Anticipation in young badminton players: Differences between real and virtual tasks and the influence of playing and training experience

Anderson Andres[1]; Francisco Felix Álvarez Dacal[2]; Diego de Carvalho[3]

[1] Badminton coach of Middlewest of Santa Catarina Association (AMOB) – Joaçaba – Brazil. [2] Área de Desarrollo y Formación. Colaborador Formación BE - BWF. Federación Española de Bádminton - Madri – Spain. [3] Professor of Biosciences and Health area – Universidade do Oeste de Santa Catarina – Joaçaba – Brazil

Introduction

Action anticipation is the ability to predict the outcome of other's action sequence (Smith, 2016). To anticipate an upcoming action based on the perception system, visual and other environmental cues are crucial to individual survival in an evolutionary perspective (Xu et al., 2016). In many sports, the high-level of action anticipation is required for different performances, such as in badminton where it is necessary to predict where the shuttlecock goes after the opponent hits it. Due to the fast nature of badminton, some authors have developed behavioral tasks in order to evaluate anticipation in this sport or in visual tasks using badminton videos or images (Jin et al., 2011; Xu et al., 2016; Liu et al., 2017).

Most studies in this area have aimed to evaluate how professional or competitive players extract the information from the environment, opponent body or equipment movement to anticipate the sequence of action of that sport requires (Savelsbergh et al., 2002; Abernethy and Zawi, 2007). The main approaches used to analyze this include the evaluation of reaction time, eye tracking and accuracy during a number of anticipation tasks (Mann et al., 2007; Smith, 2016) usually comparing non-athletes with athletes or expert versus novice or the effect of specific influence on performance.

Recently, neuroscientists have developed interest in action anticipation and included electrophysiological evaluations concomitantly to sports anticipation tasks. For example, Jin et al. (2011), asked professional players to predict the final destination of the shuttlecock only watching snapshots of badminton matches. They measured accuracy and reaction time and compared it to a non-badminton player control group. Simultaneously, they record electroencephalographic activity of the participants in order to further evaluation of event-related potential (ERP - a type of brain electrophysiological activity, as the name suggests, related to, in this specific case, visual event). Not surprisingly, the badminton athletes were more accurate and faster to predict the final destination of shuttlecock. However, they showed two specific brain activities (namely P300 and P2), enhanced and sustained, when compared with controls.

Similarly, Liu et al., (2017) found that badminton training for adult novices amplifies the action anticipation in the same-domain tasks (visual badminton tasks) and enhanced brain activities, as N2 and P2 ERPs.

Although those approaches gave several novelties for sports anticipation research, the majority of tasks are virtual or video/photo-based tasks. It is uncommon that this kind of evaluation is a simulation of real conditions of badminton. Besides, the performance comparison usually involves groups very distant in their abilities of this game, like expert-novice comparisons, or players and non-players.

Thus, the aim of the work reported here is to: 1) compare the accuracy and reaction time of young competitive players in the training of real shuttlecock returns for three ability levels of young recreational players and 2) compare players' responses to a real-execution badminton task with a video snapshot task using a computer.

Methods

All experiments were conducted in two cities: Oviedo – Spain and Joaçaba - Brazil. The participants were 38 young male and female badminton players from 6 different countries: Brazil (9), Spain (18), France (5), Scotland (1), Equator (1) and Colombia (1). All participants were 14 – 17 years old at the time of the experiments.

Firstly, the participants were subjected to an interview in order to collect personal data, years of badminton training and national or international competition experience, dominant hand and nationality. Based on this information and a division made by badminton coaches, we divided the sample in 3 groups: 1) High-experienced young badminton players – participants who have national and international competition experience, have trained badminton for more than 4 years or have a flagrant ability in the court. 2) Medium-experienced young badminton players – individuals that trained badminton for more than 3 years, have some international competition experience but without expressive achievements or national competition with medium performance and good ability evaluation by badminton coaches. 3) Low-experienced badminton players –

individuals that trained badminton for 2 years or more but without international experience and low results in local or national competitions. Besides group 3, players displayed medium or initial badminton abilities.

Thus, group 1 were formed by 11 athletes (7 male and 4 female); group 2 were formed by 17 athletes (8 male and 11 female) and group 3 were formed by 20 athletes (13 male and 7 female).

After the interview, the participants were conducted to a badminton court where they performed the real-execution badminton task. This task consisted of 32 shuttlecocks delivered by a BWF Coach level 2 (this person was the same for every participant). At the beginning of the task, a third-person served from outside court above coach's head. Then, the coach returned the shuttlecock to the court where the participants were. The shuttlecocks were delivered to 4 different positions of participant's court: 1) drop shot to the right; 2) drop shot to the left; 3) clear shot to the right; 4) clear shot to the left. The participant was not allowed to move from a rectangle (60cm x 15cm) placed at the center of their courts until the shuttlecock hit the coach's racket. The task was normally to strike back this shuttlecock. After each strike, the participant returned to the center rectangle.

All trials were recorded by a camera at 240Hz. Afterwards, all video data were evaluated using Kinovea® Software. The acquired variables were: reaction time – conventionally the time in milliseconds that the participant stepped-out of the rectangle (split steps were not considered); accuracy – conventionally if the first step was in the correct direction related to shuttlecock destination; if the participant were able to strike back the shuttlecock (even delayed) and anticipation errors - if the participant stepped-out the rectangle before the shuttlecock hit the coach's racket.

After performing the task, each participant was required to perform a virtual version of the real task. The experiment was created in the behavioral experiment builder OpenSesame (Mathôt et al., 2012). The subject was in front of computer screen (16") and were free to adjust the screen for their own preference. The experiment consisted of a training part identical to the experiment part, but with 30 trials instead 60 of the experiment.

On the computer screen was shown video frames of the same coach which delivered the shuttlecock in a real execution test. There were three types of snapshots: 1) 16 - 32ms prior to the shuttlecock hit the racket; 2) the exactly moment of the shuttlecock hit the racket; and 3) 16ms after the shuttle hit the racket. In other words, the participant was shown images of pre-execution of the stroke, the execution of stroke and post-execution of stroke. Figure 1 shows an example of images displayed.

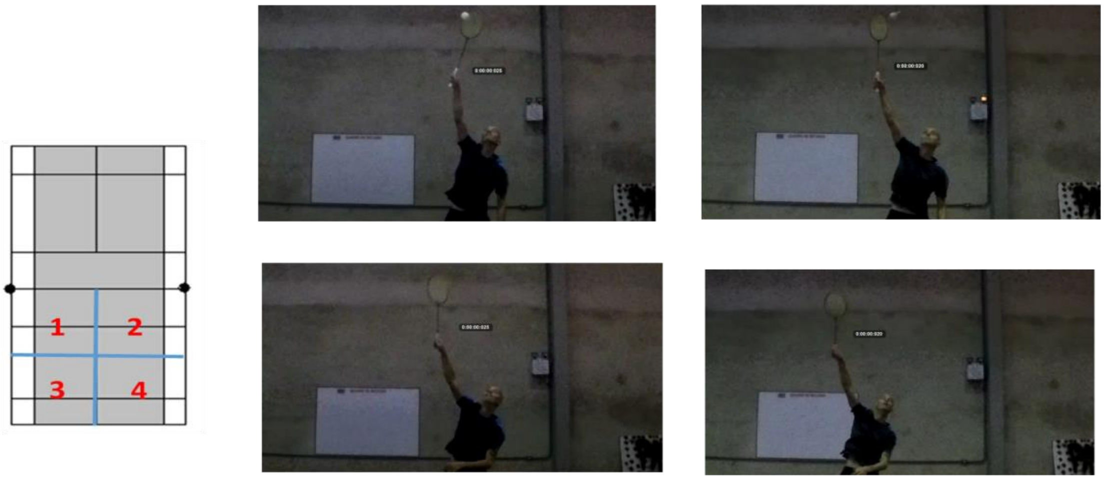

Figure 1 – Example of images displayed on the virtual test and positions of the participant's court (left).

Every image was randomly displayed on the computer screen for a maximum of 5 secs. The participant was required to respond as fast as they could as to what position of their court (1,2,3,4 – figure 1) the shutllecock would land. For this phase of experiment each participant had 60 trials. The measured variables include, reaction time, accuracy, omission error - if they did not respond within 5 secs., contralateral error – e.g. the participant responds the shuttle would land say left, but the correct answer was right.

All results were analyzed in GraphPad Prism® 6.0 or Statistica 7.0 depending on the statistic test. ANOVA was performed for each variable in each experiment. Eventually, in order to perform multivariate comparison, was performed a GLM – *General linear Models* test.

Results and Discussion

As expected, the group 1 and 2 had a lower reaction time in the real execution test, as shown in figure 2A. Group 3 had significantly higher reaction time in comparison to other groups ($p<0,0001$ from both other groups). In the same way, group 3 had poorer accuracy levels comparing to the other groups (Fig. 2B), however, note in figure 2C that group 1 have committed significantly more anticipation errors than group 2 and 3. The fact that more experienced athletes have better overall performance is well reported in the literature (Ida et al., 2011; Loffig and Hagemann, 2014; Wang et al., 2017; Hülsdünker et al., 2017; Fukuhara et al., 2017) and these results are intuitive. Nevertheless, although group 1 had greater accuracy they anticipated more. This result suggests that as the athlete becomes proficient they are able to read better the opponent's body movement and precisely predict the outcome.

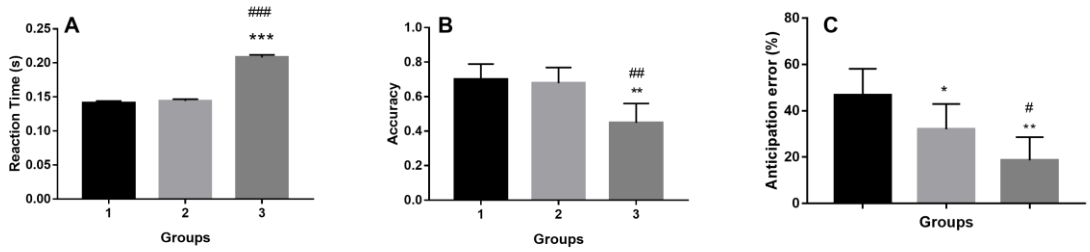

Figure 2 – Summary of the results of the experiment 1. A) mean + S.E.M of reaction time, in seconds, in each group. B) Accuracy + S.E.M of each group. C) Mean ofPercentage of anticipation error + S.E.M for each group. * represents statistic difference versus group 1 and # represents significant difference between group 2.

In contrast, for the virtual test, there was no difference between groups for both reaction time and accuracy (Fig.3 left and middle panels). However, when we analyzed the contralateral error (where the participant response was to the wrong side of the court, for example, if the correct response to one trial is anywhere on the right side of the court, a contralateral error indicates the participant responded anywhere on the left) group 3 had significantly more errors then the other groups ($p<0,0001$ for both groups and for the three types of images displayed).

When the images that showed the preparation of the stroke, execution of stroke and 16ms after the stroke were compared, all participants were more accurate for the images that showed the execution of the stroke. The preparation phase of stroke (pre-execution) is the phase that was more difficult to choose in what part of the court the shuttlecock would land.

These results show that when there was differences in experience of participants, there was no difference in the accuracy and reaction time between them. This is in contrast to the majority of papers using this kind of approach, comparing expert vs. novice (Del Villar et al., 2007; García-Gonzalez et al., 2012; Wimshurst et al., 2016) or athlete versus non-athlete (Liu et al., 2017) which have found differences in reaction time and accuracy of their participant sample.

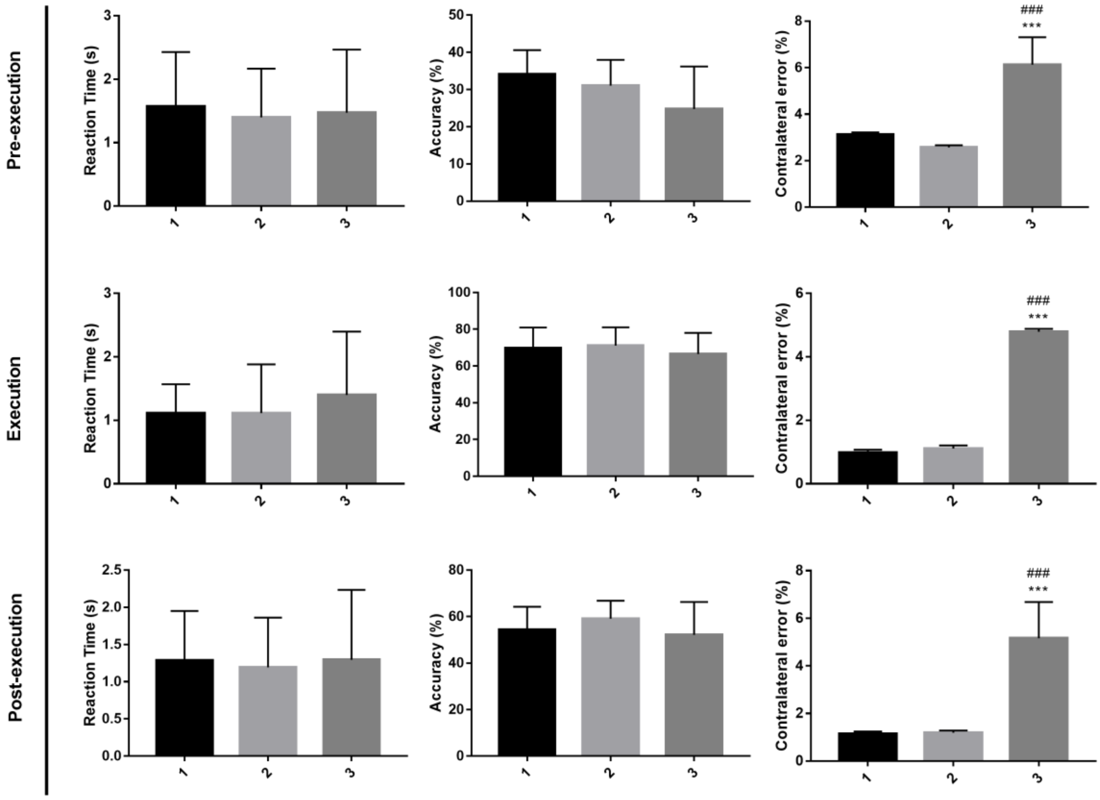

Figure 3 – Results of the three types of images displayed on virtual experiment (pre-execution, execution and post execution) for mean + S.E.M of Reaction time, in seconds (left), accuracy, in percentage (middle) and contralateral error in percentage (right).

Conclusion

Our preliminary results have shown that more experienced young badminton players have better performance in controlled real-execution experiment. They react faster and are more accurate. However, they committed more anticipation errors. This is suggestive that more-experienced players “read” opponents’ body movement better and responded properly to the outcomes. Nevertheless, in virtual versions of the same test there were no difference in reaction time and accuracy between groups, suggesting that when the level of participants is similar, virtual tasks are ineffective to evaluate anticipation. In the virtual experiment, the less-experienced participants (group 3) committed more contralateral errors, suggesting that they are more subject to major mistakes then other groups.

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