Learning From Exploration: A Reinforcement Approach To Gait Rehabilitation

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ABSTRACT
We developed a novel treadmill training protocol to test a reinforcement learning paradigm that has the potential to change the current gait training paradigm of supervised learning to benefit patients post-stroke. We hypothesized that rehabilitation grounded upon reinforcement learning will result in better retention and transfer of training effects. Our preliminary results reflect preliminary data collection involving two subjects in each group, respectively.

METHOD
Subjects: We plan to use 30 healthy subjects (ages 18-45). Our current results reflect preliminary data collection involving two subjects in each group, respectively.

Design: Two-group (Supervised versus Reinforcement), Pre-Post Design

Description: All subjects are asked to learn a target ankle position on a treadmill in a two-day experiment. The closer they are to the target, the more dollar amounts they will receive. They can only rely on visual feedback, which depends on which experimental group they are assigned to.

BACKGROUND
• Stroke is the biggest contributor to adult disability in developed countries and can lead to chronic gait impairments.1
• Robotic treadmill gait training is a popular type of gait rehabilitation method; however, outcomes have been suboptimal. Patients are given clear and constant feedback by the robot concerning their movements and errors, which is known as a supervised learning style. Since patients passively learn, they often cannot replicate the targeted skill without feedback (retention) or apply the skill off the treadmill (transfer).2,3,4,5
• Evidence has shown that active learning, such as reinforcement learning, is a more effective learning style than passive learning. Reinforcement learning gives patients rewards or punishments instead of clear instructions to learn. It forces the patient to choose their own motor plan from vague feedback to accomplish a task and learn from their errors.5,6

The purpose of this study is to test the feasibility of grounding gait rehabilitation on reinforcement learning.

Supervised Learning Feedback

Reinforcement Learning Feedback

Task: Match the blue bar (actual ankle position) to the red bar (target).
Task: Get as close to “Very Close” as possible.

RESULTS
A. Baseline Gait Training

B. Retention

C. Transfer

The subject in the reinforcement group showed less error during long-term retention (LR), short-term transfer (ST), and long-term transfer (LT), when compared to the supervised subject.

CONCLUSION
Our preliminary results support our hypothesis that gait rehabilitation grounded upon reinforcement learning will result in longer retention and better transfer of training effects when compared to supervised learning.

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References