

## Noise Enhanced Technology incorporation into movement controlled toys.

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Hemiparesis is a congenital (occurring before, during or soon after birth) or acquired (from illness or stroke) disorder that affects the motor centers of the brain. The condition is commonly caused by stroke but is also found in a form of C.P. known as hemiplegic cerebral palsy. The most common cause of hemiplegia is damage to the corticospinal tracts in one hemisphere of the brain due to obstruction or rupture of a cerebral artery or to brain tumour.<sup>1</sup> It is a debilitating disease that leads to intensive physical therapy. The main focus of our project is the currently limited resources and available therapy for children affected by hemiparesis.

There exists a project to develop toys that will allow children to gain a sense of normalcy while furthering their physical therapy. The toys currently being designed and tested include a power glove, a slot car racing controller, and a supination / pronation / flexion / extension switch. All three of these devices are built on the concept of controlled planar motion, allowing for stimulation only if the children reach a certain preset goals. Also within the toys exists a new technology designed by Afferent Corp that involves the manipulation of piezos.

Studies have shown that patients with stroke exhibit greater postural sway than healthy control subjects. This increased sway has been associated with the inability to integrate the peripheral somatic-sensory information.<sup>2</sup> It has been hypothesized and tested that sub-sensory noise can enhance the detection of pressure changes on the soles of feet, leading to better balance control. The neuronal mechanism underlying balance control involves mechanical noise from the peripheral nervous system and its interpretation by the motor cortex of the brain. By producing small changes in strain through noise enhanced technology on the receptor membrane, fluctuations on the receptor trans-membrane present themselves and a change in ion-permeability of the active cells occurs<sup>2</sup>. This change in permeability is due to the small gated potentials caused by the noise. These gated potentials partially depolarize the neuron and bring it closer to the threshold for the firing of action potentials in the presences of a weak or distorted signal. It effectively becomes predisposed to firing or sensitized to additional mechanical stimulus.<sup>2</sup> This can be simplified by the

idea that the piezos firing cause stochastic resonance which is based on the concept that the flow of information through a system can be maximized by a particular non-zero level of noise.<sup>3</sup>

Studies have shown that the addition of noise by the piezos to a system cause statistically significant reduction in each of the eight sway parameters in subjects with diabetic neuropathy, subjects with stroke, and elderly subjects proving that the noise based devices improve diabetic and stroke impairments in balance control by the supported recognition of stimulus.<sup>2,3,4,5</sup> Enabling action impulses to be sent to the brain give it the chance to interpret and reorganize accordingly.<sup>6</sup> Through these conclusions the decision was made to incorporate Afferent's noise stimulation into the Toy's.

With the supportive conclusive data that noise based techniques can be applied to adults with marked sensory deficits<sup>3</sup> it is our goal to test this hypothesis in children. It has been shown in hemiparetic patients that brain plasticity allows for the motor cortical compensation or reorganization of motor function into other areas of the brain, such as reorganization from an infarcted M1 sector to the S1.<sup>6,7</sup> This becomes a very promising idea when applied to young developing brains. Currently thresholds values for healthy and affected children are being collected. The incorporation of this technology is proposed, in addition to controlled movements, to cause marked improvements in children with hemiparesis ability to control affected limb function.

### References:

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