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The role of retraining in rehabilitation from focal dystonia

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Focal dystonia is a debilitating movement disorder which occurs as a result of many repetitions of a specific task and typically manifests in involuntary muscle contractions. In pianists, an incoordination occurs between fingers, making it impossible to play at concert level. Three pianists with focal hand dystonia participated in a retraining program based on a biomechanically sound way of playing with minimal tension. Quality of scales and repertoire were assessed before and after pianism retraining by several rating systems and included assessment by a listener blinded as to which hand was dystonic and whether they were assessing playing pre- or post-retraining. Scale quality improved with retraining in all three pianists, with improvement in both hands, but greater in the dystonic hand. While there was no change in the blinded listener being able to identify the non-dystonic hand from pre-training to post-training, they could correctly identify the dystonic hand 79% pre-retraining, but this decreased to 28% post-retraining. The test repertoire evaluation and the visual evaluation rating were shown to improve significantly by 1.0 and 1.3 points, respectively (on a five point rating scale), from pre-training to post-training.

Keywords: focal dystonia; piano technique; retraining; biomechanical

Focal dystonia is usually painless and most commonly affects only one hand, often involving involuntary flexion of just two or three specific fingers. The incidence may be as high as one in 200 professional musicians (Altenmüller 2000, Schuele *et al.* 2005). In focal dystonia, the areas in the brain responsible for the movement of adjacent fingers have become enlarged, due to over-

use, and can overlap (Elbert 1998). Treatments options have included administration of trihexyphenidyl or botulinum toxin, splinting, and limb immobilisation, but only exceptionally do musicians with focal dystonia return to normal motor control (Altenmüller and Jabusch 2007). Different methods of retraining alone without the above medical interventions have reported anecdotal success, but few have been accessed scientifically. The aim of this research was to determine whether a specific pianism retraining program would result in improvement in symptoms of focal dystonia.

METHOD

Participants

Three pianists with focal dystonia participated in a specific retraining program based on a biomechanically sound way of playing with minimal tension.

Procedure

Prior to retraining, each subject recorded three separated scales and an arpeggio with each hand alone in the same octave at a range of tempi. They also recorded segments of repertoire that were challenging because of the dystonia. Daily retraining then began for a minimum of ten sessions within two weeks, after which time the scales and repertoire excerpts were re-recorded. Recorded excerpts were assessed by a professional pianist ("blinded listener"), blinded to the identity of the subject, who was asked to determine which hand was playing and whether the playing was pre- or post-retraining. The sound only of different scales was assessed using a Scale Quality Evaluation (SQE) and a Dystonic Hand Identification Evaluation (DHIE), where the listener was asked to identify whether the hand playing was dystonic or not. During the retraining the technique of each pianist was analyzed and broken down into the smallest possible units. Posture at the instrument was corrected with particular attention to the sitting position and the height of the piano stool, and head, neck, shoulders, back, arms, wrist, and hands were freed to move with minimum tension. The retraining program began by teaching each pianist to play single notes at a very slow tempo, beginning with the non-dystonic hand and only when perfected progressing to the dystonic hand. Each finger was required to move from a supported metacarpophalangeal (MCP) joint with the weight of the arm transferred to the key without unnecessary interference from the wrist or forearm. Each finger was aligned with the key before lifting and playing,

Table 1. Subject characteristics.

	Subject 1	*Subject 2*	*Subject 3*
Age in years	53	23	23
Sex	M	F	M
Level of performance	International soloist	Graduate student	Doctoral student
Years of playing	43	13.5	16
Duration of dystonia	5 years	4 years	8 months
Hand dominance	Right	Right	Right
Hand affected	Right	Right	Left
Digits affected	D3 and D4	D2and D3	D2

meaning that the hand position was adjusting with each finger. Independent movement was not necessary as pianism rarely requires fingers to move in isolation. When single notes were accomplished with ease, consecutive notes were attempted at a very slow tempo, first at the interval of a major second before progressing to chromatic intervals and major and minor thirds. Transferring the weight across larger intervals was assisted by a downward convex movement of the wrist. It was important to take the weight on each finger before turning, lifting, and playing the following note. Each finger was deliberately released after playing and the dystonic finger actively released away from the compensatory finger. When cramping occurred, an unrelated thought was found to help the completion of the movement. Wrist and forearm relaxation was monitored on both the radial and ulna sides. In order to incorporate the retraining into repertoire, groups of notes were processed as a single thought, enabling increased speed.

RESULTS

The subject characteristics on initial assessment are presented in Table 1. An analysis of variance (ANOVA) of all five variables (subject, retraining, scale, tempo, and dystonic hand) showed that the variables that have a significant effect on the SQE are retraining [$F(1, 137)=73.8$, $p<0.0001$], dystonia [$F(1, 137)=27.04$, $p<0.0001$], and the interaction between these two variables [$F(1, 137)=7.71$, $p<0.0001$], the latter signifying a greater improvement in one hand than the other after retraining. Average scores in the non-dystonic hand improved from 3.12 to 3.78, an increase of 0.66 points, while in the dystonic hand scores improved from 2.32 to 3.54, an increase of 1.22 points (see Figure 1). Thus, the improvement in the dystonic hand was twice that of the non-dystonic hand. In terms of the DHIE score, the blinded listener correctly

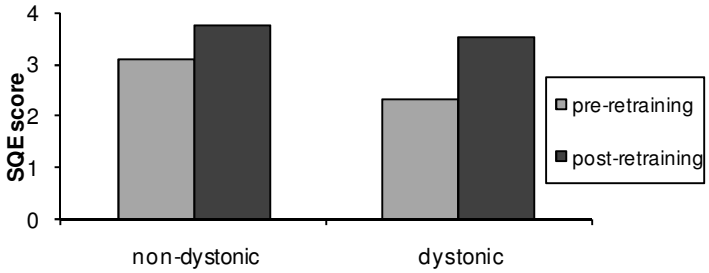

Figure 1. Changes in Scale Quality Evaluation with retraining for both dystonic and non-dystonic hands.

identified the non-dystonic hand in 41 of 55 times pre-training (75%) and 54 of 62 times post-training (87%); this change was not statistically significant. However, with the dystonic hand, the blinded listener correctly identified the dystonic hand 44 of 56 times (79%) but post-training could only correctly identify the dystonic hand 18 of 64 times (28%), a significant decrease [$\chi^2=30.44$, $p<0.0001$]. Analysis for the test repertoire (TRE) found an overall increase in scores from pre- to post-training of 1.0 point [$F(1,131)=67.13$, $p<0.0001$]; however, there was also a significant interaction between time and subject [$F(2,131)=16.32$, $p<0.0001$]. This showed increases in TRE of 1.3 and 1.9 points for two of the subjects respectively, but a decrease of 0.1 points for the other subject. Similarly, the visual evaluation rating (VER) showed an overall increase from pre- to post-training of 1.3 points [$F(1,131)=79.21$, $p<0.0001$]. However, again there was a significant interaction between time and subject, with two subjects showing increases pre- to post-training of 1.4 and 2.3 points respectively, while the third subject showed an increase of 0.3 points [$F(2, 131)=12.80$, $p<0.0001$].

DISCUSSION

The most important finding of this research is that focal dystonia can be successfully treated through retraining in pianism. Both scale playing and repertoire excerpts improved in all three subjects. Various factors emerged as crucial in the retraining process. The initial daily contact was of vital importance to the sufferers, not only because it aided the motivation but also because increments of improvement were subtle and needed to be built upon

with painstaking patience by both researcher and sufferer. This intensive period was thought responsible for the retraining method producing quicker results than those reported in the literature. Jabusch and Altenmüller (2006) reported that most responders in their study averaged treatment between two and three years, while in this study the concert pianist who had not been able to play for five years was able to return to a full time career after one year and both other subjects are now playing at concert level.

It was important to retrain the whole technique, not just the affected fingers. Retraining began with the non-injured hand and fingers only, progressing to the injured fingers once the movements were completely free of unnecessary tension.

Although postural correction was included as part of the method, the retraining protocol began with sound, as evaluating this musical element helped the pianist to monitor his/her own sense of postural balance and to differentiate between tension and release. The sound is at its best only when the body moves in the most biomechanically ideal way. Whereas many pianists believe in playing from the key, it was found that the lifting of the finger when done from the MCP joint was a freeing movement which counteracted the cramping dystonic tendency. It was important for each finger to take the weight of the arm and to release immediately after playing before turning by a rotary convex swing from the wrist to align the next finger with the key. Curling of the fingers was avoided, as was lifting in isolation. Awareness of complete lack of tension on both the radial and ulnar side of the wrist and elbow was established, and the arm hung freely from the shoulders so that the ensuing sound was round and full.

A second important finding of our research is that the scale playing of the dystonic hand improved to a level greater than the level of the non-dystonic hand prior to retraining (see Figure 1). The implication of this finding is that the overall pianism of each subject was improved by the retraining. Possible mechanisms for the improvement in pianism with retraining include: establishing a balanced posture, refining the movement patterns so that the fingers were aligned with the keys, removing the tension in the wrist and forearm, maintaining freedom of movement in the elbow and shoulder, enabling the fingers to carry the weight of the arm, and releasing each note immediately after playing.

Although focal dystonia is a neurological disease, we believe that what happens at the muscular level is of crucial importance in the development of this condition. The fact that it is possible for most musicians to engage in hours of practice at an instrument without problems of this kind means that repetition per se is not the cause. This suggests that the cortical alterations

seen in focal dystonia may be associated not just with overuse but also with misuse. If a return to the instrument involves the same stressful movement patterns as before, injury will recur regardless of what interim treatment is applied. In the case of focal dystonia, because the stress of the previous movement patterns has caused the enlargement of finger representations in the cortex, we believe that the only possible way to lasting recovery is to create "new connections" by retraining the technique.

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