

Random delay boosts musical fine motor recovery after stroke

van Vugt F T*, Kuhn W*, Rollnik J D#, Altenmüller E*²

**Institute of Music Physiology and Musicians' Medicine, University of Music, Drama and Media, Hannover, Germany*

#*BDH-Klinik, Hessisch Oldendorf, Germany*

¹Floris.vanVugt@hmtm-hannover.de, ²Eckart.Altentueller@hmtm-hannover.de

ABSTRACT

Background

Motor impairments are among the most common and most disabling results of stroke worldwide. Previous studies have revealed that learning to play the piano helps to improve motor function of these patients (Rodriguez-Fornells et al., 2012; Rojo et al., 2011; Schneider, Schönle, Altenmüller, & Münte, 2007). It has been hypothesised that the effectiveness of this therapy relies on the fact that the patient's brain receives a time-locked auditory feedback (a musical tone) with each movement (keystroke) (Altenmüller, Marco-Pallares, Münte, & Schneider, 2009). Indeed, studies with healthy individuals have shown that the presence of auditory feedback can benefit motor control and learning (Conde, Altenmueller, Villringer, & Ragert, 2012; Keller & Koch, 2006).

Aims

Our study aims to investigate whether the stroke patient's brain uses the temporal information contained in the auditory feedback in the process of music-supported motor rehabilitation.

Method

15 patients in early stroke rehabilitation with no previous musical background learned to play simple finger exercises and familiar children's songs on the piano. The participants were assigned to one of two groups: in the *normal* group, the keyboard emitted a tone immediately at keystroke, in the *delay* group, the tone was emitted after a time interval between 100 and 600ms, chosen randomly at each keystroke. To assess fine motor skill recovery, patients performed standard clinical tests such as the nine-hole-pegboard test and index finger tapping speed and regularity.

Results

Surprisingly, patients in the *delay* group improved strikingly in the nine-hole-pegboard test, whereas patients in the *normal* group did not. In finger tapping rate and regularity both groups showed equal, marked improvements. The *normal* group showed reduced depression whereas the *delay* group did not. In sum, not only did the delay group not show any rehabilitation deficit, but they actually performed better than the normal group on some tests.

Conclusions

We conclude that music therapy on a randomly delayed keyboard can significantly boost motor recovery after stroke. The mechanism underlying this effect can be based on reliance on the auditory feedback: patients in the delayed feedback group may have implicitly learned to be independent

of the auditory feedback, because the brain notices that it is not temporally reliable. Therefore, this group outperformed patients in the normal condition on those tasks where no auditory feedback is present (Salmoni, Schmidt, & Walter, 1984).

Our results indicate that it is important to consider to what extent patients in rehabilitation settings are made dependent on the materials used.

However, a limitation of our current study is the small number of patients. Currently a larger group is being tested to be able to rule out a sampling effect.

Keywords

stroke, rehabilitation, music therapy, auditory feedback

REFERENCES

- Altenmüller, E., Marco-Pallares, J., Münte, T. F., & Schneider, S. (2009). Neural reorganization underlies improvement in stroke-induced motor dysfunction by music-supported therapy. *Annals of the New York Academy of Sciences*, 1169, 395–405. doi:10.1111/j.1749-6632.2009.04580.x
- Conde, V., Altenmueller, E., Villringer, A., & Ragert, P. (2012). Task-irrelevant auditory feedback facilitates motor performance in musicians. *Frontiers in Auditory Cognitive Neuroscience*. Retrieved from http://www.frontiersin.org/Auditory_Cognitive_Neuroscience/abstract/18682
- Keller, P. E., & Koch, I. (2006). The planning and execution of short auditory sequences. *Psychonomic Bulletin & Review*, 13(4), 711–716.
- Rodriguez-Fornells, A., Rojo, N., Amengual, J. L., Ripollés, P., Altenmüller, E., & Münte, T. F. (2012). The involvement of audio-motor coupling in the music-supported therapy applied to stroke patients. *Annals of the New York Academy of Sciences*, 1252(1), 282–293. doi:10.1111/j.1749-6632.2011.06425.x
- Rojo, N., Amengual, J., Juncadella, M., Rubio, F., Camara, E., Marco-Pallares, J., Schneider, S., et al. (2011). Music-Supported Therapy induces plasticity in the sensorimotor cortex in chronic stroke: A single-case study using multimodal imaging (fMRI-TMS). *Brain Injury*. doi:10.3109/02699052.2011.576305
- Salmoni, A. W., Schmidt, R. A., & Walter, C. B. (1984). Knowledge of results and motor learning: a review and critical reappraisal. *Psychological bulletin*, 95(3), 355–386.
- Schneider, S., Schönle, P. W., Altenmüller, E., & Münte, T. F. (2007). Using musical instruments to improve motor skill recovery following a stroke. *Journal of Neurology*, 254(10), 1339–1346. doi:10.1007/s00415-006-0523-2