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# Sensory Motor Retuning: A Behavioral Treatment for Focal Hand Dystonia of Pianists and Guitarists

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**Objective:** To evaluate the long-term effectiveness of sensory motor retuning (SMR), a new treatment for focal hand dystonia in musicians.

**Design:** Prospective case series with an (adventitious) comparison group with 3- to 25-month follow-up in piano and guitar and 0- to 4-month follow-up in flute and oboe players.

**Setting:** General community in Germany.

**Participants:** Eleven professional musicians.

**Intervention:** Immobilization by splints of 1 or more digits other than the focal dystonic finger. This finger carried out repetitive exercises in coordination with 1 or more of the other digits for 1½ to 2½ hours a day for 8 consecutive days under therapist supervision. The subjects then were instructed to continue practice for 1 hour daily for 1 year.

**Main Outcome Measures:** Spectral analysis of the output of a dexterity-displacement device that continuously recorded digital displacement during finger movements and a dystonia evaluation scale on which patients rated how well they had just performed dystonic movement sequences and repertoire passages.

**Results:** The 3 wind players (adventitious placebo controls) did not improve substantially. However, each pianist and guitarist showed marked and significant improvement in spontaneous repertoire performance without the splint. The first subject is now 25 months posttreatment.

**Conclusions:** Results suggest that SMR is of value for the treatment of focal hand dystonia in pianists and guitarists.

**Key Words:** Behavioral medicine; Focal dystonia; Hand injuries; Music; Rehabilitation; Repetitive strain injury; Sensory motor performance.

FOCAL HAND DYSTONIA in musicians is a set of conditions generally characterized as occupational hand cramp or focal task-specific dystonia.[1,2] Widely accepted diagnostic criteria are lacking, but a differentiation is usually made between digital incoordination syndromes that are idiopathic in nature and those that have a known or probable organic basis.[3,4] Treatments of this condition have included psychotherapy,[5-7] biofeedback,[8] physical therapy,[9] prolonged rest,[5] and the administration of such agents as anticholinergic drugs,[6,7] dopamine agonists,[9,10] steroids,[5,6] and botulinum toxin.[11-13] Despite isolated reports[2,3,14] of success, no treatment has been beneficial on more than a temporary basis. Comprehensive reviews of the current status of treatment and understanding of mechanism have been written by Hallett and Chen.[15,16]

Work by Byl et al[17,18] in new-world monkeys showed that digital motor incoordination resulting from digital overuse is associated with an induced disorder in the representation of the digits in area 3b of the somatosensory cortex. The present research group, using a noninvasive neuroimaging technique (magnetic source imaging), found that string instrument players exhibit a use-dependent alteration in the cortical representational zones of the digits of the left hand that engage in the dexterity-demanding task of fingering the strings.[19] It is of particular interest that use-dependent central nervous system plasticity also occurred in musicians with focal dystonia; overlap or smearing of the homuncular organization of digits occurred in the somatosensory cortex.[20,21] Because behavioral mechanisms apparently underlie both the cortical disorder and the involuntary incoordination of movement, we hypothesized that a behavioral intervention focusing on movement could help reduce or eliminate these conditions.

The treatment we report here features a behavioral therapy approach that leaves free the digit exhibiting the main dystonic symptoms. We call the therapy sensory motor retuning (SMR). In it, 1 or several of the other digits are immobilized and extensive practice is given in performing individual movements of the focal dystonic finger in coordination with movements of the other fingers. The exercises are performed on each individual's musical instrument. We report here the successful treatment of 6 pianists and 2 guitarists with this intervention. A preliminary short report[22] of the data of the first 3 pianists and the 2 guitarists has appeared elsewhere. The same intervention was administered to 2 flutists and an oboist with lack of positive results.

## METHODS

### Participants

The 11 subjects were right-handed musicians (6 pianists: patients 1, 2, 5, 6, 7, 11; 2 guitarists: patients 3, 4; 2 flutists: patients 8, 9; 1 oboist: patient 10); all were professional musicians, except patient 8. Patients 1, 5, and 10 were women. All 11 subjects had chronic conditions of 2 to 34 years in duration (table 1). Each had received multiple courses of therapy for their condition including acupuncture, massage, eurythmics, neurolinguistic programming, kinetic therapy, physical ther-

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**Table 1: Subject Characteristics**

| Pt | Instrument | Gender | Age (y) | Years Playing | Years With Dystonia | Affected Fingers* | Month of Last Follow-up |
|---|---|---|---|---|---|---|---|
| 1 | Piano | Female | 40 | 35 | 3 | Left D2, **D3,** D4 | 25 |
| 2 | Piano | Male | 47 | 41 | 4 | Left D3, **D4,** D5 | 9 |
| 3 | Guitar | Male | 37 | 25 | 4 | Right **D3,** D4, D5 | 19 |
| 4 | Guitar | Male | 30 | 20 | 3 | Right **D3,** D4 | 17 |
| 5 | Piano | Female | 52 | 34 | 8 | Right D2, **D3,** D4 | 12 |
| 6 | Piano | Male | 70 | 65 | 34 | Right **D4,** D5 | 3 |
| 7 | Piano | Male | 51 | 30 | 3 | Right D2, **D3** | 5 |
| 8 | Flute | Male | 42 | 27 | 5 | Left D2, D3, **D4** | 4 |
| 9 | Flute | Male | 38 | 28 | 2 | Left **D4** | 0 |
| 10 | Oboe | Female | 38 | 26 | 5 | Right D2, **D3,** D4, D5 | 2 |
| 11 | Piano | Male | 39 | 34 | 6 | Left D3, **D4,** D5 | 3 |

Abbreviation: Pt, patient.
* Focal dystonic finger is bolded.

apy, chiropractic, and administration of anticholinergics, xylocaine, corticosteroids, and botulinum toxin.

All of the guitarists and pianists were soloists, except for patient 2, who was a chamber music pianist. They had to limit or give up their public playing. Two of the wind players were professional orchestral musicians; one of the flutists was semiprofessional. Subject characteristics are in table 1. Before project enrollment, each subject was given a neurologic examination by a neurologist (EA) experienced in musician's focal hand dystonia. Symptoms required to make that diagnosis were painless loss of fine motor coordination of finger movements, which occurred exclusively in the task-specific context of playing the musical instrument; motor disorder restricted to involuntary flexion of single digits and (compensatory) extension of adjacent digits when executing the movements; absence of other neurologic signs; no sensory deficit in any sensory test, including the sense of touch, pain, temperature, joint position, graphesthesia and vibration; and normal or above average 2-point discrimination at the tips of the fingers, the palm, and the back of the hand. Nerve compression syndromes were excluded by median and ulnar nerve neurography. Two other exclusion criteria were (1) the presence of a neurologic condition other than the focal hand dystonia and (2) maintenance on a medication for their dystonia. Informed consent was obtained from patients after they were fully informed, according to the declaration of Helsinki, about the nature of the study and their treatment. The treatment protocol was approved by the university's ethics review board.

## Treatment

In SMR therapy, a splint (fig 1A) immobilizes 1 or more finger(s) while leaving the remaining digits free (fig 1B). In this series of patients, we found that the investigators and patients usually could identify 1 finger as the focal dystonic digit and 1 or 2 other digits that were involved in performing movements that compensated for the dysfunction of the focal dystonic digit (table 1). (In other cases of dystonia, all 4 of the other fingers can be involved in the compensatory pattern.) The focal dystonic finger was identified by immobilizing in turn the other fingers involved in the abnormal movement pattern and requiring that the subject carries out sequences of alternating movements of the focal dystonic finger and the remaining digits. In each case in this series, immobilization of 1 specific finger permitted independent movement of the digit the patient had previously identified as being dystonic; it was termed the *main compensatory finger*. This was not true after immobilization of any other digit; immobilization of another compensatory finger did enable freer, independent movements of the dystonic finger but not nearly to the same extent as immobilization of the main compensatory finger.

Treatment involved immobilizing different finger(s) by means of the splint. During fixation, the patient held a finger in

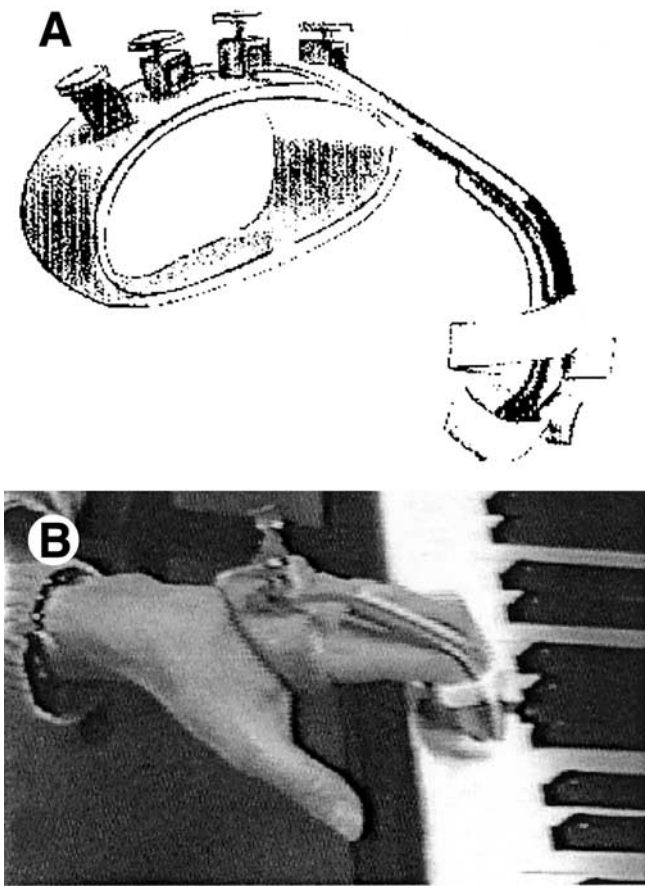


**Fig 1. Splint device used to immobilize fingers of the dystonic hand. (A) The device was tailored to the dimensions of each individual's hand and the requirements of the instrument he/she played. (B) Hand in splint with D2 immobilized.**

his/her characteristic rest position for his/her instrument. When the finger making the maximum compensatory movements was immobilized in this position, the focal dystonic finger could in each case participate in alternating individual finger movements with all possible permutations of the other fingers of the dystonic hand used in the treatment exercises, as was the case in the earlier diagnostic procedure. In these exercises, the subject was required to make sequential movements of 2 or 3 digits in extension, including the focal dystonic digit, for a period of 10 minutes in an ascending and then in a descending order in continuous repetition; for example, D2, D3, D4, D3, D2, and so on, with D4 being the focal dystonic finger and D5 the immobilized main compensatory finger. After a 2-minute rest, subjects completed a different sequence of movements of 2 or 3 fingers including the focal dystonic finger. Five such blocks of exercises were performed in an hour. In the beginning, performance was paced by a metronome and was begun at a medium tempo (usually 60bpm); the tempo was then increased and gradually decreased. (In 7 of the 11 dystonic musicians, slow controlled movements were more difficult than fast movements.) The speed sequencing was maintained in an attempt to force the subject to generate faster and faster and then slower and slower alternating movements in successive sequences. The training process was quite fatiguing for each subject. After completing the first 5 blocks of exercises, the splint was removed and subjects were given a 10-minute rest, after which they received 4 more 10-minute blocks of exercises with 2-minute rest intervals between blocks. Various permutations of possible finger movements were performed in different exercise blocks. The subjects were then given a rest of about 40 minutes.

After the rest, subjects were encouraged to play their instruments without the splint. Initially, they played 15 to 30 seconds from a self-selected musical piece. If they could not do this, they were encouraged to try a second time. After 2 successful repetitions, they were asked to attempt a different segment and were then asked to play portions of musical pieces of longer and longer duration until they had played for 15 minutes (excluding rest intervals). Some subjects were disconcerted by this process, being surprised by their new facility and also fearing a return of dystonic movements; however, they were encouraged to continue. The complexity and duration of the practice segments within the unsplinted performance period was based on the therapist's judgment of therapeutic progress. We introduced the requirement for periods of unsplinted performance for 2 reasons: first, because it represents the real-world context, and second, because it was very rewarding for the musicians to experience an unexpected ability to play frequently practiced musical pieces with a reduced number of abnormal movements or postures of the fingers. Consequently, it encouraged continuation of and compliance with the details of the therapy. After a 5-minute rest, and if the subject was not too fatigued, the splint was replaced and a second series of alternating digital maneuvers, each for a duration of 5 minutes, was performed. This regimen continued for 8 consecutive days (14d for patient 6, 6d for patient 11 because of an injury while preparing food).

The therapeutic exercises for the flute players were much the same as for the pianists and guitarists. The wind players blew into their instruments and produced tones only at infrequent intervals during the exercises. We decided that it was unnecessary for these individuals to repeatedly sustain the very taxing, prolonged, breath exhalations that would enable the same type of digital exercises peformed by pianists and guitarists for their dystonic hands; improved hand function, not breathing ability, was the intended objective.

On the last treatment day, the subjects were given the splint constructed for them and asked to practice the exercises performed during therapy while wearing the splint for 1 hour daily for 1 year after therapy. They were also instructed to engage in unsplinted repertoire practice for 10% of the time that was their usual custom before the onset of dystonia. It was recommended that this period be increased a further 10% in each succeeding month if they had no deterioration of the motor control that had been attained. Follow-up was performed for 25 months in the patient treated first and 3 months in the most recently treated patient (table 1). The intention is to gradually fade out the therapeutic exercises in the second posttreatment year according to a schedule worked out individually with each patient. Patients' compliance with the home exercises was assessed by regular phone interviews.

### Measurement

Patient status was quantified with 2 measurement instruments: a dexterity and displacement device and a dystonia evaluation scale (DES). The dexterity and displacement device continuously recorded digital displacement during metronome-paced movements of 2 fingers performed for 50 seconds; spectral analysis[23] of the record provided information concerning the smoothness of the movements before, during, and at the end of the 8 days of treatment. Measurements were done at the beginning of the treatment session on days 1, 4, and 8. To quantify the subject's performance, we divided the spectral power in the frequency of the metronome (0.9–1.2Hz) by the power in the side bands (0.1–0.9Hz plus 1.2–1.9Hz). The side bands defined in this manner contained the record of movements that were irregular and did not conform to the instruction to follow the metronome beat (values are missing for patients 1 and 11 because of procedural problems).

A DES was used to rate how well patients performed (without the splint) movement sequences and passages from their repertoire that had tended to generate dystonic movements in the past; this, in effect, provided information on the clinical status of the patients. The average of the ratings for the selected movement sequences and repertoire passages represented the DES score for a single day. The ratings on the scale are as follows: 0, dystonia as bad as at its worst; 1, slightly improved; 2, moderately improved; 3, almost normal; and 4, normal.[22] The number of movement sequences and repertoire passages that were rated varied between patients (median, 20). The first rating occurred before treatment and was then repeated after the first 1-hour block of exercises on the first treatment day. This protocol enabled the patient to recognize how much improvement in the relief of dystonic movements had been achieved during that brief period. In subsequent sessions, the DES was administered at the beginning of each treatment day after a warm-up of approximately 3 minutes and by telephone in follow-up. Follow-ups were obtained after 1 month, 3 to 4 months, about 6 months, and the time of this writing (month of last follow-up, see table 1).

## RESULTS

The DES scores are given in figure 2 for the following time points: pretreatment, posttreatment, and last follow-up. Each of the 6 pianists (closed inverted triangles) and 2 guitarists (closed upright triangles) improved very substantially from pretreatment to posttreatment while the 2 flutists (open circles) did not. The other wind player (oboist, open square) showed a modest improvement from pre- to posttreatment but 1 month into follow-up had regressed and remained close to pretreatment levels at the 2-month follow-up point. A 1-way analysis of variance (ANOVA) that included all 11 musicians revealed

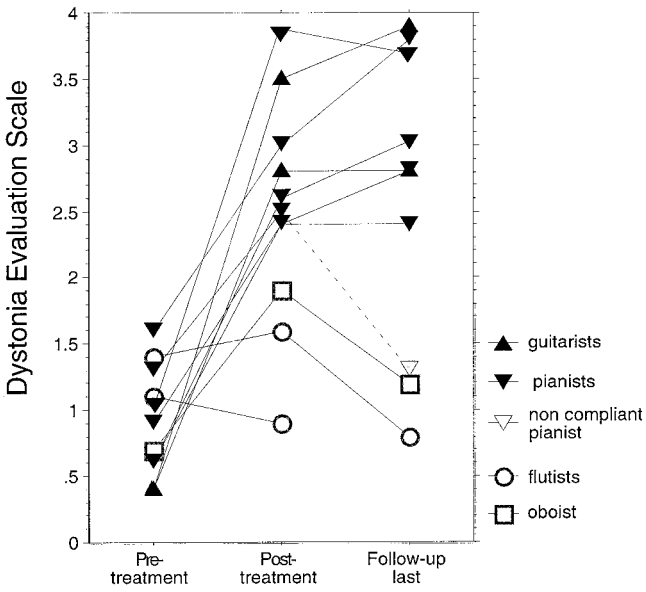


**Fig 2. Mean DES ratings of all 11 patients for the pre- and posttreatment and last follow-up periods. Rating scale: 0, dystonia as bad as at its worst; 1, slightly improved; 2, moderately improved; 3, almost normal; and 4, normal.**

that, even when the 3 wind players are included, the scores at pretreatment, posttreatment, and last follow-up differed significantly from each another ($F_{2,20}=16.5$, $P<.0001$). Post hoc Scheffé tests indicated that pretreatment scores differed significantly from posttreatment ($P<.0001$) and last follow-up ($P<.0001$) scores. At the time of this writing, follow-up had proceeded for different lengths of time for different subjects, depending on when their treatment had taken place (table 1, column 8). One guitarist (patient 3) and a pianist (patient 1) showed marked improvement at the end of treatment and then continued to improve into the normal range at 25 and 19 months, respectively, after treatment. Patient 11 (piano) scored very close to normal at the end of treatment. These 3 patients and patients 5 and 7 (piano) performed the posttreatment home-practice exercises at frequent intervals. Patient 2 (piano) performed home practice approximately half the time for the first 5 months posttreatment. At 4 months posttreatment, this individual, although only partially compliant, had retained the substantial therapeutic gains he had obtained during treatment. After 5 months, he stopped home practice entirely, and by 9 months he had relapsed to pretreatment levels. Patient 6 (piano) was compliant with the posttreatment home practice requirement for 3 months but then the demands of professional activities reduced his compliance substantially for the next 3 months. As figure 2 indicates, there has been as yet no regression in this patient's performance. Patient 4 (guitar) and patient 5 have stabilized in follow-up with a large improvement compared with very low pretreatment levels. Patient 7 exhibited a good response to treatment, and has improved somewhat in the 5 months during which he has been followed to date. In the opinion of these patients, treatment produced significant and long-term improvement of digital coordination, and these results were clearly superior to the effects attained by previous therapy with anticholinergic drugs or with local injections of botulinum toxin type A.

The data for the wind players contrasted to those of the pianists and guitarists. Pretreatment, their DES scores did not differ significantly from the other types of instrumentalists. However, a 2-way ANOVA with group (wind players vs pianists and guitarists) and time as factors indicated that a significant difference occurred between the 2 groups over time (pre- to posttreatment to last follow-up; interaction group × time, $F_{2,18}= 10.5$, $P<.001$).

The results on the DES and the clinical evaluation were confirmed by the laboratory findings obtained from the dexterity and displacement device (fig 3). During paced movements, the smoothness of the movements of the nondystonic hand did not significantly change from pre- to posttreatment, as revealed by spectral power analysis. These analyses served as control measurements for the dystonic hand. The finger movements of the pianists' and guitarists' dystonic hand were clearly smoother after treatment ($t=2.9$, $P<.05$). In contrast, no improvement occurred from pre- to posttreatment for the wind players; the difference in treatment effect between the 2 groups was significant for the dystonic hand ($F_{1,7}=10.0$, $P<.05$ for the interaction of group × time). Figure 3 is a scatterplot showing the relationship between change in DES score from pre- to posttreatment and change in the relative fast Fourier transform power on the dexterity and displacement device scores from pre- to posttreatment for 9 subjects. The correlation is $r$ equal to .70 ($P<.05$) showing that the measures exhibit considerable concordance in showing an improvement or lack of improvement in the dexterity of musical performance after treatment.

The 2-fingered dexterity and displacement device exercise did not always elicit the maximum amount of dystonic movement. For patient 6 (piano), a 3-fingered pattern yielded a particularly dramatic demonstration of treatment effect. This individual had a pronounced dystonic condition of 34 years in duration. The required alternating movements in his 3-fingered test exercises always involved the focal dystonic finger (D4), the maximal compensatory finger (D5), and the least-involved digit of the dystonic hand (D2) in 3 different orders and the homologous fingers of the nondystonic hand in the same 3 orders. Each sequence continued for 75 seconds with a 3-minute rest between sequences. Figure 4 shows the dexterity and displacement device record for the last 10 seconds of the first sequence (D2, D4, D5) for the nondystonic and dystonic hands on the fourth day of treatment (panels 3, 4) and the day after the end of treatment (panels 1, 2). The tracings represent

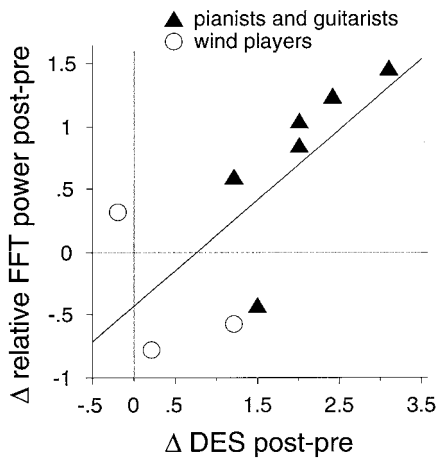


**Fig 3. Scatterplot of pre- to posttreatment change for the DES and for the fast Fourier transform (FFT) power values for spectral analysis of dexterity and displacement device performance (which gives the smoothness of movement) for the focal dystonic fingers.**

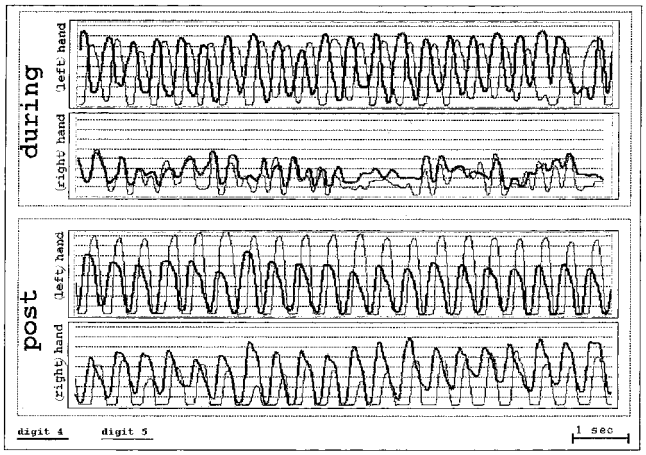


**Fig 4. The extent and duration of the movements of the focal dystonic (D4, dark line) and maximal compensatory finger (D5, light line) of the dystonic hand and the corresponding fingers of the nondystonic hand in patient 6 recorded during and after treatment. Each record is for the last 10 seconds of the first exercise, which was the same at the 2 time points and for both hands. Note the improvement in the dystonic hand (panels 1, 3).**

the excursion and duration of the key depression for the focal dystonic finger (D4, dark lines) and the maximal compensatory finger (D5, light lines) and for the same fingers on the nondystonic hand. On day 4 of treatment, when this subject had already improved considerably, the movements of the digits of the dystonic hand were still markedly abnormal. The very substantial improvement that had taken place after 8 days of treatment may be seen by comparing panel 1 with panel 3. The figure by itself, however, does not show the most noteworthy change that occurred. On day 4 of treatment, by the time 45 to 50 seconds had elapsed during each of the 3 exercises with the dystonic hand, hyperflexion of D4 and D5 had developed to such an extent that this subject had to complete the exercises by playing with his knuckles. It is remarkable and a tribute to his skill that he could maintain the metronome-specified tempo as well as he did. Posttreatment, his movements were not normal (as indicated by comparison to the data from the nondystonic hand—panels 2, 4), but they were greatly improved. Playing on the knuckles did not occur at all. From time to time, a tendency emerged for D4 or D5 or both to hyperflex, but in each case the subject was able to bring the 2 digits into a more appropriate extended position and complete each exercise without further abnormal movement.

It should be noted that patients 3 and 6 reported that performing home practice with the splint for 1 hour every day over an extended duration was fatiguing. They found that practicing the therapeutic exercise every other day appeared to give them a better result for repertoire performance. Four pianists and guitarists have passed the 1-year follow-up (patients 1, 5, 3, 4). Each of these patients stopped carrying out the therapeutic exercise at 21, 12, and (contrary to instructions) 4, and 2 months, respectively. None of them has experienced a decrement from the maximum treatment gains that they exhibited.

Figure 5A shows a characteristic dystonic pattern before treatment with right D4 and D5 in flexion spasm as the pianist attempts to depress the keys with the fingers of the dystonic hand. In figure 5B, the same pianist playing the same piece after treatment is able to depress the piano keys with D4 and D5 in a more correct extended posture.

## DISCUSSION

The basic principles of SMR therapy are as follows.

1. The focal dystonic finger was not splinted.
2. The main compensatory finger was splinted first in the sequence of daily exercise blocks, at an angle similar to the patient's normal resting angle of that finger on the instrument. (In other patients, there may be more than 1 main compensatory finger.)
3. Subsequently, exercises were performed with the other fingers on the dystonic hand splinted.
4. The speed at which the dystonic finger was required to move in concert with the other fingers of the hand was increased and then decreased with progressively more exacting requirements (eg, to extend the fingers as much as possible when playing).
5. It was valuable to have daily repertoire practice. This practice helped to sustain patient motivation and to accomplish transfer of the exercise-induced improvement in motor control to the target behavior.
6. Repertoire practice of the dystonic hand was intensive but not to the point when excessive fatigue was induced.
7. Home practice of the treatment exercises after conclusion of therapist-administered treatment is important to maintain therapeutic gains and continued improvement.

In 5 cases, the performers' musical careers were not interrupted by the dystonia because they resorted to well-known

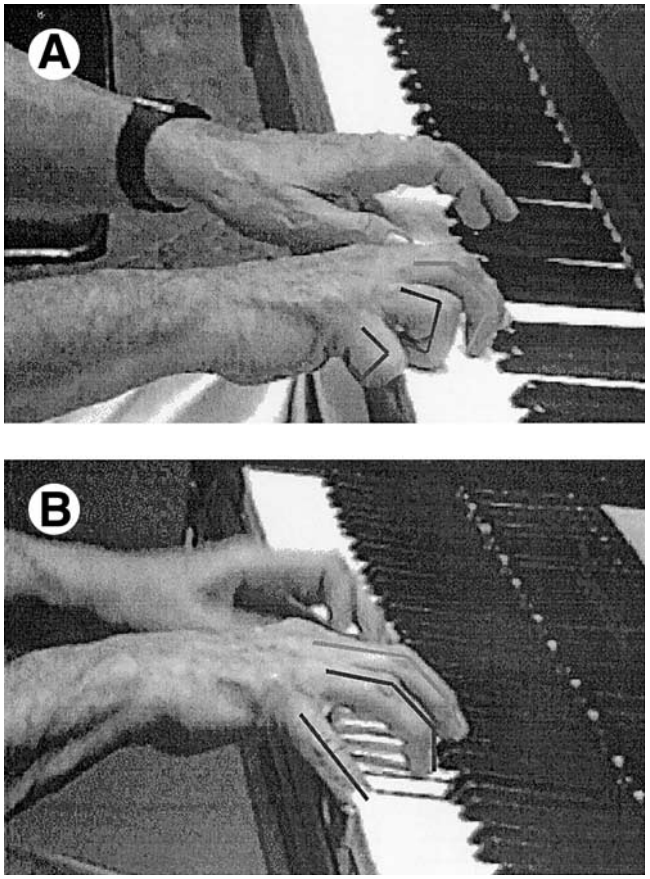


**Fig 5. The hands of a pianist playing the same passage (A) before and (B) after treatment. The lines outline the flexor spasm of right D3, D4, and D5 before treatment and the correct positioning after treatment.**

tricks (eg, see Lederman[7]) that allowed them to perform some (but not other) concert pieces publicly, though accomplished with great difficulty. The tricks are substitute maneuvers such as using different and atypical fingerings to avoid use of the focal dystonic digit, and adopting special postures to allay incoordination-inducing maneuvers. Although their concert performance had never been completely halted, SMR initiated a dramatic improvement in instrument-related manual dexterity for these 5 musicians. All judged their performance after treatment to be superior and much easier than before therapy. The tricks were either no longer necessary or the need for them was greatly reduced. For 4 of the 8 pianists and guitarists (patients 1, 3, 7, 11) who continued performance, there was a return close to the level of performance carried out by the dystonic hand before the onset of pathology. Because follow-up proceeded from 3 to 25 months and is 12 months or more in 4 cases, the treatment effect appears to be long-term.

The 3 wind players can be viewed as treatment failures, given the original study objectives. However, because they were treatment failures, they can be viewed as a comparison group (although entirely unplanned and unintentional on our part) for the following reasons: (1) the wind players were musicians with focal hand dystonia, just as were the pianists and guitarists; (2) they were as strongly motivated to improve as the pianists and guitarists, (3) we firmly that believed they would improve; and (4) they received the same basic treatment procedure as the pianists and guitarists, who did improve. Thus, all the nonspecific factors associated with treatment of the wind players were the same as for the pianists and guitarists. Consequently, if the good treatment effects with pianists and guitarists were a placebo effect, then the wind players should have improved as well. That they did not indicates that the positive outcome obtained with the experimental subjects would appear to be because of an interaction between the treatment and the type of instrument played rather than to a placebo effect.

The question arises as to why SMR treatment was successful for pianists and guitarists and not for wind players. The first possibility is that the need for finger-mouth coordination in playing wind instruments creates an effect on brain mechanisms that is not adequately addressed by the present therapy, which focuses only on movements of the digits and not the mouth. For example, it is possible that, in focal dystonic wind players, not only do the cortical representational zones of the fingers overlap and fuse, as occurs in pianists and guitarists,[20,21] but also the cortical representational zones of the digits and mouth move closer together and meld. This possibility could be experimentally evaluated with neuroimaging techniques. In addition, it would be of interest to require wind players to make movements of the fingers while simultaneously blowing into their instruments; the latter element was not part of the therapeutic regimen reported here. The exercises would be designed to facilitate an increased differentiation between digit and mouth cortical representations.

A second explanation for the lack of results with the wind players might be that the therapy is not effective for musical performance that involves exerting a fairly constant and firm force during performance with D1 to hold the instrument and maintain its correct orientation. The combination of the required static load involved in holding the instrument and skilled movement in the same hand might hinder successful learning of digital performance in patients with focal dystonia. (Although guitarists hold the neck of their instruments with the thumb of their left hand, both guitarists treated in this experiment exhibited focal dystonic patterns in their right hand, which is used to pluck the instrument's strings.) If this explanation is correct, a therapy designed to reduce the pressure exerted by D1 during performance might be effective. A third possibility is that the posture of the digits and the nature of the fingering involved in playing wind instruments is not amenable to a reduction of focal dystonic patterns in the same way as is the posture of the digits and the nature of the fingering during performance on the piano or guitar.

The present results from 11 subjects must be considered preliminary. However, they should be interpreted in the light of 2 considerations. First, each patient had a chronic condition that had persisted for years, in 1 case 34 years. Second, the condition had become intractable for each of the patients and was not responsive to a variety of commonly used medical treatments; they therefore, in effect, constitute placebo treatment in these patients. Thus, each individual case assumes increased therapeutic interest.

## CONCLUSION

This work exemplifies how changing the way body parts are used can elucidate and possibly remediate pathologic conditions resulting from overuse. This is especially the case in light of recent neuroimaging results[20,21] indicating that focal hand dystonia in musicians involves an alteration in brain organization; this may also be the case in some other overuse syndromes.

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