A STUDY ON THE PERCEPTUAL AND MOTOR BASES OF PREDICTION

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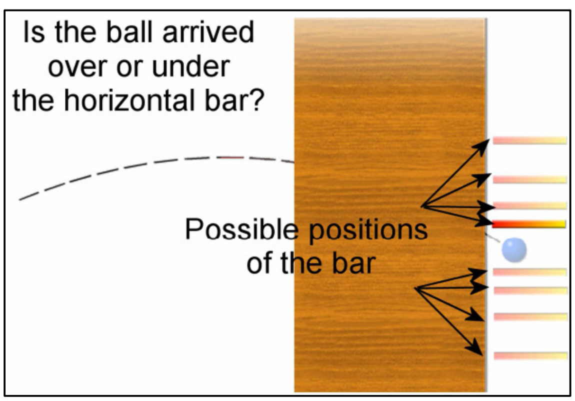
INTRODUCTION

Many are the circumstances in which action–perception dissociations have been observed (e.g. [1], [2]). Among the best known cases there are the pictorial illusions which induce errors in perception but cannot deceive a motor act. It is not yet clear however in which other conditions this separation could be noticed [3]. Following the work of Dubrowski [4] and Zago [5] we wanted to investigate whether action-perception dissociations affect also prediction. We performed an experiment to evaluate whether prediction is differently realized when it's aimed at driving a motor act and when instead its purpose is "perceptual-only". In particular we focused on how dynamical information of target motion is used depending on prediction goal. In a previous experiment (an interception task) we observed that predictive performances where significantly better when the target maintained unvaried its dynamic features (i.e. the force field that drove its motion). Furthermore, when the target was driven by a force field similar to gravity interception resulted easier. We wanted to check if the same results could be found in a predictive task in which no motion was involved.

METHODS

37 subjects participated in the experiment. They sat in front of a monitor (BARCO Calibrator system) at a distance of 57 cm and kept in their hand a small push-button panel (CB6 Response Box, Cambridge Research Systems). The stimulus, realized with a ViSaGe stimulus generator (C.R.S.), was a ball, which crossed the screen following a parabolic path and disappeared behind an occlusion. Subjects were instructed to press a button, as soon as the ball disappeared, to select whether the ball



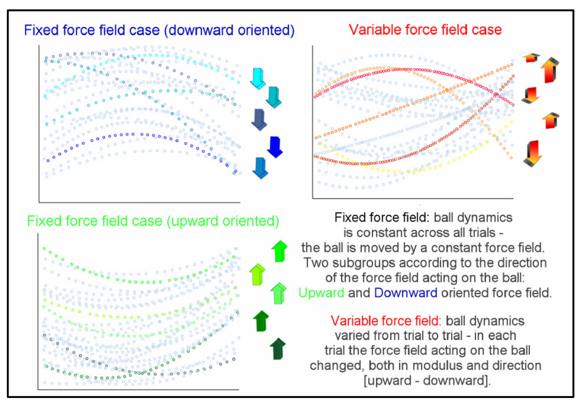


Fig. 1 - Experimental setup: a schema of the game.

Fig. 2 - Examples of ball trajectories and diagrams of the force fields applied to the ball.

would have arrived over or under an horizontal line. The line was placed at the right extremity of the scene, at a fixed distance from the real ball arrival point (see Fig.1). After subjects had made their choice the ball arrival point was shown and a further key press was awaited, to start another trial. In each experiment subjects were presented with 14 possible distances between the ball arrival point and the horizontal line and each distance was presented in 10 different trials. Moreover before the real experiment all subjects were trained with 70 straight trajectories (10 trials x 7 distances), to let them familiarize with the setup and to assess subjects baseline ability in the task. To analyze the results the psychometric curve for each subject was obtained by fitting with a cumulative Gaussian the probability of answering "ball under line" as a function of the real ball-line distance. From each curve two parameters were extracted: the PSE (point of subjective equality), a measure of the minimum distance perceivable by the subject, and the slope of the curve, an indicator of the perceived task difficulty. Subjects were divided into different groups: some of them had to predict the ending positions of balls driven by a constant force field, while others had to deal with balls that changed their dynamical features from trial to trial (red panel in Fig.2). Furthermore we considered two different kinds of fixed force fields: both were vertical, one was downward oriented, similar to gravity (blue panel in Fig.2) and one was instead characterized by upward orientation (green panel in Fig.2). In all cases trajectories were always parabolic and each trial differed from the previous one, since ball initial position and speed changed. The main difference among conditions was therefore given by the constancy or variability of the force field acting on the ball and by force field orientation.

RESULTS AND DISCUSSION

We ran a single factor ANOVA and a Tukey – Kramer multiple comparison test to evaluate if the different conditions (fixed or variable force fields, and gravitational or anti-gravitational oriented force fields) were characterized by different perceived difficulty. If prediction was based on a unifying model of ball dynamics features, as we have previously observed in an interception task, the condition in which ball dynamics changed each time would have been perceived as significantly more difficult. Furthermore we could estimate whether a gravitational like environment allowed for better prediction even when no motor act was involved.

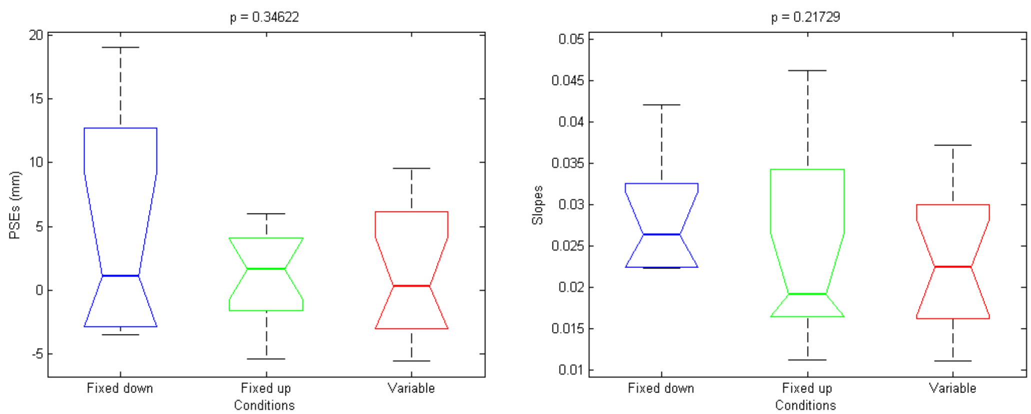


Fig. 3 – One – way ANOVA box plots of PSEs (left) and slopes (right) among the three conditions represented in Fig 2: [blue] constant force field similar to gravity, [green] constant force field of opposite orientation, [red] variable force field. Neither PSEs nor slopes are significantly different among conditions.

The analyzed indicators (PSEs and slopes) result to be not significantly different between the condition in which the force field is kept constant and those in which the force field changes from trial to trial. Also "gravitational" and "anti-gravitational" conditions are perceived as equally easy in prediction. Results show therefore that, in contrast to what we observed in an interceptive task, ball dynamics stability doesn't affect perceptual prediction. The dynamic visual information seems to be processed differently when its purpose is a motor act versus a perceptual one.

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