

Using Tongue-Based Biofeedback to Improve Balance

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Maintaining an upright position requires sensory information from various sensory systems including the visual, vestibular, and somatosensory systems. If one of these sensory systems is dysfunctional or is inefficient, then balance can greatly be affected to the point where it is unhealthy and detrimental to the person due to an awkward center of balance. If a person's center of balance is not where it should be located, this can result in failure to stand upright as well as potentially leading to other injuries to the lower back and other various parts of the body.

When one of these sensory systems is lost or damaged, then one way to maintain a good balance and posture is by substituting the damaged sensory system with another sensory modality which can send information to the CNS. One way this can be done is by using tactile sensory information from the tongue to tell the brain when the body is not balanced correctly. This method is called biofeedback, or taking information from the user's own body to provide feedback to the user. Using tongue-based biofeedback to replace a dysfunctional sensory system can successfully maintain a good balance and posture of the user.

With this knowledge, Dr. Vuillerme et al. conducted an experiment to see if the tongue-based biofeedback system can successfully improve balance in healthy adults. 10 healthy adults had to close their eyes and stand as immobile and completely upright as possible. They all wore pressure sensors in their insoles which measured various pressures on the bottom of the foot, which was then used to fine the center of foot pressure. Vuillerme then found what they call "dead zones," which were found for each test subject. The dead zones of the subjects were determined by taking the standard deviation of the position of the center of foot position in the first ten seconds of each trial. The dead zones were set as the standard center of foot pressure location so that the patient has good balance. Two trials for each subject were conducted: one with biofeedback and one without biofeedback.

When the subject was conducting the experiment, the center of foot pressure was being measured and recorded. If the subject's center of foot

pressure was located outside of the standardized dead zone, then the tongue biofeedback system would send an electrical impulse to the tongue via an electrode matrix placed on the tongue, which the CNS of the brain would then read the information and tell the user to correct his center of foot pressure.

The matrix of electrodes was divided into eight zones: the front, rear, left, right, front-left, front-right, rear-left, and rear-right. When the subject had a center of foot pressure outside the dead zone, the device would apply an impulse to the zone in the electrode matrix which corresponded to the location of the center of pressure relative to the location of the dead zone. When the user adjusted his or her center of foot pressure location accordingly back to the standard dead zone, then the impulses to the tongue would cease and the user would know that he or she is maintaining proper balance.



The results of the experiment showed that the trials with biofeedback successfully caused the user to have a decrease in center of foot pressure displacement as well as increased the user's control of the location of the center of foot pressure. The decrease in displacement is similar to effects of a person who is standing with his or her eyes open. Therefore, the tongue-based biofeedback system can efficiently replace a damaged sensory system so that a person can maintain balance. Future possibilities of the tongue-based biofeedback system could include improving the balance of someone with somatosensory loss in feet due to diabetes.

Works Cited: Vuillerme, N., et al. "A plantar-pressure based tongue-placed tactile biofeedback system for balance improvement." *Computer Methods in Biomechanics & Biomedical Engineering* 10.(2007): 63-64. *Academic Search Complete*. EBSCO. <http://www.newsscientist.com/article/dn14058-tongue-display-helps-you-keep-your-balance.html>
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