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REACHING COORDINATION ANALYSIS OF 6-YEAR-OLD CHILDREN

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INTRODUCTION

For many years, reaching has been topic of discussion between developmental researchers due to its contribution for understanding the coordination of upper extremity [1]. However, most of the work about the development of reaching has been done with children under the age of 3 years and the precise characterization of this ability during early and middle childhood has been largely ignored, leading to very little information available from these periods [2].

According to previous studies, reaching appears around the 4th or 5th month after birth [3] and continues to mature during infancy until the age of 12, when it is possible to identify adult like patterns of coordination [4]. Moreover, in the period of 6 to 12 years old it is common to diagnose children with developmental coordination disorder (DCD), a problem that affects the coordination of fine and gross motor skills and whose prevalence is around 6 to 8% of all school-aged children [5,6]. Else, there is evidence that a poor coordination can alter not only motor development but social and psychological development as well [7].

Furthermore, in order to evaluate coordination in a development frame it is important to fully understand all ages of coordination development, specially those of school age, where children can be accompanied by professionals who have the knowledge to investigate whether the child's movements are still within the normal range, whether they reflect a developmental delay, i.e. comparable to the behavior of a younger child [5].

Therefore, this study aims to investigate the coordination patterns of the upper extremities of 6 year-old children in a reaching task by a kinematic analysis.

METHODS

A total of 20 healthy children (10 girls and 10 boys) aged 77.10 ± 2.53 months were selected from a public school of Ribeirão Pires (SP). Children were included if they had a score of 0.7 in Snellen e-chart on both eyes and were right-handed with level of hand preference at least 90%. Before the trials, weight (27.81 ± 7.51 m) and height (1.22 ± 0.07 m) were measure for all children and motor development was quantified by MABC-II (78.4 ± 12.42).

Children performed reaching movements in a horizontal plane. Three anatomical marks were used (acromium, lateral epicondyle of the humerus and head of the third metacarpus) to create a model of the arms with two segments (lower arm and upper arm) and two joints (elbow and shoulder).

The child seated in a chair, with the wrist immobilized by an adjustable orthesis and both arms resting in an ergonomic table designed for the study. On the table´s surface there were 4 marked points, the starting point and 3 targets that required 19-cm-long movements, numbered from 1 to 3 and oriented respectively at 45, 90 and 135 degrees of the horizontal axis. The table was adjusted according to the child´s height (upper extremity perpendicular with the trunk in the frontal plane) and the chair was positioned in a way that the starting point was in the middle line of the body. Each child was asked to move the arm as fast as possible from start position to one of the 3 targets, as soon as the verbal command of experimenter was heard. All children performed a familiarization session followed by the experimental session (60 trials with each arm). The protocol was approved by the Ethics Committee and was performed in accordance with the ethical standards.

The trials were recorded by a camcorder, JVC GR-DVL9800, which registered the movement in its principal plane with a frame rate of 120 Hz. Then, the data extracted from the camera was digitalized in APAS (Ariel Performance Analysis System) and kinematic variables were calculated using a MATLAB routine. We analyzed hand trajectories of movements calculating the following measures of task performance: linear distance, cumulative distance and hand path deviation from linearity. Additionally, we calculated angular displacement of the shoulder and elbow, ratio of angular displacement between shoulder and elbow, movement duration and peak of tangential velocity of the hand.

Two-way ANOVA was applied to compare results from both hands (dominant (D) and non-dominant (ND)) and targets 1 (ipsilateral) and 3 (contralateral). For all analysis, statistical significance was tested using an alpha value of 0.05 and Tukey's test was used for post-hoc analysis.

RESULTS AND DISCUSSION

Means of the individual dependent measures of task performance were analyzed using ANOVA with hand (right = dominant = D and left = non-dominant = ND) and target (direction from horizontal axis: 45º and 135º) as the within subject factors. Subjects were treated as random factor. Results showed significant differences between hands in cumulative distance, deviation from linearity and movement duration. In comparison between targets variables linear distance, deviation from linearity, movement duration and peak of velocity were found to be also statistically different. Interaction between factor hands and targets were observed in cumulative distance, deviation from linearity, movement duration and peak of velocity. Post hoc analyses revealed that interaction were significant for all targets in cumulative distance and only for target 3 in movement duration and deviation from linearity (Figure 1). For peak of velocity this analysis showed distinguished differences between targets for the same hand, dominant or non-dominant.

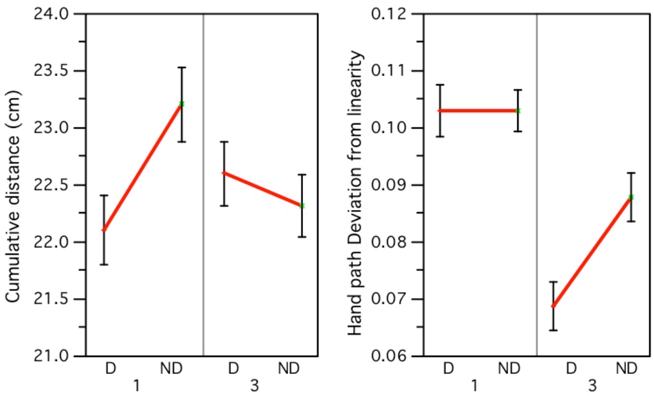

Figure 1: Parametric measures of cumulative distance and deviation from linearity, across subjects (mean ± SE), for dominant (D) and non-dominant (ND) hands across targets.

Typical hand paths from individual trials for a representative participant are shown in Figure 2. The analysis of hand trajectories for both hands and targets confirmed the interactions shown in the statistical analysis. Hand path's curvature for target 3, which requires more displacement at the shoulder joint were found to be greater. Trajectory for this target was more curvilinear for the non-dominant hand and its shape was different from the dominant hand. Shoulder and elbow displacements and its ratio were not significantly different between hands.

These results suggest that 6-year-old children show similar reaching coordination behavior as compared to adults with respect to trajectory's linearity and handedness [8]. It also suggests distinct pattern of coordination for ipsilateral targets and contralateral targets due to observed behavior of the peak of velocity to targets that were equally distant from the start point.

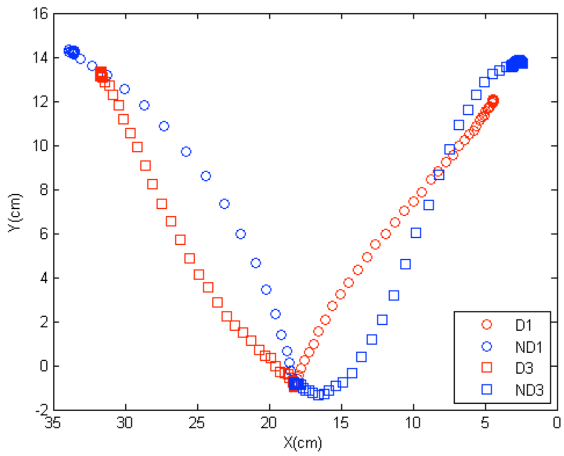

Figure 2: Representative samples of hand trajectory profiles for the dominant (D) and non-dominant (ND) hands towards targets 1 and 3.

CONCLUSIONS

Children at the age of six seem to present some adult like matured features in reaching and some are still in the process of development.

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