**The effect of robotic reinforced movement learning technology on the development of prone mobility in infants at low and high risk for cerebral palsy**

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*Abstract:*
Children at risk for cerebral palsy (CP) have a wide range of mobility constraints that impact functional independence across the lifespan. Chief among them is prone mobility. The development of prone mobility coincides with a period of highly active synaptic formation in the brain making it a critical gateway and target for reinforced movement learning interventions. We hypothesized that: a) infants will recognize and use augmented movement to propel the SIPPC and b) infants at risk for CP using reinforced learning from a combination of the SIPPC and accelerometer sensors (SIPPC-E) will show a pattern of goal directed mobility similar to that of typically developing infants (SIPPC-T) compared to a control group receiving assistance from the SIPPC alone (SIPPC-C).

We used a repeated measures experimental design with 3 groups: experimental group (SIPPC-E), 2 control groups (SIPPC-T and SIPPC-C). Participants were 27 infants, 4.5 – 6.6 month old, at low and high risk for CP. Except for the typically developing infants (SIPPC-T), those at high risk for CP were randomly assigned to the experimental (SIPPC-E) or control group (SIPPC-C).Training in prone mobility on the SIPPC occurred twice a week for up to 12 weeks and performance data were collected simultaneously during training. We compared the weekly distance travelled by the groups, combinations of arm and leg movements from accelerometer data, and goal directed movements from the Movement Observation Coding Scheme (MOCS). We used correlations and randomized three-way ANOVA with repeated measures to test the hypotheses.

As hypothesized the mean distance travelled for all groups increased over the 12 week period with the largest increase in the SIPPC-T group (p=.001) followed by the SIPPC-C and E groups (p=.01). Distance travelled data show that infants as young as 4.5 - 6 months of age are capable of using reinforcement offered by robotic sensors such as the SIPPC to learn a complex and high dimensional movement like prone mobility. Correlation coefficients between the movement patterns and the distance traveled ranged from r=.71-.94 for the SIPPC-T, r=.55-.83 for the SIPPC-E, and r=.32-.56 for the SIPPC-C group, respectively. Infants in the SIPPC-T group displayed goal-directed prone mobility beginning at 4-6 weeks of training compared to 7-9 weeks and 10-12 weeks for those in the SIPPC-E and SIPPC-C groups, respectively. The differences in the correlation coefficients and emergence of goal directed mobility suggest that cognition and type of brain lesion may play a major role in reinforced robotic movement learning among infants at risk for CP. A third of the infants were diagnosed with severe hypoxic encephalopathy.
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