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# Mirror treatment of lower limb phantom pain: A case study

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## Abstract

*Purpose:* Phantom limb pain (PLP) can be an enduring and distressing experience for people with amputations. Previous research has shown that ‘mirror treatment’ can reduce PLP for some people who have an upper limb amputation, and that it can increase a sense of motor control over the phantom in people with lower limb amputations who are not reporting PLP. There has been no previous report of therapeutic ‘mirror treatment’ for lower-limb phantom pain.

*Method:* We present the first case study of the use of ‘mirror treatment’ in a person with a lower limb amputation who was reporting PLP at the time of treatment.

*Results:* During the intervention there was a significant reduction in his PLP, an increase in sense of motor control over the phantom and a change in aspects of the phantom limb that was experienced.

*Conclusion:* This case study, conducted in a conventional clinical setting, supports the potential of ‘mirror treatment’ for PLP in people with a lower limb amputation.

## Introduction

Phantom limb pain (PLP) is a common problem for many people who experience limb loss. While for some people such pain reduces in intensity and frequency over time, the majority continue to experience pain over many decades, including sometimes pain of great severity.<sup>1</sup> Despite the plethora of treatments that have been tried, PLP frequently remains resistant to clinical intervention.<sup>2</sup> Recently, Ramachandran and colleagues demonstrated the potential of using a mirror to treat PLP in people with upper limb amputations.<sup>3</sup> In this

procedure, people with upper limb amputations placed their intact arm into a box, with a mirror down the mid-line, so that when viewed from slightly off-centre, the reflection of their arm gave the impression of having two intact arms. By using a series of arm movement exercises some people experienced a reduction in phantom pain.

While it has been shown that such illusory body experiences<sup>4</sup> may be influenced by a range of psychological factors, studies of phantom sensation have also been related to cortical re-organization in the somatosensory cortex<sup>5, 6</sup> and the suggestion that greater neural plasticity is associated with more severe phantom limb pain.<sup>7</sup> MacLachlan *et al.*<sup>4</sup> found that scores on their Trinity Assessment of Body Plasticity (TABP) measure were related to the strength of illusory body experiences induced by each of the Mirror Box Procedure, Rubber Hand Procedure and Extending Nose Procedure. Furthermore, ratings on creative imagination and somatic preoccupation were also related to the latter two induction procedures, respectively. Thus psychosocial variables would seem to be involved in these induction procedures, in addition to any neurological mechanism that might underlie them. Such neurological research is motivated by a belief that the mechanisms at play in induced illusory body experiences, relate in some way to the re-mapping of somatosensory cortex reported when the inputs from an amputated area cease, allowing migration of neighbouring somatosensory reception sites into these ‘vacant’ areas.<sup>5, 6</sup>

Although there have now been several attempts to treat phantom limb pain using ‘mirrors’ in people with upper limb amputations, the individual variations in responses to this intervention is notable.<sup>3</sup> For instance,

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Ramachandran and Ramachandran found that while the 'mirror box' method had strong effects in some of their sample, it had little, only transitory or no effect at all, on others. Only one study has previously attempted a similar procedure in those with lower-limb amputations.<sup>8</sup> While that study did demonstrate increased 'motor control' over the phantom limb as a result of performing leg exercises in front of a mirror, the fact that none of the participants was experiencing PLP at the time of the study precluded any conclusions about the effects of 'mirror treatment' for PLP for people with lower limb amputations. The present case study is therefore the first to report the effects of 'mirror treatment' on a person with a lower limb amputation who was experiencing distressing PLP.

### Clinical context

Alan, aged 32 years, was admitted to have fluid drained from his leg. However, during this procedure necrotizing fasciitis was found, necessitating a through-hip amputation to save his life. Over the next month Alan was extremely unwell and spent periods in intensive care and on high doses of drugs, with the result that he only became consciously aware of the amputation some 5 weeks after it had occurred. Following the amputation he was transferred to another hospital for further debridement, wound cover and care. Subsequently, with a slow healing wound, he was transferred to a specialist orthopaedic facility and a limb-fitting service. At this point (prior to limb fitting) he was referred to a clinical psychologist (MM) with a number of difficulties, including phantom limb pain and pain in his residual tissue. He had been receiving pain medication (neurontin) for several months at the time of referral.

Although Alan agreed to see a clinical psychologist ('I'll try anything'), he seemed rather uncomfortable and defensive during the first session. Initially psychological intervention focused on trying to establish a timeline of events over the past few months, since Alan was quite confused about what had happened, when things had happened, and for what reason and just how ill he had been after his amputation. Following two sessions where events could be put into some kind of perspective, MM and Alan jointly decided to focus on Alan's phantom pain as the next therapeutic target.

### Phenomenology

Alan's phantom pain started 2 days after he became fully conscious. He felt as though two of his toes were

crossed. The pain tended to worsen as the day progressed: in the early morning on awakening he experienced 'pins and needles in the toes', this usually progressed to being 'painful but bearable' around lunch-time, building to severe pain by the late afternoon. He felt a full phantom leg, except for it being about a foot shorter than his other leg. The phantom leg was raised off the floor in the position of the back-stroke of the lower leg when walking. The phantom limb felt as though it was in a cast from the thigh down to the toes, which were pointing downward towards the floor from the raised foot. He also experienced a 'crushing' phantom pain, from time to time, in his calf muscle.

Alan had been prescribed neurontin at a pain clinic and referred to physiotherapy for a 1 week course of daily TENS (transcutaneous electrical nerve stimulation). However, the TENS treatment was discontinued before the course was completed as he complained that it worsened the pain. Despite having the concern that any treatment that focused Alan's attention on his phantom pain may provide a mechanism to worsen it (as may have been the case with TENS), we offered him the opportunity to try a 'relatively new treatment for phantom pain using the mirror reflection of your leg'. He was informed that the treatment may be of no benefit and that although it had benefited some people with upper limb amputations it had not been shown to do so with people who had lower limb amputations, although increased control over the phantom limb had been reported.

Although Alan had talked to other people with amputations he was not aware of the possibility of having a sense of control over a phantom limb and reported having never had any sense of control over it. Alan was cautioned that it was possible that the treatment could worsen his pain and if he experienced this he should stop the mirror exercises immediately. With his consent we proceeded to the first treatment session when all three authors were present, so that the treatment procedure could be standardized.

### Intervention

Following the procedure of Brodie *et al.*<sup>8</sup> Alan was asked to complete the following exercises 10 times each:

- (1) Slowly straighten and then bend your legs at the knee at the same time.
- (2) Slowly straighten and then bend your legs at the knee alternatively as if walking.
- (3) Point your feet upward, and then point your feet downwards at the same time.

- (4) Turn your sole in towards each other and then away from each other at the same time.
- (5) Move your feet around in a circle to the left and to the right.
- (6) Lift your feet off the ground in a walking movement.
- (7) Point your toes upwards, and then downwards whilst trying to keep your ankle and foot still.
- (8) Clench and unclench your toes.
- (9) Spread your toes and then relax them.
- (10) Point up your big toes and point down the other toes, then reverse it so that your big toe is pointing down and your other toes are pointing up.

The treatment intervention began intensively with either an occupational therapist (DM) or a physiotherapist (JW) carrying out the mirror sessions twice a day. A phased reduction in therapists' presence took place so that Alan undertook intensive exercises without staff present and then subsequently without the mirror. We approached the exercises as a skill task where initially Alan would need relatively intensive input from clinical staff to encourage and support his acquisition of developing the skill, but that once acquired he could develop it further on his own, at a pace that suited him. Clinical workloads determined that two sessions per day was the maximum that could be undertaken by the therapists involved. At each mirror session Alan was seated and a full-length mirror (measuring 36 by 120 cm) was positioned by him so as to provide the most complete reflection of his leg. The protocol was as follows:

*First 5 days:*

Daily morning + afternoon with one therapist at each session, with mirror.

*Weekend*

Daily morning + afternoon on his own, with mirror.

*Second 5 days:*

Daily morning or afternoon with one therapist at each session, with mirror.

2–3 times daily on his own each day with mirror.

*Weekend*

3–4 times daily on his own with mirror.

*Third 5 days:*

2–3 times daily on his own without mirror.

## **Outcome**

Alan found the bending and pushing down exercises easier than those involving lifting and straightening the

leg. He appeared to find the first two sessions, in which he saw his reflected leg for the first time, quite emotional; even though he had no sense of having any control over the phantom leg until the fourth session. The sensation of his toes being crossed diminished throughout the second week. By the end of the third week Alan had no sensation whatsoever of phantom crossed toes and minimal phantom pain. The therapists also asked Alan to rate his phantom pain and stump pain (1 to 10, where 1 = none at all and 10 = excruciating), control over his phantom leg (none at all = 0%, complete = 100%) and to indicate the position of his phantom leg. At the outset, in the afternoon sessions when pain was worst, Alan reported phantom pain ranging between 5–9 and stump pain between 0–2. By the end of the third week he rated his phantom pain as 0 and stump pain as 1. His initial rating of control over the phantom was 0% and after 3 weeks it was 25–30%. He reported his phantom leg still being about a foot shorter than his other leg, but that he 'straightens it out' in the morning (so that it is not bent upwards from behind as previously). However this straightening requires great concentration and he now has a feeling of a tight bandage around his calf muscle, after he has done this.

Alan reported that if he accidentally bangs his stump this sends a pain sensation down his calf muscle but that it does not produce any sensation of phantom toes. Although the medication dosage remained the same throughout the 3 weeks of treatment, toward the end of the second week the nursing staff tried a different (silicon) type of dressing on his stump. All other aspects of his treatment remained the same and he continued as an in-patient throughout this period.

## **Discussion**

In accordance with the only other previously reported research on 'mirror treatment' with people who have experienced a lower-limb amputation,<sup>8</sup> Alan experienced a greater sense of control over his phantom limb than he did prior to using these exercises. In addition, this case study demonstrated, for the first time for a person with a lower limb amputation, that such increased control over the phantom can be associated with a reduction in phantom limb pain: as has previously been reported for people with upper limb amputations.<sup>4</sup> As the vast majority of limb amputations are of the lower limbs this is an important finding. While our case study supports the possible value of 'mirror treatment' it cannot indicate the extent to which beneficial effects are due to somatosensory cortex re-mapping,<sup>7</sup> psychosocial factors

such as individual differences in ‘body plasticity’, somatic preoccupation or creative imagination,<sup>4</sup> or to other factors.

The influence of placebo effects may be strong in people with pain and our intensive use of the mirror box—being more intensive than that reported in previous studies—might allow this interpretation. However, the fact that Alan’s PLP had not responded to medication or to the use of TENS (which he reported had worsened his pain) is noteworthy. Furthermore, our ‘fading out’ of therapist-mediated intervention was explicitly designed to encourage ‘ownership’ of the treatment by Alan rather than attributing it to clinicians. It was felt that for practical reasons Alan could not carry a mirror around with him and so he should try to ‘internalize’ the procedure and the feedback that the mirror provided. This internal representation of the phantom offers an alternative to the internal representation that the phantom itself constitutes. Although based on, and shaped up, through repeated use of the mirror reflection of his other leg, we cannot be sure of the exact nature of this consciously constructed ‘alternative phantom’ representation. We suggest that this might offer an interesting avenue for further research.

While some of the factors noted above mitigate against a purely placebo explanation of the dramatic effect reported here, it is important to acknowledge the clinical reality of other extraneous factors that may have influenced treatment, such as a change in the type of dressing used. Nonetheless, this case study, conducted under routine clinical conditions, offers some support

to the possibility of therapeutically using ‘mirror treatment’ with people who have lower limb amputations and are suffering through severe PLP.

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