Visual behavior and upper limb variability in coordination comparision between novices and experts performers in basketball free throws

Comportamento visual e variabilidade dos membros superiores na comparação da coordenação entre novatos e peritos em lançamentos livres de basquetebol

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Alejandro Troncoso T
School of Physical Therapy, Facultad de Medicina Clínica Alemana, Universidad Del Desarrollo
Laboratorio de Cognición y Comportamiento Sensoriomotor, Departamento de Kinesiología, Universidad Metropolitana de las Ciencias de la Educación.
Center for Social and Cognitive Neuroscience, Universidad Adolfo Ibáñez, Santiago, Chile
Email: Alejandrotroncoso@udd.cl

Christian Cancino B
Laboratorio de Cognición y Comportamiento Sensoriomotor, Departamento de Kinesiología, Universidad Metropolitana de las Ciencias de la Educación.

Juan José Marimán
Laboratorio de Cognición y Comportamiento Sensoriomotor, Departamento de Kinesiología, Universidad Metropolitana de las Ciencias de la Educación.

Joel Álvarez-Ruf
School of Physical Therapy, Facultad de Medicina Clínica Alemana, Universidad Del Desarrollo
Laboratorio de Cognición y Comportamiento Sensoriomotor, Departamento de Kinesiología, Universidad Metropolitana de las Ciencias de la Educación.

ABSTRACT
The objective of the present research is to determine the differences in visual behavior and the upper limbs variability in coordination between expert performers and novice performers in basketball free throws. **Methods:** Nine right-handed men were tested. The skilled group consisted of four players who had an experience of 9.2 years (SD: 1.2) and play 9 hours per week (SD: 12). The novice group consisted of five players with no experience in Basketball. Visual behavior was evaluated using an eye-tracker head mounted and the upper limb kinematic behavior using a High-speed camera during 30 free throws**. Results**: There was a significant difference between the expert and novice performers in accuracy for the 30 trials ($p<0.034$). In Visual behavior were no significant differences the duration of the last visual fixation before the onset of elbow extension in execution phase ($p>0,05$) between expert and novice groups. There were statistically significant differences in the elbow-wrist variability in coordination in the throws duration time-windows of 100%, 90%, 80%, 30% (pvalue <0.05). 100% represent the last time-windows before ball release. The expert performers shows greater consistency in coordination, however novice subjects exhibit greater variability in the coordination in these intervals. **Conclusion:** The results suggest that the task of shooting free throws requires a long visual fixation to the site of interest, which temporarily is similar in subjects with different levels of skill. The higher reproducibility pattern suggests elbow-wrist coordination to be the key perceptuo-motor behavior in order to reach expert performance.

Keywords: Perception-action coupling, Basketball skills, Variability in coordination, Quiet Eyes, Free throws

RESUMEN

El objetivo de la presente investigación es determinar las diferencias en el comportamiento visual y la variabilidad de los miembros superiores en la coordinación entre ejecutantes expertos y ejecutantes novatos en los tiros libres de baloncesto. Métodos: Se examinaron nueve hombres diestros. El grupo de expertos estaba formado por cuatro jugadores que tenían una experiencia de 9,2 años (SD: 1,2) y jugaban 9 horas a la semana (SD: 12). El grupo de novatos estaba formado por cinco jugadores sin experiencia en baloncesto. El comportamiento visual fue evaluado utilizando un eye-tracker montado en la cabeza y el comportamiento cinemático del miembro superior utilizando una cámara de alta velocidad durante 30 tiros libres. Resultados: Hubo una diferencia significativa entre los expertos y los novatos en la precisión de los 30 ensayos (p<0,034). En el comportamiento visual no hubo diferencias significativas en la duración de la última fijación visual antes del inicio de la extensión del codo en la fase de ejecución (p>0,05) entre los grupos de expertos y novatos. Hubo diferencias estadísticamente significativas en la variabilidad codo-muñeca en la coordinación en las ventanas de tiempo de duración de los lanzamientos del 100%, 90%, 80%, 30% (pvalor <0,05). El 100% representa las últimas ventanas de tiempo antes del lanzamiento del balón. Los ejecutantes expertos muestran una mayor consistencia en la coordinación, sin embargo los sujetos novatos exhiben una mayor variabilidad en la coordinación en estos intervalos. Conclusiones: Los resultados sugieren que la tarea de lanzar tiros libres requiere una larga fijación visual al sitio de interés, que temporalmente es similar en sujetos con diferentes niveles de habilidad. El patrón de mayor reproducibilidad sugiere que la coordinación codo-muñeca es la conducta perceptivo-motora clave para alcanzar un rendimiento experto.

Palabras clave: Acoplamiento percepción-acción, Habilidades en baloncesto, Variabilidad en la coordinación, Ojos quietos, Tiros libres

1 INTRODUCTION

The way we perform complex tasks like throwing a ball accurately to a basket, requires not only make an accurate and adaptive movement, but also requires to extract the key environmental information, in order to use such information in the process of decision making and selection of motor strategies (Wolpert, 2011; Yarrow, 2009). Through practice and observation of these tasks, the performers manifest changes in behavior that will increase the accuracy and adaptability to different constraint (Seifert,2013). These changes are manifested in cognitive, perceptual and motor domains where the performers through learning will change the way we perceive information and generate movement patterns, which are accompanied by changes in the processing and organization of the CNS, and neuromuscular adaptations (Yarrow,2009) Thus, it has been described different ways of perceiving the environment through study of visual behavior, and motor coordination in individuals with different skill level (Vickers,1996; Oliveira 2006; Oliveira 2008; Button2003;).

In the research of visual perception on aiming to near targets have been described that expert performers display longer eye fixations that nonexpert performers (Mann et al. 2007). In basketball, particularly, it suggests that there are critical periods in the extraction of visual information, such as prior fixation at the beginning of the last phase of throw, which has a longer duration in expert performers in comparison with near experts performers (Vickers, 1996a). This finding suggests that expert performers are able to pre-program movement parameters based on the visual information extracted in that critical period. However, other authors suggest that the critical period for information extraction depends on the type of free throw style that is performed, the extraction is more important in early stages of the throw with low shooting style and more importantly the extraction in the last stages of the throw with high shooting style, where the latter would be more relevant on-line control of movement (Outjeans 20002; Oliveira, 2008). This controversy has arisen because of the different study methods of visual behavior, there is still a gap in understanding the visual behavior of expert and novice performers with a high shooting style (Vickers, 2006).

The approach to the visual behavior exposes the need for visual extraction of essential variables for coupling with patterns movements executed (Davids 2008, Fajen 2008). The research of such patterns of movement from the perspective of traditional biomechanics has been addressed by discrete analysis of solitary joints, such as displacement, velocity and joint angles (Barlett, 2002; Wheat and Glazier, 2003). Bartlett, 2002 and Vaughn, 1996, have been trying to find an optimal pattern. However, this approach does not consider that motor behavior is based on patterns of coordination between joints and the intrinsic variability derived from the abundant possibilities of movement (Latash et al, 2002; Harbourne and Stergiou 2011). This conceptualization has shifted the traditional approach to the study of motor learning to the study of coordination between joints and trial-to-trial variability (Button et al 2003; Mullineaux 2011).

It has been reported that skilled individuals have a greater consistency in movement patterns on the repetitive task of free throw basketball (Button et al., 2003). However, this conclusion has been raised by the qualitative interpretation of angle-angle plots lacking objectivity in evaluation. Currently described quantitative methods, such as vector coding for the assessment of the variability in coordination, which has opened a window for understanding how movements coordinate to learn a skill (Tepavac and Fieldf-Fote 2001; Wheat and Glazier 2003; Mullineaux 2011)

Therefore, for better understanding of the key variables that differentiate performers at an early stage and final stage of learning the ability to make a precision shot, the approach is needed based on current concepts of motor control, which include motor behavior as a couple between perception and coordination of movement patterns. Such an approach has not been studied together under the same conditions of the task and the environment in basketball free throw. Moreover, as noted, there is controversy in the findings in both perceptual and motor domains, which arises from the different theoretical methods used and to addressed approaches. The objective of the present research is to determine the differences in visual behavior and the upper limbs variability in coordination between expert performers and novice performers with high shooting style.

2 METHOD

Study Design.

Cross- sectional

Participants.

Nine right-handed men were tested. They were categorized as either skilled or novice basketball throwers on the basis of their experience level and an initial performance test. The skilled group consisted of four players (M=22,75 years of age, SD=1,8 years) who had an experience of 9.2 years (SD: 1.2) and play 9 hours per week (SD: 12). The novice group consisted of five players (M=22,6 years of age, SD=1,5) who had an experience of 0 years and play 0 hours per week.

Apparatus:

Visual behavior.

We collected eye movement data by using a Eye-Tracker Head-Mounted (Neurosistemas Laboratory, University of Chile, model Babcok & Pelz, 2002). An Eye Tracker mounted head, designed by neurosystems Laboratory of the University of Chile (Fig.1), was used. The Eye Tracker has an eye camera 30 fps (frames per seconds) that has been proven to be enough for recording fixation and saccades eye movement (Jason S. Babcock & Jeff B. Pelz 2004). This system has a stable, lightweight and secure base that allows free head movements. In conjunction with the eye camera there is a sensitive CMOS cameras that allows to evaluate the position of the pupil and corneal reflection (Fig.2) . A second miniature camera is placed above the right eye and is used to capture the scene from the perspective of the subject, which is then calibrated with a board synchronization. Both cameras are connected to a circuit which supplys power and allows them to connect to independent video cameras to record.

Upper Limb Kinematic Analysis.

High-speed camera (240hz) for kinematic record of the upper limb was used. It is suggested that the optimal range of hz for the analysis of a throw corresponds to 200-500hz. (Bartlett, 2002).

Visual-in-action approach.

To determine the variable visual fixation prior to the onset of elbow extension, called, quiet eyes, was necessary to synchronize cameras and visual camera of the upper limbs.

Procedure.

Initial performance test for skill classification; After a warm-up, each subjet took 10 free throws to determinate the accuracy.

Performance Trials. Once the initial test was completed, participants were fitted with the eye-tracker head-Mounted and passive marker. The calibration procedure consisted of having the player fixate on a sequence of 13 equidistant points located on a target board placed on top of the basketball table. Once the calibration procedures, are completed, 10 shots were perfomed. The calibration and the set of shots were repeated three times, completing 30 throw in total.

Dependent Measures

Performance.

The performance measure consisted on the porcentage of successful shots upon the 30 basketball free throws.

Visual Behavior

The visual behavior was analyzed in the 30 free throws. The interest variable was "Quiet eye", defined as the duration of the last visual fixation before the onset of elbow extension in execution phase.

Upper Limb Kinematic. The elbow-wrist variability in coordination was analized with the vector coding method after low-pass filtering at 6 hz with a second order Butteworth filter. The dependent measures were analyzed with Matlab 2013 (Mathworkis ® 1984-2014).

Statistic Analysis:

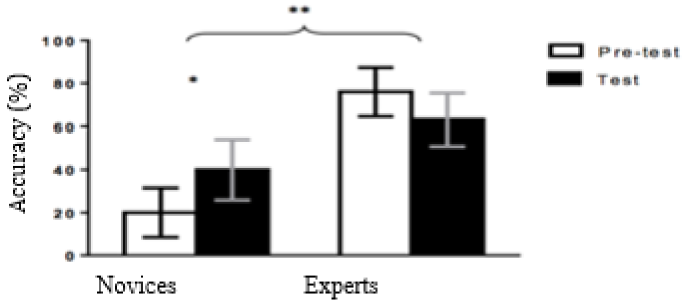
To compare the dependent measures between expert and novice performers, we analyzed them with independent T-Student test to normal data distribution and Mann Withney U to nonnormal data distribution. The level for statistical significance was set at $p<0.05$. The statistical procedures were performed using Prisma 6 (GraphPad Software Inc. 1994-2014).

3 RESULTS

Pre-test performance: There were significant differences ($p=0.0002$, t-test) between the expert and novice performers in accuracy for the pre-test. For the expert group the mean was 78% (D.E=10%) and for the novice group the mean was 18% (D.E=10%)

Test Performance: There was a significant difference between the expert and novice performers in accuracy for the 30 trials ($p=0.034$, t-test). For the expert group the mean was 62% (D.E=12.25%) and for the novice group the mean was 40% (D.E=14.14%).

Fig.1. Performance Comparision Between Novices and Experts.



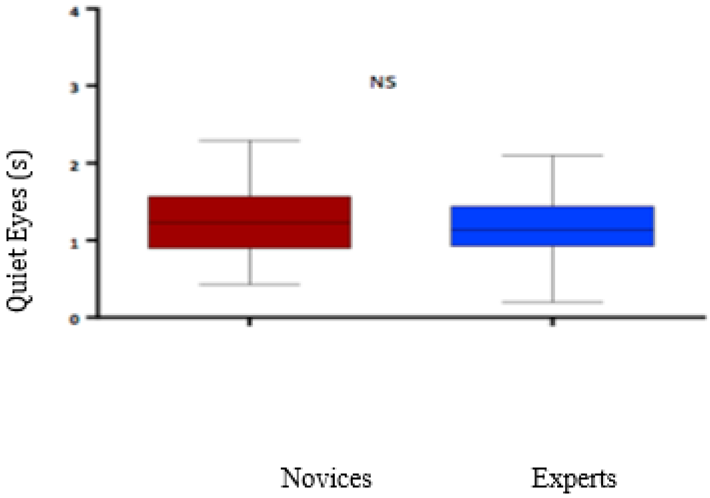
*Significative Differences Between Pre-test and Test in Novices Performers (T-Test).
**Significative Differences between Novices and Expert Performers in pre-test and test accuracy.

Quiet Eye:

The Quiet Eye duration was compared between expert and novice performers (fig.2).

There were no significant differences (p>0,58, Mann Whitney U) between expert and novice groups with a median of 1,2 s (ICR=0,61 s) and 1,150 seg (ICR= 0,54), respectively (Fig. 2)

Fig.2 Quiet eye Comparision between Novices and Experts.



NS: No Significative Differences.

Variability in coordination:

The figures 3 and 4 display the 30 trials kinematic elbow-wrist patterns of representative performers. The following interpretation of graphs angle-angle is purely qualitative.

The first important observation is that no graphics launch throw is identical trial to trial in each subject reflecting the inherent variability in the repetition of a movement. It can see the wide variability in the use of the degrees of freedom of the elbow and wrist by expert and novice subjects. That is, each subject has different movement patterns relating to their own shooting style..

According to Button (2003), the interpretations of the consistency of the patterns used by individuals are interpreted by the dispersion of joint couples. Patterns with greater pooling data show greater consistency trial-to trial, however, a greater dispersion of data reveals a less consistent trial-to-trial (Button et al 2003). Novices have a higher qualitative interpretation dispersion patterns of joint trial to trial compared to the experts (fig.3). The trial-to-trial consistency is more important at the end of the movement (Mullineaux 2011) and observing the final moments of each release it can be seen clearly that skilled individuals are more consistent (fig.4), Such as observed in the study of Button (2003). However, a quantitative method to assert such a premise is necessary. This was corroborated with the vector coding technique.

Fig 3. Representative Novice Performer

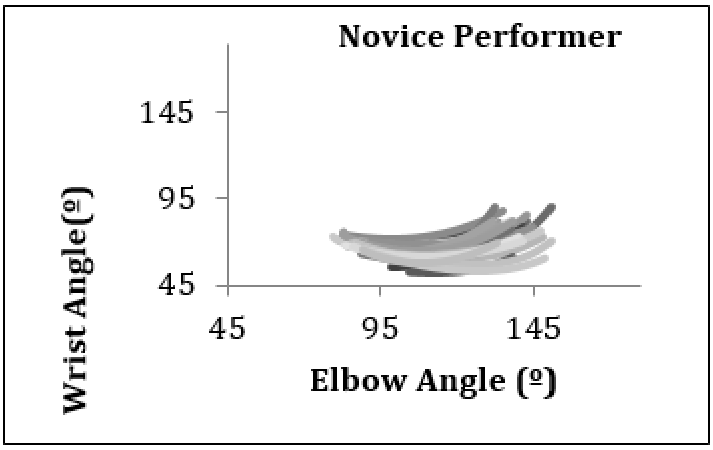


Fig 4. Representative Expert Performer.

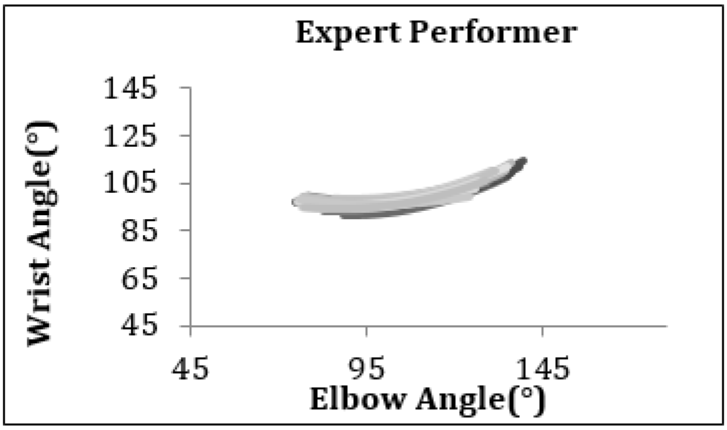
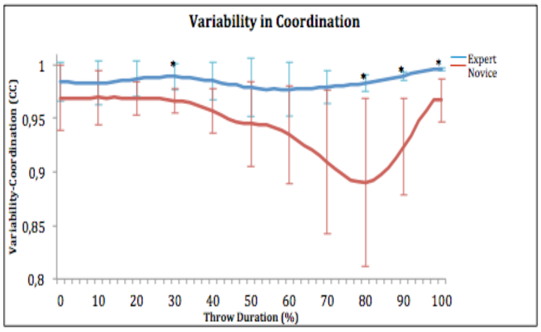


Fig.5 Variability In Coordination Comparision



Between Expert and Novice Performers. *Statistic Significative Differences.

The variability in coordination was compared between expert and novice performers every 10% of the throw duration (fig 5) with Vector Coding method. Statistically significant differences in the range of 100% (pvalue = 0.04), 90% (pvalue = 0.037), 80% (pvalue = 0.031) and 30% (pvalue = 0.0375), where expert performers have CC values greater than the novice performers (Fig 5). A value close to one, means less variability in coordination. Therefore, expert performers show greater consistency in coordination, however novice subjects exhibit greater variability in the coordination in these intervals. There were no statistically significant differences for the other intervals (pvalue> 0.07).

4 CONCLUSION

The results suggest that the task of shooting free throws requires a long visual fixation (Quiet eyes) to the site of interest, which temporarily is similar in subjects with different levels of skill. The higher reproducibility pattern suggests elbow-wrist coordination to be the key perceptuo-motor behavior in order to reach expert performance. Furthermore, our study suggests that greater coordination variability found in novice subjects is the need to explore different degrees of freedom between the elbow and wrist in order to find a range of motor options that will generate successful behavior on the task performed. This greater variability in the initial stage described essential for effective learning of a repetitive motor behavior. The differences found in the motor domains but not found in the visual domain does not show that the higher level of free throw shooting skill is exclusively reflecting of greater motor skill domains. This can be interpreted as the expert performers associated visual information more effectively with the previous experience of the task (low in Novice).

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