Relationship Between Choice Reaction Time and Expertise in Team and Individual Sports: A Gender Differences Approach

Ali Heirani (PhD.), Amir Vazini Taher, Zahra Soori, Moslem Rahmani

Abstract: Experts in sport benefit from some cognitive mechanisms and strategies which enables them to reduce response times and increase response accuracy. Reaction time is mediated by different factors including type of sport that athlete is participating in and expertise status. The present study aimed to investigate the relationship between CRTs and expertise level in collegiate athletes, as well as evaluating the role of sport and gender differences. 44 male and female athletes recruited from team and individual sports at elite and non-elite levels. The Lafayette multi-choice reaction time was used to collect data. All subjects performed a choice reaction time task that required response to visual and auditory stimuli. Results demonstrated a significant overall choice reaction time advantage for male athletes, as well as faster responses to stimuli in elite participants. Athletes of team sports did not show more accurate performance on the choice reaction time tasks than athletes of individual sports. These findings suggest that there is a relation between choice reaction time and expertise in athletes and this relationship can be mediated by gender differences. Overall, athletes with intrinsic perceptual-motor advantages such as faster reaction times are potentially more equipped for participation in high levels of sport.

Key words: Reaction time, Elite and non-elite athletes, Sex differences, Type of sport

INTRODUCTION

Sport expertise is referred to the ability of demonstrating high athletic performance in a constant way. Experts in sports have significantly higher skill, ability or performance than novices (Ericsson, 2003; Côté, et.al, 2003). They are usually more skilled at extracting and utilizing environmental information and adopting it to existing knowledge so that they can select and execute appropriate responses. The ability of expert performers to exploit perceptual cues can lessen the temporal constraints required in a reaction time task (Buckolz, et.al, 1988).

Researches indicated that experts benefit from some cognitive mechanisms and strategies which promote the anticipation skill in athletes. This phenomenon enables them to reduce response times and increase response accuracy (Ericsson & Kintsch, 1995). Therefore, it seems that reaction time is an important variable that may be significantly effective in sport performance (Baur et al., 2006).

Reaction time, as a measure of the speed of perceptual system, is the time required for perception, evaluation and initiating a response to the stimulus. In a choice reaction time (CRT) task the participant has to respond as soon and accurately as possible while there are different stimuli requiring different responses (Magil, 1999; Schmidt and Lee, 1999). Little reference is made to examine the relation between perceptual functioning and level of expertise in sport. Research on collegiate athletes has indicated that more experienced subjects show faster RTs (Nakamoto and Mori, 2008). On the other hand, there are a few studies that show no relation between time spent on sport participation and CRT (McMorris and Graydon, 2000; Lemminkand Visscher, 2005). Until present, the differences between expert and non-expert athletes in CRTs are not clearly determined.

There are different factors which may influence RT, such as subjects’ characteristics (e.g. age, gender, and handedness). Gender differences on CRT have studied severally and these efforts have indicated that males typically have faster RTs than females, and this gap is not filled by practice (e.g. Adam et al., 1999; Dane and Erzurumlugoglu, 2003; Der and Deary, 2006), though, there is some evidence that these differences in response to stimuli may be a function of the type of stimuli (Archer Lloyd, 1985; Burnstein, Bank, et al., 1980). Women are superior at tasks including a RT to a semantic or auditory stimulus, whereas men exhibit faster responses to spatial or visual stimulus (Lahtela, Niemi, and Kuusela, 1985). However, recent studies have postulated that with more women participating in driving and fast-action sports, men are not as superior as past in visual RT (Silverman, 2006). Accordingly, this study applied a mixture of auditory and visual RT tasks to examine the overall CRTs. The question presenting in this study is whether gender differences exist in relation between choice reaction time and expertise.
Another factor which is influential on RT performance of athletes is the nature of sport that they are involved in. There are large variations in reaction times of athletes indifferent sports (Moka, et al., 1992). Team and individual sports have basic differences in many ways, including perceptual-motor skills like RT. There has been little attention paid to examination of mediating effect of nature of sports on relation between RT and expertise.

If there is a relationship between reaction time and level of expertise in athletes, one would hope this relationship could be used to help in estimating the potential success of athletes in future. The main goal of this study was to investigate relationship between CRTs and expertise level (divided to elite and non-elite) in collegiate athletes, as well as investigation the mediating role of nature of sport which players are participating in, and gender differences.

**MATERIAL AND METHODS**

**Participants:**
Fifty-four athletes (22 male and 22 female) were recruited from collegiate sports that require quick reaction times with short bursts of speed. These athletes were classified into elite and non-elite groups based on their experience of participation in professional games. Elite athletes had experience of competing at national level in their respected sport with at least 8 years passing from their beginning. They were come from either team sports (soccer, handball, volleyball, futsal) or individual sports (tennis, swimming, shooting, karate, taekwondo). All subjects had normal vision and were right handed. Subjects were in their off-season when this study was conducted.

**Apparatus and Task:**
The apparatus used to collect data was Lafayette multi-choice reaction time device (model 63035) which contains four visual stimulation lamps, an auditory stimulation alert, and five response keys each relevant to one of the five stimuli. The reaction time was measured by asking the athletes to put their right and left index and middle fingers on push buttons and respond to the visual or auditory stimuli as quickly as possible.

**Procedure:**
Subjects were instructed to avoid from maximal exercise for 24 hours and consumption of caffeina and heavy meals 2–3 hours before testing (ACSM, 2006). A series of three practice trials were given following three blocks of twenty recorded trials. Thus, the total number of trials in all blocks was 60. A five-minute rest time was given to the participants between the blocks. Each trial started at random intervals (2-4 seconds). Consent form was completed by subjects before administration of tests and they were fully informed about experiments’ designs.

**Statistical Analysis:**
All data were analyzed using a statistical analysis software package (SPSS v. 16.0). Statistical analysis of the data was performed using univariate analysis of variance (ANOVA) and independent t-test at significance level of P<0/05. RTs for incorrect responses were not used for data analyses, restricting results to the correct responses. Besides, reaction times exceeding the mean by more than 2 standard deviations were considered outliers and excluded from analyses in each block. The means and standard deviationsof all the 60 trials were calculated, after removing outliers.

**Results:**
Age means and standard deviations in male and female players were 23±4 and 22±3 years, respectively. Analysis of data using t-test between two genders showed that females were significantly slower at CRT task than males [t=0/002, p< .05]. Reaction time mean values by expertise status are shown in table 1.

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Expertise</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>Elite</td>
<td>22</td>
<td>407.12</td>
<td>75.32</td>
<td>241 - 693</td>
</tr>
<tr>
<td></td>
<td>Non-elite</td>
<td>22</td>
<td>473.67</td>
<td>90.63</td>
<td>290 - 711</td>
</tr>
<tr>
<td>Male</td>
<td>Elite</td>
<td>11</td>
<td>402.95</td>
<td>73.91</td>
<td>241 - 521</td>
</tr>
<tr>
<td></td>
<td>Non-elite</td>
<td>11</td>
<td>435.26</td>
<td>81.33</td>
<td>290 - 577</td>
</tr>
<tr>
<td>Female</td>
<td>Elite</td>
<td>11</td>
<td>417.74</td>
<td>78.26</td>
<td>293 - 693</td>
</tr>
<tr>
<td></td>
<td>Non-elite</td>
<td>11</td>
<td>502.31</td>
<td>103.10</td>
<td>325 - 711</td>
</tr>
</tbody>
</table>

Analysis of CRTs using ANOVA in all subjects revealed significant effect for expertise [F=5, 297, Sig = 0.043, p< 0.5], indicating that elite athletes tended to show shorter CRTs than non-elite athletes. Regarding the CRTs, results of study in male athletes indicated a significant expertise effect [F=11, 216, sig = 0.002, p< .05].
Besides, these analyses in females revealed a significant effect for expertise status \( [F=7, \ 856, \ sig = 0/045, \ p< .05] \). These data shows superior reaction times on behalf of the elite athletes in both sexes. The descriptive data classified according to the type of sports is shown in table 2.

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Sport</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>Team</td>
<td>22</td>
<td>420.38</td>
<td>82.42</td>
<td>241 - 711</td>
</tr>
<tr>
<td>Male</td>
<td>Team</td>
<td>11</td>
<td>397.28</td>
<td>70.34</td>
<td>241 - 521</td>
</tr>
<tr>
<td>Male</td>
<td>Individual</td>
<td>11</td>
<td>439.86</td>
<td>79.20</td>
<td>290 - 577</td>
</tr>
<tr>
<td>Female</td>
<td>Team</td>
<td>11</td>
<td>450.54</td>
<td>88.23</td>
<td>293 - 711</td>
</tr>
<tr>
<td>Female</td>
<td>Individual</td>
<td>11</td>
<td>466.72</td>
<td>94.37</td>
<td>325 - 693</td>
</tr>
</tbody>
</table>

There was no significant effect for type of sport in overall subjects \( [F=1, \ 158, \ sig = 0/218, \ p< .05] \). The results indicated that there was no significant effect for type of sport both in female athletes \( [F=2, \ 240, \ sig = 0/128, \ p< .05] \). But there was a significant effect in male athletes \( [F=5, \ 416, \ sig = 0/022, \ p< .05] \).

Discussion:
Researchers have suggested that amount of exercise an athlete have been accomplished, results in an enhancement of response time, as well as RT performance (Tomporowski, 2003). Therefore, the expertise level plays an important role in determining how fast an athlete can respond to visual and auditory stimuli. This study aimed to determine if a gender influence exists on the relationship between choice reaction time and expertise, also considered the mediating effect of sports’ types.

According to our findings, a significant difference was found in CRT means between two genders, where males were faster than females. These findings are in line with Deary and Der (2005), also Der and Deary (2006) who observed higher CRTs in female adults, but are contrary to results of Landauer et al. (1980) and Landauer (1981) which reported female superiority in CRT. The type of task used in RT studies is a key factor in the sex differences in results. Particularly, women excel at RT tasks involving auditory stimuli, while men outperform in tests with visual stimuli (Lahtela et al., 1985). Therefore, we administered RT tests involving both type of stimuli to decline the probability of task type effect on results. On the other hand, McEwen (2001) suggested that sex hormones which begin to secrete at puberty lead to different effects in male and female brains. These changes, subsequently, due to higher discrepancies in response times between two genders after early adulthood. Thus, it seems that these results are affected mostly by gender differences induced from sex hormones, which in turn are influential in information processing strategies that men and women employ.

The results of this study, consistent with many previous researches, indicate a superior response on behalf of the elite athletes (Lahtela, et al., 1985). These data show that members of the elite groups in both sexes possessed significantly higher speeds in responding to a CRT task. This is in line with many studies concluding that athletes performing at higher levels show a faster RT (Thomas and Thomas, 1994). However, Landauer, Armstrong & Digwood (1980) showed no difference in CRTs between males and females. Generally, expert performers benefit from more experience gained from practice and professional competition which is correlated to higher knowledge and skill (Thomas and Thomas, 1994). It seems from previous findings that RT performance improves as a result of the time spent on practice (Buckolz, et al., 1988). The results of present study support previous findings regarding the advantage of elite athletes in CRT tasks over their non-elite counterparts.

Based on the findings of present study there was no significant differences between team and individual sports in CRT of overall participants. However, analyses of CRT in male subjects showed that athletes participating in team sports were significantly faster in CRT task. In open or high strategy sports, responding to peripheral stimuli is more important. Therefore, there is a high demand of environmental changes during team sports activities, though there is less fluctuations in peripheral cues in individual sports (Magil, 1999). Hence, faster CRTs in male athletes of team sports can be attributed to their experience of participating in sports with high demand of quick decisions and performance. Although, results in female athletes were controversial and need more research to determine the underlying reasons behind the results.

Conclusion:

Overall, these results indicated that there is a relation between CRT and expertise in athletes, and this relationship is same in both sexes. Then, it seems from these findings that athletes with intrinsic perceptual-motor advantages such as faster reaction times are potentially more equipped for participation in high levels of sport. On the other hand, these findings do not support the idea that the nature of sport influences the way choice reaction time differentiates elite athletes from non-elite athletes. Analyses of mediating role of type of sport showed that there was just team sports superiority in male athletes.
In conclusion, the more sports experience the athletes would have, the faster their CRTs would be. These findings are practical in both genders.

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REFERENCES


