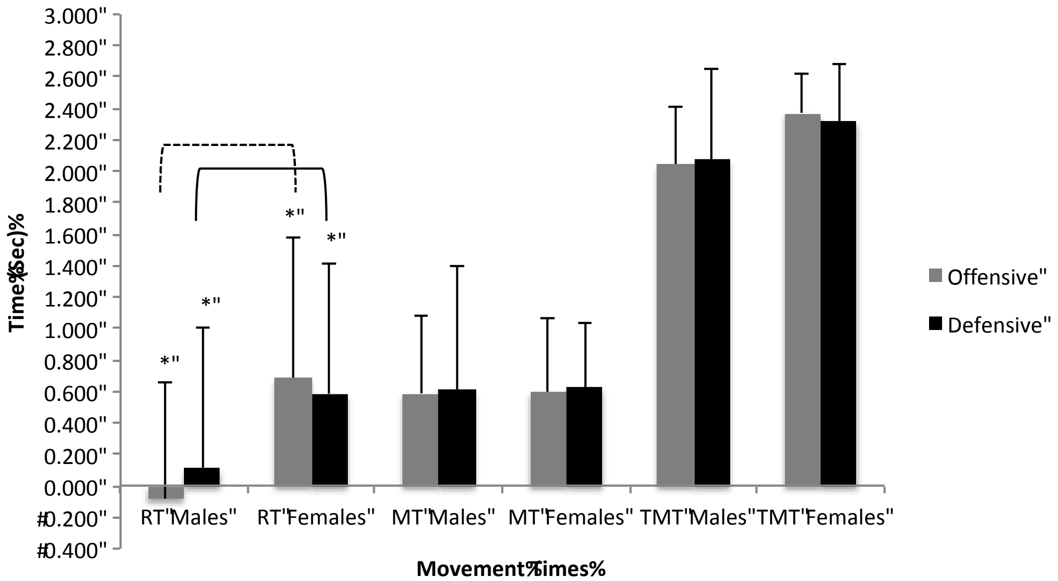

Figure 4: Gender differences in movement times between offensive and defensive conditions
* Significant difference in means between males and females (p≤0.05)

DISCUSSION

The purpose of this study was to determine the differences in specific movement time variables (RT, RMT and TMT) between genders, as well as offensive and defensive conditions during a RAT using a human stimulus. Previous studies have only investigated expert-novice differences in movement times during RAT's responding to a compatible stimulus from a defensive perspective. The current study has expanded on the results of previous studies, finding males produced faster RT, RMT and TMT than female subjects with faster movement times observed during the defensive compared to the offensive condition.

Limited research investigating gender differences in movement times during RAT's exist. Studies investigating gender differences in RT have used isolated lower body or upper body RT tests to provide a measure of RT, however the suitability of these measures to provide an indication of RT during a sporting situation is somewhat limited. Innate differences in RT between males and females have previously been attributed to different information processing strategies used and processing time (18). Adam (1) suggests that females employ a 'serial' reasoning strategy whereas males use a 'gestalt' strategy to process information. The 'serial' strategy adopted by females has been associated with greater interhemispheric interaction, which has been suggested to increase RT and DM ability (1). This supports the results of the current study as females displayed a longer RT than males, suggesting a longer processing time affects RT. Males also produced a greater ability to anticipate the upcoming action by eliciting a higher percentage of negative RT results then female subjects. Baker and colleagues (2) suggest greater ability to produce faster anticipation time is a result of the kinematic content available to subjects. Employing a human stimulus during reactive agility protocols increases the availability of specific body kinematic cues for subjects to identify, creating a more realistic and accurate measure of RT during a sport setting. A greater percentage of negative RT results demonstrated by male subjects indicate they have an improved ability to identify specific body cues necessary to make an accurate decision, faster then female subjects.

Differences in RMT and TMT were also observed between genders with males producing faster times than female subjects. Spierer and colleagues (18) reported similar findings, investigating lower body RT in male and female subjects during a straight sprint/acceleration task, measuring response times to auditory and visual stimuli. Findings suggest males demonstrated a faster RT during the visual stimulus condition in addition to an overall faster transit time and speed than female subjects. Other studies have suggested variations in RMT and TMT may be due to neuromuscular differences between genders. Differences in the quantity of type I and type II fibres, muscle tendon unit stiffness and strength have been identified to influence change of direction performance (11,12) and could also contribute to the faster RMT observed in male subjects. However these variables were not directly measured during the current study thus future research may wish to investigate this further.

Change of direction during sport is unpredictable, often in response to opposition player's movements (6). Offensive and defensive orientations are common during sport with many unplanned directional changes involved in both situations. Currently, RAT have only required athletes to move in the same direction as the stimulus in a compatible situation (4-6,8,13,14,17,16,19). However as players are required to respond in the opposite direction to opponents in offensive situations or run towards an open space on the court or field, measuring agility performance during both offensive and defensive situations or compatible and incompatible S-R conditions would be advantageous. Studies have shown faster RT is often observed during compatible S-R conditions as the required response can be processed within intrahemispheric nervous circuits in contrast to incompatible condition which requires a contralateral response and a transfer of information from one hemisphere to the other (9,10). The findings of this study support this observation as a faster RT was observed during the defensive condition compared to the offensive condition. However, when investigating gender differences between offensive and defensive conditions results indicate males display a significantly faster negative RT then females suggesting a pre-planned response or anticipation during the offensive condition compared to the defensive condition. This finding could indicate a "risk associated RT deficit" whereby differences in aggression, risk taking behaviour and arousal result in faster RT observed between genders and offensive and defensive conditions, specifically observed in the male populate in the current study. Faster RMT and TMT were also observed during the defensive condition for female subjects, whilst males produced faster response times during the offensive condition, however the specific cause for this is unknown. It can be assumed a faster RT would result in a faster RMT as the ability to organise information and prepare the body for the upcoming response in a shorter time period could result in a faster ability to execute the planned movement (RMT) that in turn would reduce TMT. However, further research is needed to identify the specific factors that contribute to a faster RMT and during compatible conditions.

CONCLUSION

In summary, the results of this study indicate differences in RT and TMT between genders and between genders for RT of offensive and defensive reactive agility conditions, highlighting the importance to measure specific movement times individually to gain further insight to athletes agility performance. Future research should investigate if elite athletes with more developed situational perception skills than recreationally trained individuals, respond differently in RT, RMT or TMT between offensive and defensive conditions. Additionally, research to identify the specific body kinematic cues that enhance RT and anticipation time of subjects which can be used to train decision making ability during reactive agility tasks would appear beneficial.

PRACTICAL APPLICATIONS

The results of this study demonstrate males and females differ in specific movement time variables when performing RAT's that should be isolated individually to enable further insight into the specific component of total movement time that could be trained to improve reactive agility performance. Further, differences observed in RT, RMT and TMT between offensive and defensive reactive agility conditions highlight the importance to test athletes' agility performance under both conditions as specific playing positions in sport maybe more offensive orientated then defensive or vice versa, which could result in differences in RT between the two conditions for a single athlete. Additionally by testing athletes during both conditions may enable coaches to identify the specific movement time; either RT and/or RMT within TMT, which may be trained to improve reactive agility performance in offensive and defensive conditions.

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