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# Handball goalkeeping and the analysis of the perception-action coupling in virtual environment

Vignais N<sup>1</sup>, Bideau B<sup>1</sup>, Kulpa R<sup>1</sup>, Craig C<sup>2</sup>, Brault S<sup>1,2</sup>, Multon F<sup>1,3</sup>

<sup>1</sup>M2S Laboratory, UFR APS, Rennes 2-ENS Cachan University, Avenue Charles Tillon, 35044 Rennes, France

<sup>2</sup>School of Psychology, Queen's University Belfast, N. Ireland

<sup>3</sup>IRISA BUNRAKU project, Campus de Beaulieu, 35042 Rennes, France

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## Introduction

In sports science, the link between the experimental protocol and the subject's behaviour in real condition is a key issue. Ecological studies consist in carrying-out experiments in real situations without interfering with the natural behaviour of the subjects. However the historical predominant influence of an information processing approach has often created rigorous and tight experimental conditions. Consequently perception and action has been separated during experimental studies, especially for ball interception tasks (Williams et al., 1999; Davids et al., 2002). Studying the degree of perception-action coupling in real environments is very difficult because of the shortage of visual information control. This limitation could be overcome in virtual environments where the situation is numerically simulated. Hence, visual information can be controlled in a systematic manner, ensuring reproducibility between trials. We thus used an acceptable framework (Bideau et al., 2003) for studying the influence of the degree of perception-action coupling on the performance of handball goalkeepers in a virtual environment.

## Methods

### a) Motion capture and animation in the virtual environment

In this first phase, we captured the motion of handball throwers and used the resulting data in a virtual environment. We recorded the kinematic data from two top-level handball players by using the VICON motion capture system (Oxford Metrics Ltd, Oxford, UK). They were alternately asked to throw the ball 12 meters from the goal aiming for nine areas of equal size within the goal (no goalkeeper was present). Captured throwing data were then incorporated into the animation module Manageable Kinematic Motion (MKM, IRISA, Rennes, France) (Kulpa et al., 2005) which enabled us to animate the virtual handball thrower in real time.

### b) Motion capture of goalkeepers' responses in virtual environment

8 national handball goalkeepers were asked to wear a pair of glasses that enabled stereoscopic vision when looking at the display on the screen (semi-immersive system, IRISA<sup>1</sup>). They reacted to the actions of the virtual handball thrower in two conditions: a judgment condition and a motor task condition. In the judgment condition, goalkeepers were asked to make a perceptual judgment with their hand in their own time after the virtual throw; in the motor task condition, goalkeepers had to react in real-time to the virtual throwing motion. For both conditions, goalkeeper's responses were recorded using the VICON system.

## Results and Discussion

Results showed that percentage of successful response was higher in the motor task condition and radial error (distance between the ball and the closest limb when trial was unsuccessful) was lower for the same condition.

Similarly to findings from Farrow and Abernethy (2003), the results of this study showed that participants were more accurate in performing responses in the motor task condition than they were in the judgment response mode. However our results considerably differ from Ranganathan and Carlton's (2007) study. These authors showed that participants were significantly more accurate in performing a prediction task in the judgment response mode than in the motor response mode. Nevertheless, from our point of view, two points would have biased Ranganathan and Carlton's results: the perception of kinematic differences and the evaluation of presence in the virtual environment used. However, in light of the conflicting results found in the literature, it appears that further clarification on the specificity of the task is necessary.

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