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Preschool-aged children's jumps: Imitation performances

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ABSTRACT

Imitative behavior underlaid by perception and action links during children's development in complex locomotor skills has been the object of relatively few studies. In order to explore children's motor coordination modes, 130 children divided into five age groups from 3.5 to 7.5 years were instructed to imitate jumping tasks in spontaneous motor situation and in various imitative contexts by an adult providing verbal orders and gestural demonstrations. Their conformity to the model, stability and variability scores were coded from a video analysis when they performed jumps with obstacles. To evaluate their postural-motor control level, the durations of the preparatory phase and jumping flights were also timed. Results showed that all age groups generated the demonstrator's goal but not necessarily the same coordination modes of jumping. In imitation with temporal proximity, the model helped the youngest age groups to adopt his coordination modes and stabilized only the oldest age groups' performances starting from 5.5 years old, without effect on learning imitation. Differences between the youngest and oldest children in the jump duration suggested that the reproduction of a complex motor activity such as jumping with a one foot take-off would require resolution and adjustment of main postural stability.

1. Introduction

Interference between action observation and action execution was demonstrated in numerous behavioral studies (Meltzoff and Decety, 2003; Kilner et al., 2003; Prinz, 2005). The basic process involved several paradigms allowing the reproduction of hand or foot movements performed by another person to achieve a goal (Fadiga et al., 1995; Iacoboni et al., 1999; Rizzolatti et al., 2001; Rumiati and Bekkering, 2003; Buccino et al., 2004). A few studies investigated imitative complex motor skills among children (Cadopi et al., 1996) but fewer in jumping activities. Due to embodiment differences between adult models and children, when dealing with environmental constraints and motor skill levels (Newell, 1986), the mapping between observation and production could not be direct (Jackson and Decety, 2004). It was shown that children acquired a wide variety of novel actions via imitative motor learning (Bandura, 1977; Abravanel and Gingold, 1985). But very often a mere copy of the behavior surface displayed by an adult might not be appropriate or might even be impossible for children to perform, due to different limb lengths, body sizes, perspectives and available skills in motor repertory (Prinz, 2005; Buxbaum et al., 2000; Erlhagen et al., 2006). Before the age of eight, children feel more difficulties in representing their body segments. This *a priori* makes it difficult for them to imitate any model demonstrations (Deloache et al., 2004). Thus, the present study explored children's capacity to imitate a complex motor task at different age levels.

As to the main constraints, Assaiante et al. (2005) suggested that the first step for children to control their locomotor activities was to build a repertory of postural strategies and then, to select the most appropriate postural mode, depending on their ability to maintain equilibrium and to exert force. In jumping, the two essential functions involved a compromise between body propulsion and maintenance of whole-body stability (Assaiante et al., 1997). Other jumping constraints were specifically linked to take-off or landing modes (one foot versus two feet) and to the ground environment (flat ground versus ground with obstacles) or to the previous actions associated with the jump (Vaivre-Douret and Bloch, 1995; Labiadh et al., 2003). To solve these constraints, children attempted to manage postural adjustments according to their developmental calendar. Thus, from 21 to 36 months, the main difficulties of spontaneous jumps were to acquire the thrust necessary for the support foot or feet to become airborne and to organize the stopping movement upon landing (Vaivre-Douret and Bloch, 1995). For 6 and 7 year old children, the transition in the organization of balance control took place at the level of lower limb coordination during the take-off preparatory phase (Assaiante et al., 1997). Another parameter involved in jumping consisted of vertical forces exerted on the lower limbs (Jensen and Phillips, 1991).

Concerning the ontogenesis of jumping, Jensen et al. (1994) demonstrated the appearance of a mature pattern of jumping coordination at the earliest stages of behavior (3–4 years old), requiring

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however a gradual evolution of the process. The emergence of jumping was linked to solving two main constraints – equilibrium and propulsion. From a developmental point of view, Paoletti (1999) distinguished three conventional jumping types, with each type divided into three stages. (1) The drop jump enabled the children aged under 5 years old to go down the last stair of a staircase. Initially, there was no clear jump but rather a long stride. Then, the take-off took place simultaneously on both feet. Equilibrium when landing on both feet was unstable. (2) The long jump concerned children aged 3–5.5 years. At first the children used their arms to help them to maintain balance during flight. The landing was stiff and the children were off-balance. Finally, they gave a complete push forward with their legs while swinging their arms. (3) Lastly, the vertical jump concerned children aged 4–6 years. At first, take-off on both feet was badly synchronized and landing was unsuitable. During flight, full body extension was not complete. Finally, the children performed a synchronized flight with leg greater flexion to prepare take-off.

From this literature investigating constraints and gradual development in jumping, the fact that a child is precociously able to imitate a model gesture does not mean that this child will be able to reproduce the kinematics details of the movement or the whole movement. A child will copy the action but not the details of the movement. The imitation is not concerned with an accurate kinematic gesture, but rather with a global morphological organization, an action (e.g. taking a glass, lifting an arm) (Deloache et al., 2004).

From this literature, the first hypothesis was that imitative matching between adult model demonstration and child performance would be defined in terms of goals – succeed in the jump regardless of coordination means or modes. Knowing that an adult's biomechanical and motor jumping repertory was different from a child's, the second hypothesis was that adult model coordination would not influence child behavior whatever the imitative context. However, it could have an influence when children reach a more advanced jump control repertory.

To check these assumptions, a developmental approach explored children's imitative performances from 3.5 to 7.5 year olds and their motor control capacity to imitate jumping tasks from an adult experimenter's verbal orders and gestural demonstrations. Their imitative performances were coded from a video analysis when children performed vertical jumps, then drop jumps with obstacles.

2. Method

The experiment was realized by the adult experimenter in a spontaneous motor situation and in imitative contexts. The spontaneous motor situation allowed various levels of children's motor control to be revealed and a referential basis compared to the imitative contexts to be established. The locomotor activity was chosen because it could be precociously monitored (Paoletti, 1999). The jumping task was adopted from the beginning and performed whatever the imitative circumstances.

This study had been approved by the Ethics Committee of the Paris Descartes University.

2.1. Participants

The experimental group was instructed by the adult model to imitate jumping only in the imitative contexts. It was composed of 85 children divided into five age groups (3.5, 4.5, 5.5, 6.5 and 7.5 year olds). Each age group was comprised of 17 children. The experimental group performed the task from the gestural demonstration of the adult experimenter. Another group marked as the control group was formed in order to avoid possible interactions with the experimental group because all the children belonged to the same school and were likely to meet each other during the entire duration of the experiments. Thus, there would be no communication between the experimental and the control groups to preserve the behavioral spontaneity of the control group. The control group was composed of 45 children also divided into five age groups – 3.5–7.5 years. Each group was comprised of nine children. These children reproduced the same tasks as the experimental group only in the spontaneous motor situation from a verbal order given by the same adult experimenter. Each child from each age group performed the task alone with the adult experimenter. Authorizations were obtained from the children's parents, the school director and the teachers.

2.2. Material

The children's performances were filmed both forward to backward with one video camera (JVC, 25 images/s) fixed to the ground and operated by a cameraman who followed their reproductions in the sagittal direction (see Fig. 1).

Three 30 cm diameter bowls were placed in the experimental course in various places. Two were put at each extremity of the course (n°1 and n°3) and were used to materialize the departure and the arrival of the locomotor activities. Bowl n°2 was put in the middle of the course and used as a landing strip after jumping.

Four 30 cm long, 20 cm wide and 10 cm high obstacles were put in pairs between bowls n°1 and n°2, n°2 and n°3. Each obstacle was separated by 25 cm used for the reproduction of the jumping modes: vertical jump, then drop jump.

2.3. Protocol

The jumping task was preceded by a walk because the originality of this research was to produce linking motor actions in a course. This course took place in a school sports room. There were neither spectators nor other activities during this experiment. A preliminary experiment was carried out by each age group to check the compatibility of each set of tasks (vertical then drop jumps). The model order in the imitative contexts was: «look at me and then try to do exactly the same thing».

At forward, the model started with his feet in bowl N°1 and walked on the two first obstacles. Arriving at the second obstacle, he jumped by taking-off on one foot and landing on both feet in bowl N°2. From this bowl, he walked forward placing each foot between the two last obstacles. Arriving in front of the last obstacle, he jumped across by taking-off on one foot and landing on both feet in bowl N°3.

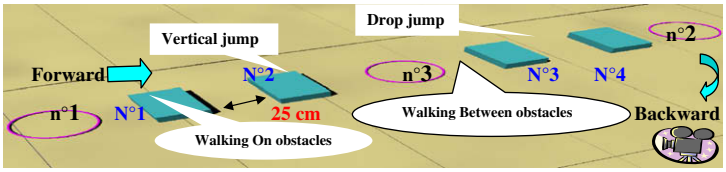

Fig. 1. Experimental course of tasks in a spontaneous motor situation and imitative contexts.