# Interaction with Virtual Games through a Vision-based Gesture-recognition Interface and Interpretation of Motion Scenarios

**Erez Porat[1], Galit Botzer[1,2,3]**
[1] Technologies in Education Graduate Program, Faculty of Education, Haifa University, Israel
[2] The Institute for Alternatives in Education, Faculty of Education, Haifa University, Israel
[3] LIRT and the CRI institute, Haifa University, Israel
jezporat@gmail.com

## ABSTRACT

*This paper examines how young children interact with computer games through a vision- and gesture-based interface. The interface enables users to interact with digital objects naturally, without any mechanical devices, and may provide immersive interaction that has the potential of binding together interactivity, engagement, and learning. We use the theory of embodied cognition to examine the role of bodily actions in the conceptualization of motion. In the learning setting we designed we engaged four children aged 5 to 9 in a ping-pong game simulation, using the Sony PlayStation EyeToy application. The learning tasks involved interpretation of motion scenarios before and after interaction with the game. Findings show that the interaction with the game enhanced the children's conception of motion and enabled them to provide in the post-activity period more detailed interpretation of motion scenarios then during pre-activity. Furthermore, we found that gestures played a major role in the development of concepts about motion. The findings of this pilot study have implications for the possible contribution of bodily interaction with computerized artıfacts for learning.*

**KEYWORDS:** *Learning through play, Human-computer interaction, Gestures, Embodied cognition*

## INTRODUCTION

The present paper examines how young children interpret a motion scenario they experienced while interacting with a computer ping-pong game through a vision-based gesture-recognition interface. This type of interface responds to natural user gestures, especially dynamic hand and full-body motion (Maes et. al. 1995). The users stand in front of a large screen on which a virtual environment is displayed. Video cameras capture their image, so they also see themselves within the virtual world. This interface has the potential to enhance young children's interaction with virtual games. In particular, games that involve motion such as sports games or car racing can facilitate intuitive understanding of motion scenarios by enabling perceptuo-motor activities within the virtual environment. Expanding research in the field of embodied cognition (Gibbs, 2006; Lakoff & Nunez, 2000) supports the idea that bodily activities may be involved in the conceptualization of motion. Motion is interpreted continuously during everyday activities. One can estimate intuitively the distance of a moving object and thereby avoid a collision or catch the object. However, the transformation from embodied implicit knowledge about the physical world into formal concepts is complex and still needs to be examined. Our exploratory pilot study, focused on interaction with a dynamic gaming environment that was not designed for educational purposes but for entertainment. We examined how such interaction may enhance children's understanding of motion scenarios.

In particular we addressed the following questions:

1. How interaction with a virtual ping-pong game environment, supported by a gesture-recognition interface, can facilitate understanding of motion?
2. How children use gestures to interpret motion scenarios?

## RESEARCH DESIGN

The setting we created enables children to experience bodily interactions and then reflect upon them by interpreting visual snapshots from the game world.

**The learning environment**: We used a simulation of turntable tennis (ping-pong). The hands of the player served as a paddle for hitting the ball. The intensity of the stroke and its direction determined the velocity of the motion of the ping-pong ball on the screen. The game has four levels, moving from easy to difficult. Figure 1 shows the learning environment, which included a TV screen and the EyeToy camera, and presents the learning tasks.

Active engagement with the application | The task: interpretation of motion scenarios | A motion scenario | The EyeToy camera

***Figure** 1. The learning environment*

**Participants:** Four children participated in this pilot study: two nine year old elementary school boys, a five year old pre-elementary school boy, and a 6 year old girl in the first grade. The children volunteered to join the research within an informal framework. None of the children had any formal background in physics. The two 9 year old boys had limited experience with the Sony Playstation console; none of the children was familiar with any EyeToy applications or games. None of the participants had any practical training with the specific game title used in the research nor with table tennis, either physically or virtually.

**The learning tasks:** The learning activity consisted of three parts. The first part (pre-activity) included interpretation of six snapshots showing various situations of the opponents and their paddles. The children were asked to describe the player's actions, predict ball motion in each scenario, and justify their claims. The second part included an active experience with a simulated ping-pong game in which the players see their image as a part of the virtual gaming environment. In the third part (post-activity), the children were asked once again to interpret motion scenarios on the screen. To help the younger children (aged 5 and 6) to overcome language difficulties, they where provided with printed photographs of the scenarios and a pencil, and they were asked to describe by drawing "What happens to the ball…?"

**Data collection and analysis**: The experiences of the participants (part 2) were fully documented. The children's verbal responses and gestures were videotaped, and notes were taken to document behaviors that have not been captured on video (for example, the course of drawing). Interviews were conducted during performance of the tasks to clarify the participants' responses and validate the findings.

## FINDINGS

The findings shed light on two major behavioral patterns: learning by doing (Dewey, 1957) or learning through play (Roussou, 2004), and use of gestures to describe and explain object movement and motion. We chose to focus here on the learning experience of Shahak, a nine year old elementary school boy which was representative of the experiences of the entire group.

**Pre activity task:** Shahak's response to the question "What's happening to the ball now?" reflects embarrassment "Silence…". *Brings left hand near the mouth, places hands on knees and begins to play with fingers; clasps hands, brings them near the mouth again, stares at screen; places hands on knees and begins to play with fingers; stares at screen* and a difficulty to interpret the scenario. Even when he gives some interpretation "the ball is going to go off the court" his description of motion is rather poor. Shahak expresses insecurity in his responses "I don't know…" and provides only partial justification for his claims "It's most likely to go in this direction". Shahak uses gestures rather then words to describe the motion of the ball "From my side it looks as if you can see him *touches a player* going to the right from where I'm sitting *while talking, points to himself*; That's what I think. I don't know" *leans his body forward*. "He hits it from this angle *takes left hand and imitates the movement made by the player in the picture*. It's most likely to go in this direction" *takes forefinger of right hand and moves it from the paddle towards the right side of the screen*. The use of gestures enables him to predict reasonably well the direction of motion without using any formal concept.

**Post activity task:** Following active engagement within the virtual ping-pong game environment, Shahak was asked again to interpret the same motion scenario. Shahak's responses now reflect much more confidence and he responds without hesitating. He refers to the player's actions and to the motion of the ball "The old man is hitting the ball…" "From this side …". His responses reflect deep understanding of the rules of the game "because I've played and if you touch the ball *makes an open-palm movement with his left hand as if with a paddle, and moves* *as if striking the ball* then either the ball lands on the opponent's side *at which he points to various spots on the screen* or the opponent takes the ball" and of the relation between the intensity of the stroke and the characteristics of it's the ball's motion "It stops quicker a ball that is hit hard". The use of gestures is tightly connected with concepts about motion and position in space. The gestures enriched Shahak's ability to express conceptual ideas about motion and position, beyond his ability to describe motion verbally "The old man is hitting the ball. It comes off here *points with left forefinger at the bat and makes a movement to the right, but does not touch the figure of the player in the picture, as if to show that he means behind the player* and it's going to this side". *He makes a movement in the air that looks like a little hill, as if he tried to express that he meant the other side of the court*. This gesture indicates deep understanding of the game. Shahak was able to predict the behavior of the player and the motion of the ball based on his concrete experience within the game environment.

## SUMMARY AND DISCUSSION

Our findings show that the interaction with the computerized game environment enhanced the children's conception about motion. The active engagement in the game enabled participants to improve their ability to provide detailed and coherent interpretations of motion scenarios. We attribute the construction of knowledge to processes of learning by doing (Dewey, 1957) and learning through play (Roussou, 2004), which occur in the virtual game environment. The children did not express conceptual knowledge in words but with the use of gestures. Gestures often precedes the use of formal language and can emphasize and clarify the verbal message, embody new meanings, and impart interpretation to various concepts that cannot be expressed literally. The findings of this pilot study have implications for the possible contribution of bodily interaction with computerized cognitive artifacts to learning.

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