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Mirror Visual Feedback Therapy. A Practical Approach

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ABSTRACT: Mirror visual feedback (MVF) was first proposed as a therapy to relieve amputee phantom limb pain in the early 1990s. It is increasingly used to treat a range of other chronic pain conditions. The evidence base to date is limited. Much of the literature consists of pilot projects or case study designs although larger randomized controlled trails are now emerging. However, the described protocols for MVF are inadequate to adapt to clinical practice. In addition, the therapist sees a heterogeneous population whose characteristics may fall outside those of the tight inclusion/exclusion criteria of research studies. This article provides the theoretical background to MVF and a detailed description of applying this therapy in clinical practice.

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Ongoing pain is often unresponsive to current medications and therapies. Since the middle of the 1990s, some health professionals have been inviting patients with ongoing pain to gaze into a mirror in search of relief. At best, this could be perceived as a cheap distracting technique for a condition that uses vast health care resources and at worst, harmful quackery. In future years will we look back and laugh at our naivety for believing mirrors could ever advance our understanding of pain or indeed relieve it?

A mirror is a well-established tool in the therapist's treatment armory with mirrors used to help patients understand posture and gait; providing real-time visual feedback to assist in the retraining. However, mirror visual feedback (MVF) is a therapy in its own right and importantly, requires the therapist to use a mirror in a different manner to these more traditional techniques. Like any other therapy, the therapist needs to understand the theoretical background behind this treatment to ensure the safe delivery of it and to recognize efficacy or contraindications in the patient they are caring for. With MVF, patients are invited to position their limbs either side of a mirror, or within a mirror box, so that the affected limb lies hidden from view on the nonreflective side, and the reflected image of the unaffected limb is in the perceived position of the affected one; thereby giving the impression of the subject having two ''normal'' limbs (Figure 1). It is almost 20 years ago since Ramachandran and Roger-Ramachandran[1] first used this technique with amputees to relieve paralysis and spasm in amputees' phantom limbs. MVF is used for phantom limb pain (PLP),[2–5] stroke,[6–9] Complex Regional Pain Syndrome[10,11] (CRPS), and for ongoing pain after wrist fracture[12] and hand surgery.[13] It has also been incorporated within a program of therapies designed to sequentially enhance motor planning[14,15] and an adjunct to more established rehabilitation approaches.[16]

Firstly, this article will provide the theoretical background to MVF and describe the experimental data, which underpins the development of this technique. This section will present studies that have demonstrated MVF can relieve pain and improve function in those with chronic pain. It is this positive treatment affect that MVF is commonly associated with and its primary purpose in the clinical setting. However, studies will also be described that demonstrate MVF can *generate* pain and other sensory problems in those without pain, and exacerbate pre-existing symptoms in those with chronic pain. The findings of these studies highlight the importance of having a sound understanding of the science behind MVF to ensure the safe use of it in the clinical setting.

Secondly, this article will provide a detailed description of the clinical protocol, which has been informed by this scientific literature. Information will

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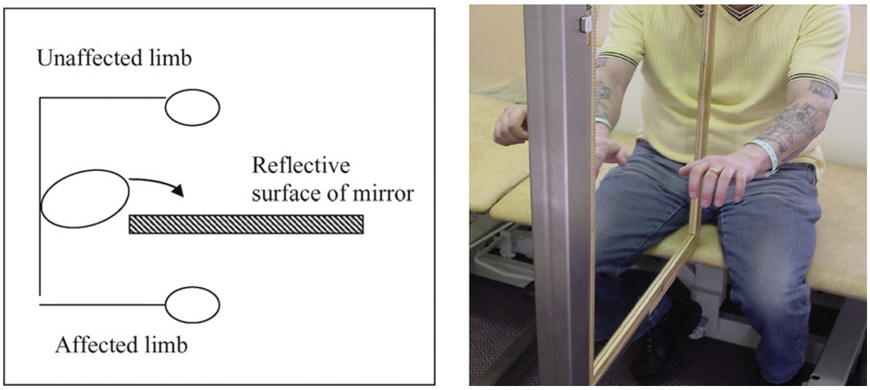

FIGURE 1. Position of mirror for upper limb mirror visual feedback therapy.

be given on how to decide whether a patient is appropriate for this therapy, the contraindications to continued treatment, and how to evaluate efficacy. It will be stressed that patients need to be treated as individuals and there is no ''one size fits all'' approach. Like any other therapy, MVF requires the therapist to use their theoretical knowledge and observational skills so as to accurately interpret an individual's presenting symptoms, assess their appropriateness for MVF, and then review their response to treatment. In the hands of a skilled therapist, MVF can give you a unique understanding of a patient's symptoms and a greater insight into how treatments can be targeted to relieve them.

HOW CAN MVF RELIEVE PAIN?

The mechanisms by which MVF works are not clear (see Ramachandran and Altschuler, 2009 for review[17]), but theories include the correction of a mismatch between motor and sensory systems,[1,10,18,19] sustained attention to the painful limb, which increases perceived ownership of that limb,[14] or simple distraction therapy. The viability of the last two theories has been questioned, as it appears surprising that such long-term pain relief can be gained from simply attending to a limb or being distracted from the pain.[11] However, it is known that if a limb no longer feels as if it belongs to you then it will become objectively cooler with sensory information from that limb having less importance than that of the ''owned'' limb.[20] Furthermore, if ownership of a limb is temporarily transferred to a dummy limb, positioned beside a subject, then the perceived location of the actual limb can be shifted from the reality.[21]

Many of the conditions where MVF has been most rewarding include those where patients neglect their painful limb (CRPS[22] and stroke,[23] in particular). MVF could improve perceived ownership of a painful limb by getting the sufferer to have to engage with their limb, which in turn may improve sensory perception from that limb; effectively a reversal of the problems cited above in a disowned limb. Conversely, perceived ownership of the ''mirrored limb'' may further disconnect the subject from their painful, actual limb thereby reducing sensory input and pain.

It has also been proposed that mirror therapy may work by reducing kinesiophobia; the subject perceives a ''normal'' moving limb and therefore the link is broken between fear of movement and pain. Through repetitive use of the mirror, the subject becomes less anxious about moving their affected limb and therefore the subject's behavior changes, movement increases, and rehabilitation progresses. This theory is more difficult to understand in those where reduced function is the dominant feature of their affected limb rather than pain. For example, in stroke or those with a pain free but stiff phantom limb. In these populations MVF has been shown to improve movement in the paretic or phantom limb with almost immediate effect for some.[3,9] Perhaps, in this scenario, the mirror provides recall of the performance of the affected limb when it was intact. Case study data using functional magnetic resonance imaging (fMRI) has suggested visual memory systems may be activated when MVF is used.[24]

The other proposed mechanistic theory is that of the sensorimotor incongruence theory of pain. Here, the suggestion is that MVF provides corrective sensory feedback into a system where a discrepancy exists between motor output and sensory feedback. Changes in sensory processing play a key role here.

Turning then to this theory and how MVF may correct an underlying sensorimotor incongruence, we need to first understand how a discrepancy between the motor and sensory systems can induce pain.

GENERATING PAIN VIA SENSORIMOTOR INCONGRUENCE

Most of us have missed our footing on the curb of a pavement or misjudged the height of a step as we descend a flight of stairs. On these occasions, we

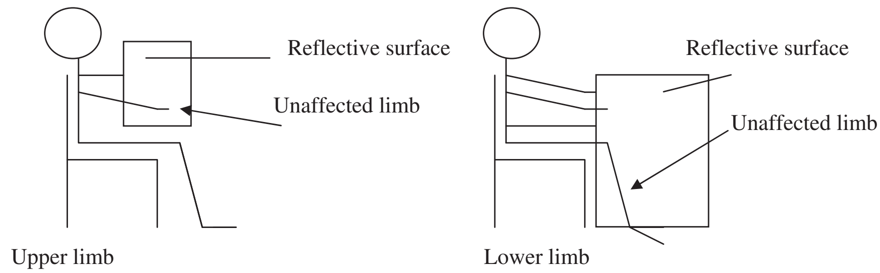

FIGURE 2. *Position of the mirror for upper and lower limb therapy.*

suddenly become more aware of our actions, are surprised that things have not gone as we had intended and commonly we look down at our feet to see why the problem occurred but also to reassure ourselves that we are now safe to move on with our journey. This simple event will have given us a brief insight into the usually unconscious processes of our motor control system, and what happens when the expected sensory feedback of an intended action does not match with the actual sensory feedback. In the words of psychologists, the normally mindless task of walking has suddenly become mindful.

When this paradigm is deliberately created in healthy volunteers, using a mirror to disturb sensory feedback, over 60% of subjects describe changes in temperature, weight, loss of ownership of a limb, discomfort, or even pain in the limb hidden behind the mirror.[25] These sensations can be turned ''off'' and ''on'' by corrective or abnormal visual feedback thereby demonstrating that a range of sensations, including pain, can be generated in the absence of neural damage. If the same protocol is repeated in those who already have chronic pain, their symptoms are exacerbated but importantly only transiently while visual input is pertrubed.[26] For example, in those with fibromyalgia, a widespread chronic pain condition of unknown etiology, subjects reported an exacerbation of pre-existing symptoms or the generation of new ones, when a mismatch between motor output and sensory feedback was deliberately created under experimental conditions. Subjects performed a series of bilateral, upper, and lower limb movements in a congruent and then incongruent manner; firstly, while simply looking at their limbs (baseline assessment), and then while attending to a whiteboard (control) or mirror surface. When performing incongruent limb movements while viewing the mirror, the subjects would perceive, via the mirror illusion, that they were moving their limbs in the same direction. However, motor output would recognize the limbs were moving in opposite directions. This stage of the protocol generated the greatest mismatch between sensory input and motor output. New perceptions included disorientation, pain, perceived changes in temperature, limb weight, or body image and were reported when motor output and sensory feedback were disrupted. Similar results were seen in those with CRPS when the same study protocol was followed.[27]

When a conflict arises between motor and sensory systems, there is increased activity in the right dorsolateral prefrontal and parietal cortices.[28] These areas are known to be active during complex motor tasks[29] and those that require increased motor effort.[30] In patients with chronic pain, there are also changes to the primary motor and sensory maps, with representations of the painful body part, as observed with fMRI, becoming either shrunken or enlarged. Associated changes may also occur within the thalamus, visual cortex, and brain stem.[31–33] Studies have shown that there is a direct relationship between perceived pain and the extent of cortical remapping, with pain reducing as the changes on the somatotopic map start to reverse.[34,35] These structures that are vulnerable to cortical remapping are also integral to the motor planning system. Before the execution of a movement, the body has to make a ''guestimate'' of the sensory consequences of that movement to prepare the body for further activity, ensure the smooth execution of that movement, and maintain the safety of the individual. Once the movement is actually performed then this ''guestimate,'' or efference copy, is matched against actual sensory feedback and the motor planning system is updated.[36] The efference copy will in part be informed by the cortical maps. In the presence of cortical reorganization, where the motor and sensory maps may no longer accurately portray the actual location of body parts, then it is easy to see how a mismatch between motor output and sensory feedback could be generated.[37] As we have learnt from the healthy volunteer study described above, once a mismatch is created, then a range of sensory and motor problems will be generated.

MOTOR EXTINCTION

When patients diagnosed with CRPS and fibromyalgia try to perform bilateral, synchronized upper limb movements with one limb obscured from vision by a mirror, some of these patients are convinced that they are performing these movements although the hidden limb remains static or only moves for a brief period before stopping. Our group have termed this phenomenon "motor extinction" as it struck us as meeting the definition provided by Laplane and Degos[38] of an "underutilization of one side, without defects of strength, reflexes, or sensibility," as when the hidden limb is viewed, normal movement returns.

Motor neglect or extinction is normally associated with lesions in the brain, such as in patients after stroke, and when it is present it is considered to be a poor prognostic marker for rehabilitation potential. Two theories have been proposed for the cause of motor extinction.[39] According to one theory, it may arise due to a deficit in *intention*. If one hemisphere of the brain is compromised, as in stroke, then motor planning systems favor the motor commands from the dominant, unaffected side thereby reducing movement on the contralesional side. An alternative theory is that motor extinction is a problem of *attention*. As we have seen above, motor planning relies on sensory feedback from the limbs to confirm the accuracy of movements and inform the planning of future movements. When sensory feedback is reduced, then motor planning systems become less effective and motor output is disrupted.

In our patients diagnosed with CRPS, we have recently observed, in a small exploratory study, that patients who exhibit motor extinction have higher levels of pain and poor ability to perform imagined movements. In addition, they have high levels of disturbance of body perception whereby they imagined their affected limb to be grossly distorted in size and shape (see Ref. [40] for review). Our data suggest to us that motor extinction in CRPS is more likely to be attributable to poor sensory feedback and therefore a problem of *attention*. This deficit becomes particularly apparent when a limb is hidden from view, such as behind a mirror, as the body has to rely on internal body representation maps without the aid of visual feedback. With these maps "corrupted" in those with chronic pain, the body becomes particularly dependent on external visual cues. Evidence to support this hypothesis comes from a case study by Wolpert et al.[41] who describe a woman with motor extinction after a left superior parietal lobe lesion. When the woman was not looking at her right arm, the grip strength in this limb gradually diminished and eventually disappeared although she was not aware of this. With active visualization of the limb, her grip strength returned. The authors propose that due to the damage in the parietal lobe this woman was unable to store the image of her right limb and plan movements from this image so that eventually movement was compromised. That is, without sensory data to inform the production of an efference copy she was unable to plan movements and therefore movement eventually ceased. Maladaptive sensory processing could occur in those with CRPS at the peripheries through a reduced ability to extract information from the surrounding environment (allodynia is a common feature of CRPS) or centrally, via problems with processing the peripheral neural input due to an altered sensory map. In either scenario, normal sensory information processing is affected and this in turn may affect motor output.

The degree of pain experienced by patients may further influence sensorimotor processing. Of interest, a recent study by Diers et al.[42] has shown that the degree of pain experienced in amputees with a phantom of the upper limb, directly correlates with the degree of activation in the sensorimotor cortex as seen by fMRI; the higher the pain the less cortical activity seen in this region. When the moving residual upper limb was viewed in a mirror, this generated the greatest activity in the contralateral sensorimotor cortex for those with pain, compared with moving the residual limb without the mirror or imagined movements. However, in those with pain all of the three types of movement (with mirror, actual, and imagined) demonstrated significantly reduced activity in the contralateral and ipsilateral sensorimotor cortices compared with those without pain or healthy volunteers.

CORRECTING SENSORIMOTOR INCONGRUENCE

Considering the mechanistic theories described above, MVF is thought to work by improving sensory perception of the affected limb via false but congruent visual feedback of the unaffected limb thereby restoring the normal pain-free relationship between sensory feedback and motor intention.[1,10,19] Data suggest that it is more effective in those with PLP at relieving deep tissue pain (e.g., pressing, taut) than more superficial pain (e.g., knife-like, burning) or pain associated with temperature (e.g., burning, freezing).[43] Subjects' ability to believe in the visual illusion of the mirrored limb may determine the effectiveness of MVF as patients with PLP have been shown to gain less benefit from MVF when they cannot feel ownership of the mirrored limb.[5] For those where motor extinction is present on baseline assessment (i.e., the subject is unable to perform bilateral synchronized movements when the affected limb is hidden behind the mirror), then MVF *should not* be persisted with, as it may increase pain and motor problems as described in the healthy volunteer and chronic pain studies above.[25–27] What maybe more appropriate for these patients is to simply look at the reflected image without movement as this will still provide corrective sensory feedback although the image may appear less believable than when movement accompanies it. Alternatively, this motor extinction group may progress through the graded motor imagery program, as described by Moseley.[14,15] However, even with this premotor training program, it has been shown that some patients with CRPS develop adverse side effects such as an increase in pain on imagined movements or the limb laterality task, and development of pain in an unaffected limb (ipsilateral [lower or upper limb to that affected] or contralateral limb).[44]

It seems reasonable that MVF could have a positive impact on body perception disturbance. Viewing the reflected image of the unaffected limb in the mirror as if it was the affected limb plausibly provides a corrective visual representation of the affected limb. This normal visual representation may contribute to correcting the body schema. Patients have reported that they are more willing to look at their affected limb as a consequence of MVF. Further investigations of the effects of MVF on body perception disturbance are merited.

Recent work[35,45,46] has suggested that treatments designed to improve sensory perception in CRPS and PLP, such as manual and electrical sensory discrimination training devices, improve tactile discrimination, give a modest reduction in pain, and correlate with a reversal of cortical reorganization. It has been proposed that MVF could be used to enhance tactile acuity as seeing a limb being touched while simultaneously perceiving it being touched, improves sensory feedback.[46,47] With this in mind, one could touch the unaffected limb while the subject views this limb in the mirror; thereby apparently tolerating touch to a perhaps intensely allodynic limb.[47] This method could be combined with the more traditional approach of using a hierarchy of textures, which are usually applied in a graded manner to the allodynic limb, but here they would be applied to the unaffected, mirrored limb. As desensitization techniques are rarely used as a stand-alone therapy, it has been difficult to objectively assess the added value such treatments give within a multidisciplinary rehabilitation program or to determine the optimum frequency and duration of such treatments.

In summary, there is evidence of changes in sensory perception and motor planning in those with chronic pain. Pain and other sensory changes can be evoked in healthy volunteers when a mismatch is generated between these two systems. In addition, pre-existing symptoms and new ones can be evoked, in those with chronic pain when sensory motor incongruence is artificially created. One theory is that MVF may work by correcting this mismatch and thereby relieve pain and improving motor control. In those where bilateral, congruent movements cannot be performed and maintained, then MVF may exacerbate symptoms due to the development of a sensory motor mismatch. Therefore, assessment of the patient and their presenting symptoms is crucial for the safe use of MVF in the clinical setting. It is not a stand-alone therapy but should be used within a multidisciplinary rehabilitation program and may be a useful adjunct to desensitization therapy and enhancing body perception.

MVF IN THE CLINICAL SETTING

There are no evidence-based protocols for MVF in the clinical setting. Limited data exists on who would and would not benefit from MVF. Similarly, trials have not been conducted to determine the frequency or duration of MVF, and no comparisons are available to determine if therapeutic protocols should vary across conditions. Consequently, MVF techniques tend to be passed down between therapists in an anecdotal manner and local variations made as experience is collected over time. The St. Gallen protocol was published to try to address some of these local variations and was based on the care of over 50 patients with a range of different upper limb, chronic pain problems seen at the St. Gallen clinic, Switzerland.[48] Case studies published with this protocol demonstrate the subtle individual variations needed when using MVF. The protocol described below is the one used at the Royal National Hospital for Rheumatic Diseases (RNHRD), Bath that has evolved over the past ten years predominantly based on caring for those with CRPS (both upper and lower limb). The RNHRD is the national UK referral center for CRPS with over a 100 new referrals per year. Like the St. Gallen protocol, there is no definitive pathway that suits all patients, but the general principles of the Bath protocol are described below.

INTRODUCING MVF TO THE PATIENT

A mirror is not traditionally considered an analgesic device by the general public, so introducing one to a patient in severe pain within the clinical setting can often seem awkward and difficult to explain. It is helpful therefore to first demonstrate to the patient that they perceive their limb differently to how it actually is. A simple technique to use is to invite the patient to *close their eyes* and describe to the therapist how they perceive their limbs. This can be done in a systematic manner working through each of the limbs toward the region of interest. For example, in a left upper limb affected patient the therapist would ask them to first compare and contrast their lower limbs with each other. They would then ask them to consider if the feet, knees, and hips are perceived as the same size and shape as each other, the legs the same length; taking each section of the limb in turn so that the patient really learns to attend to each part of that limb and become aware of any perceived difference between the limbs. The therapist would then move the patient's attention to the right upper limb and finally the left, affected limb. They would invite the patient to compare and contrast the size and shape of their two limbs and consider if all sections of those limbs are present, what size or shape they perceive them to be and if the limbs are the same length. For those with CRPS, gross distortions are commonly reported in relation to the affected limb[22] and for those with PLP they may describe a phantom limb. For some patients, this altered world is a revelation to them as it maybe the first time they have considered their limbs in this way.

With the patient now aware that there are two versions of their limb present, one when they actively view it and another when they close their eyes, it is possible to explain that there is discordance between how the brain perceives their limb and how it actually is. A mirror can then be introduced as a device to "trick" the brain into correcting this distortion by providing the illusion of a normal limb. It is important to stress that because the brain is involved, this is not an indication that the patient is "mad" or it is "all in the head." The simple analogy of seasickness can sometimes help patients understand how the brain can generate new sensations when information is confused; discordance between visual information and that from the auditory canals creates a sensory conflict in seasickness with the outcome of nausea rather than visual or auditory problems.

IMAGINED MOVEMENTS

A rehearsal of imagined movements, before MVF, may give an insight into the function of motor planning pathways. Patients should be asked to imagine moving the contralateral, unaffected limb first. Imagined movements should be focused on the joint/s that would be painful on the affected side and the one/s immediately above or below this. The ease or difficulty of this task for the patient should be noted and if it evokes any sensory or motor changes. This process should then be repeated on the affected side. Conducting this exercise on the unaffected side first, enables the patient to become familiar with the task and for the therapist to establish if they are able to rehearse imagined movements easily in a limb where pain is not present.

It is our clinical experience that those who are unable to perform imagined movements on the affected side commonly find MVF more problematic and may exhibit motor extinction. However, this is by no means applicable to all and for some patients the rehearsal of imagined movements becomes much easier once MVF has been started. This maybe explained by MVF potentially enhancing sensory feedback and thereby improving the motor planning process as explained in the theory of reduced attention (see Motor Extinction above).

THE BATH MVF TREATMENT PROTOCOL

The patient needs to be positioned comfortably (Figure 2) so that they can easily accommodate the mirror between their affected and unaffected limbs and visualize the mirror image. The mirror should be large enough for them to see the whole length of the reflected limb, be able to perform a range of bilateral movements easily and to not see the limb behind the mirror; a mirror box maybe too restrictive in some cases, particularly for those with lower limb problems. At Bath, we do not use any specially designed mirrors but simply use ones that are available from standard high street stores; patients supply their own for continued treatment at home. Most people have a mirror somewhere within the home, and it is important to keep MVF cheap and accessible to those who need it. However, many rehabilitation departments have developed mirrors especially for the delivery of MVF so as to improve comfort for the patient and ease of use. Commonly, these specially designed mirrors have the mirror supported on a stand and they may be slightly angled so that the mirror image can be more easily viewed without the subject having to twist their torso. The ideal device is one that will encourage the patient to use it little and often. Therefore, it should be easily accessible to the patient, comfortable to use so they can easily visualize their whole limb, be within their personal budget or ideally, provided free by their treatment center.

The therapist should now ask the patient to first look at the mirrored limb, without movement, and to try to believe that it is their limb; this may be easier to do if all jewelry has previously been removed from the unaffected limb. Once the patient feels engaged with the mirrored limb invite them to perform slow, easy to achieve bilateral movements (perceived bilateral movements in PLP) while continuing to look at the reflected image. As they try to perform these movements, the therapist should check behind the mirror for any signs of motor extinction (in those with CRPS) to ensure that the unaffected limb is moving, moving synchronously and not stopping after initial movement. The actual manner of movement appears not to matter as long as it is bilateral and synchronized. For those where movement is impossible, or if pain or stiffness limits the duration of therapy, then they should simply look at the reflected image until they feel ready to progress.

To fully believe in the illusion requires considerable concentration and it seems sensible therefore to advise the patient to perform this technique little and often (e.g., five to six times per day until concentration is lost but for no more than 5 minutes). A single half hour session once a day or once a week appears to provide little benefit in our experience. The

St. Gallen protocol recommends a very structured progression from looking at the limb to moving the limb, this may occur over a number of days or weeks. In our experience, this slow progression does not appear to be required for those who can easily perform bilateral movements. However, for those with motor extinction or no actual movement then the St. Gallen protocol may prove to be more effective.

ONGOING MVF IN THE HOME SETTING

Patients are advised that MVF should become part of their planned exercise program with "little and often" being the mantra to follow. Like any new technique, it will need practice and may require several trials before they become used to it. They are advised to practice their therapy in a quiet area where they will not be disturbed so that concentration levels can be at their optimum. For those who may be concerned that they are not moving both limbs, they may find it helpful to have another in the room initially to observe their movements. As stated above, the exact type of movement does not appear to influence the analgesic benefits of MVF but patients may find it useful to rehearse specific therapy prescribed exercises or those with a functional purpose (such as the opposition of fingers with the thumbs) or the bilateral grasping of objects.

WHEN TO STOP MVF

Again, there is no sound data to base this advice on but if pain levels increase with MVF, tremor or dystonia is exacerbated, then MVF should be immediately discontinued. Occasionally patients experience perceived changes in weight, temperature or altered body perception (as in the healthy volunteer study described above). These sensations are much less common when both limbs are moving synchronously, but they will quickly cease once the affected limb is viewed and MVF stopped.

For those where analgesic benefit and/or increased range of movement is quickly achieved then MVF should be continued until the patient feels it is no longer helpful to them. Commonly patients establish a routine that suits them and they will naturally reduce the number of therapy sessions as their symptoms improve. Conversely, for patients where no benefits are perceived within the first two weeks of therapy, adherence to therapy reduces and they may have stopped rehearsing MVF by their follow-up appointment with the therapist.

In summary, from our experience at Bath, the contraindications to MVF are motor extinction, increased pain, exacerbation of movement disorders, or an inability to believe in the illusion. Treatment should be discontinued if any of the above occurs or no benefit is gained within a reasonable time period.

CONCLUSION

The use of mirrors within clinical practice has undoubtedly increased our knowledge of central pain mechanisms and that in itself is a useful contribution in an area where we know relatively little. Mirrors have also given significant pain relief to some and improved motor control in others where traditional treatments for chronic pain have failed. It is a cheap and easily accessible device. As chronic pain affects so many and its multifaceted nature makes it so difficult to treat, these advances must be good news. However, the lack of robust clinical trial data still leaves MVF to be a "proven therapy."[47]

The literature presented here has shown that patients with chronic pain have both motor and sensory problems, cortical reorganization, and altered perceptions of their painful body parts. Therapies that are aimed at reversing these changes have been demonstrated to give analgesic benefit and improvement in function. Conversely, pain can be generated in pain-free individuals, and exacerbated in those with pre-existing symptoms, if sensory input and motor output are deliberately distorted so that expected sensory input no longer matches actual feedback. By simply manipulating this motor control pathway, we can relieve or generate pain. This relatively new finding is an important amendment to traditional pain mechanism theory, where neural damage was thought to be the only route by which pain could be generated. In understanding that pain can be generated by the brain, one can better appreciate the range of symptoms patients present with in the absence of objective physical damage. Explicitly stating to a patient that pain in these circumstances is "real," can in itself prove to be therapeutic.

The delivery of MVF therapy is a relatively straight-forward process, but the apparent simplicity of it can lead patients and therapists to think it is an "off the shelf treatment" that anyone can use with little or no training. This is not the case. Not only can symptoms be exacerbated if MVF is not used correctly but a unique insight into the function of a patient's motor control system can be gained when an informed therapist uses this device. Such information can provide an evidence base for future treatment decisions.

Further research is required on the optimum frequency and duration of MVF and what patient characteristics determine therapeutic efficacy. For those where MVF exacerbates pre-existing symptoms, we need to gain a greater understanding of why this occurs and which mechanisms drive these problems. MVF uses the visual system to correct a mismatch between sensory and motor systems, but perhaps other sensory modalities, such as hearing or taste, could be targeted to achieve a similar affect in those who cannot tolerate MVF?

There is still much to learn in this fascinating field, but it is only through taking detailed clinical histories and listening to our patients that we will really move forward in relieving chronic pain.

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#1. MVF is a form of
  a. a holistic approach
  b. biofeedback
  c. myofascial release
  d. temporal adaptation

#2. MVF is predicated on the concept
  a. that memory of the dysfunctional limb is erased from the brain
  b. of reverse visual imagery
  c. of dysdiadakokinesia
  d. that seeing the uninvolved limb in the mirror provides an image of the opposite, involved limb which the brain can view as normal

#3. Originally the primary condition that MVF addressed was
  a. visual dysfunction
  b. impaired ADL
  c. pain
  d. digital insensibility

#4. The authors describe the equipment as
  a. expensive
  b. cheap
  c. affordable
  d. fiscally responsible

#5. The authors state that the currently described protocols in the literature are inadequate to adapt to clinical practice
  a. true
  b. false

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