

Mechanical Engineering Doctoral Defense

Exploring the utilization of startle as a therapy tool in individuals with stroke

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Abstract

Stroke is a debilitating disorder and 75% of individuals with stroke (iWS) have upper extremity deficits. IWS are prescribed therapies to enhance upper-extremity mobility, but current most effective therapies have minimum requirements that the individuals with severe impairment do not meet. Thus, there is a need to enhance the therapies. Recent studies have shown that StartReact -the involuntary release of a planned movement, triggered by a startling stimulus (e.g., loud sound)- elicits faster and larger muscle activation in iWS compared to voluntary-initiated movement. However, StartReact has been only cursorily studied to date and there are some gaps in our knowledge. Previous studies have only evaluated StartReact on single-jointed movements in iWS, ignoring more functional tasks. IWS usually have abnormal flexor activity during extension tasks and abnormal muscle synergy especially during multi-jointed tasks; therefore, it is unknown 1) if more complex multi-jointed reach movements are susceptible to StartReact, and 2) if StartReact multi-jointed movements will be enhanced in the same way as single-jointed movements in iWS. In addition, previous studies showed that individuals with severe stroke, especially those with higher spasticity, experienced higher abnormal flexor muscle activation during StartReact trials. However, there is no study evaluating the impact of this elevated abnormal flexor activity on movement, muscle activation and muscle synergy alterations during voluntary-initiated movements after exposure to StartReact. This dissertation evaluates StartReact and the voluntary trials before and after exposure to StartReact during a point-to-point multi-jointed reach task to three different targets covering a large workspace. The results show that multi-jointed reach tasks are susceptible to StartReact in iWS and the distance, muscle and movement onset speed, and muscle activations percentages and amplitude increase during StartReact trials. In addition, the distance, accuracy, muscle and movement onsets speeds, and muscle synergy similarity indices to the norm synergies increase during the voluntary-initiated trials after exposure to StartReact. Overall, this dissertation shows that exposure to StartReact did not impair voluntary-initiated movement and muscle synergy, but even improved them. Therefore, we suggest that StartReact is safe for more investigations in training studies and therapy.



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Zoom Link: <https://asu.zoom.us/j/6974457089>