Introduction

- Children with unilateral cerebral palsy (CP) have been shown to improve their motor performance with sufficient practice.
- Little is known about how children with CP learn goal-oriented tasks.
- General motor learning principles that have been established based on the research of healthy young adults may not always apply to children with CP (Duff & Gordon, 2003).
- Most studies of motor learning in children with CP only investigated the changes of task performance before and after practice.
- Learning pattern for children with CP is not known.
- There are two proposed learning patterns for healthy adults: the power law of practice (a linear log-log relationship between performance measures and practice trials, Snoddy, 1926) and the multiple time scales of nonlinear dynamic systems* (persistent and transitory changes in task performance evolve from different subsystem time scales, Liu, Mayer-Kress, & Newell, 2010; Newell, Liu, & Mayer-Kress, 2001).
- Since the current study only had 45 practice trials and no manipulating control parameters, it may fit a single exponential function.
- It is not known which learning pattern children with unilateral CP and typically developed children (TDC) will follow.

Hypothesis

- Children with hemiplegic CP will have a different, and delayed learning rate.

Methods

21 children with unilateral CP (age 4-10 years; MACS levels I-II) and 21 age-matched, TDC participated in the study. Children were seated and asked to perform a speed stack task bimanually. To assess their progress of learning the speed stacks task, the speed stacks task was performed three times consecutively each morning at a fast as possible speed for 15 days. Faster speed indicated better bimanual coordination since the task requires proper and rapid coordination between the two hands to complete the task. The speed stacks task was not practiced outside the test. The average times of the three trials of each day for each child was compared over 15 days of practice for the children with unilateral CP and TDC.

Results

Average movement time performance of the speed stack task over 15 practice sessions (practice, group, and practice x group all Ps<0.001). Children with unilateral CP showed no significant change in the first three days of practice and most of the changes were between the 4th to 6th or 8th day. For the TDC, significant difference happened within the first three days.

![Figure 1. Schematic drawings of the experimental setup (a) at the starting position with three stacks of cups and each stack has three cups (bottom up), (b) with the first stacks of cup built up to form a pyramid.](image)

![Table 1. Averaged accounted variance between the task performance and practice sessions by fitting power law of practice and exponential function for both groups. Post-hoc analysis indicated that the exponential function accounted for more variance for unilateral CP group, but not TDC group](table)

<table>
<thead>
<tr>
<th>Functions</th>
<th>Unilateral CP</th>
<th>TDC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n=21)</td>
<td>(n=21)</td>
</tr>
<tr>
<td>Power law of practice (SD)²</td>
<td>0.55 (0.21) *</td>
<td>0.70 (0.18)</td>
</tr>
<tr>
<td>Exponential function (SD)²</td>
<td>0.58 (0.21) *</td>
<td>0.69 (0.16)</td>
</tr>
</tbody>
</table>

Note. SD = Standard deviation; CP = cerebral palsy; TDC = typically developed children; * p < .05 power law of practice compared to exponential function.

Conclusions

- Both groups demonstrated their ability to learn the current bimanual task, but their rate of improvement and learning pattern differed.
- Children with unilateral CP overall were slower and improved ~10% less than TDC.
- Most of the improvement occurred during the first 3 days for the TDC, whereas performance did not plateau until 6-8 days for the children with unilateral CP.
- The initial slower learning rate for children with unilateral CP was also confirmed by better fitting of the curve to an exponential function than the power law function (P<0.05).
- Therefore, when working with children with unilateral CP, sufficient practice is important (two to three times more than for TDC), and delayed improvement is expected.

References