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### Analgesic effects of multisensory illusions in osteoarthritis

SIR, There is increasing evidence that drug-free illusion therapies can be beneficial for the amelioration of chronic pain, particularly so for conditions in which some of the pain is thought to have a cortical origin. For example, mirror therapy and size reduction illusions can reduce pain in complex regional pain syndrome type 1 (CRPS1) patients, the majority of whom have disturbed body representations with some reporting their hand as larger than in reality [1] and others describing parts of their hand as foreshortened [2]. If cortical misrepresentation of body parts contributes to pain, then manipulating the appearance of those body parts might be a useful tool in the reduction of pain. This letter describes an exploratory experiment using unique visuo-proprioceptive illusions that manipulated the perceived size of painful and non-painful parts of the hand in an attempt to modulate pain experienced in OA.

Illusions were applied using a MIRAGE system [3] that presents real-time video capture of the actual hand from the same position and perspective as if viewing the real hand directly (Fig. 1a). Visual manipulations can be applied to the image such that they appear to happen to the real hand. The experimental manipulations were stretching (Fig. 1b) and shrinking (Fig. 1c): gently pulling or pushing on part of the hand while simultaneously elongating or shortening the image gives a strong illusion that the hand is being stretched or shortened (see supplementary material for video). Control illusions included stretching and shrinking a non-painful part of the hand and visually enlarging/reducing the entire hand.

A total of 20 OA sufferers [2 males; mean (s.d.) age: 70.5 (6.5) years] with clinically diagnosed arthritic pain in the hands and/or fingers for >12 months were tested. Participants gave written consent in accordance with the Declaration of Helsinki. The study met with ethical approval from the University of Nottingham School of Psychology Ethics Committee (code: 20072010). None of the participants were pain free on the day of testing and none had used pain medication other than paracetamol. Participants verbally reported their pain levels on a 21-point numerical rating scale (NRS) with 0 indicating no pain at all and 20 indicating the most unbearable pain imaginable. The scores were adjusted relative to a baseline condition of gently pulling or pushing the hand without visual manipulation. NRS ratings of pain for the painful part of the hand were taken before and after stretching or shrinking the painful and non-painful parts of the hand as well as before and after enlarging or reducing the entire hand.

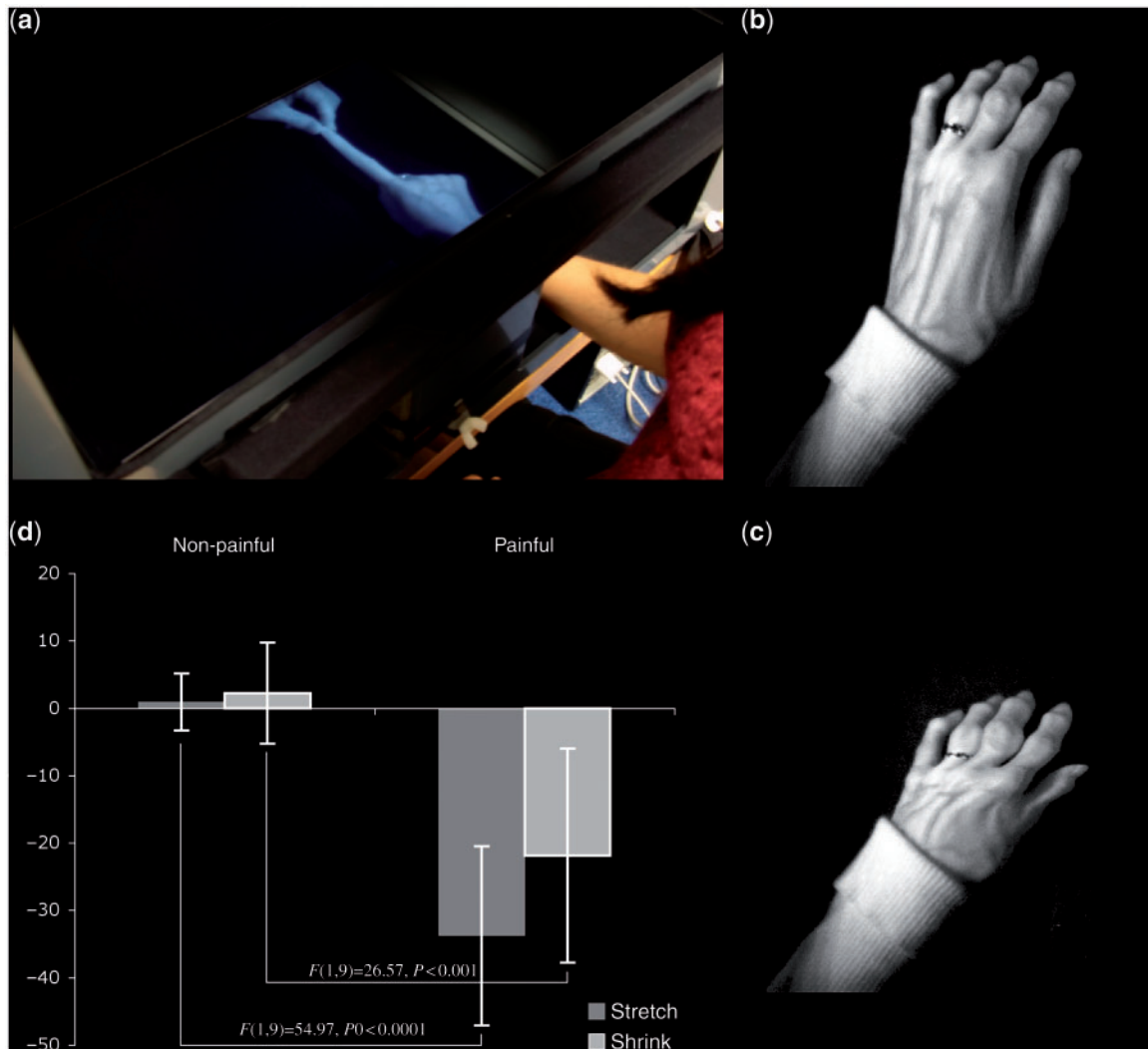
Overall, illusory manipulation was extremely beneficial, on average halving the reported pain in 85% of participants. Some reported greater reduction in pain for stretching, some for shrinking and some for both. Crucially, pain reduction was only observed when the painful part of the hand was manipulated and not when manipulating the non-painful part (Fig. 1d) or when enlarging or reducing the whole hand (although the latter was only tested in a minority of participants). For those in whom stretching was beneficial, the mean reduction in pain was ~50% (pre = 6.42 on the NRS; post = 3.33), while beneficial shrinking produced a ~45% reduction (pre = 5.83; post = 3.15). Remarkably, illusory stretching or shrinking of the painful body part temporarily eliminated all pain in one-third of all participants and in 41% of those for whom the illusion was effective. Although not formally assessed, many participants spontaneously reported an increased range of movement following manipulation and most reported pain reduction before active movement was permitted. Many participants gave spontaneous verbal reports such as: 'I can feel my whole body relaxing.'; 'My pain has completely gone.'; and 'I wasn't able to move like that before.'

This experiment demonstrates a strong analgesic effect of multisensory illusions for OA, which (though not tested directly) is consistent with the idea that some of the pain experienced in arthritic conditions may result from dysfunctional representations of the body [4]. Furthermore, the methods described may provide a mechanism for promoting therapeutic exercise normally prevented by painful movement. The effects of mini-magnification appear to be specific to the part of the body in which the pain is experienced and do not require active movement of the hand. Intriguingly, both shrinking and stretching were found to be beneficial in different, and sometimes the same, participants. This may be due to two distinct processes: the matching of cortical representations and the reduction of apparent swelling, which may vary between participants according to different physical and cortical representations. Although the current experiment describes striking analgesic effects, it does not completely rule out placebo effects and more comprehensive experimental research is necessary to investigate the underlying mechanisms and validate the beneficial effects. In particular, the effects of having attention drawn to the painful part of the hand while being manipulated must be adequately controlled for. However, these initial results suggest that multisensory illusions are a useful avenue of research for the treatment of pain in OA.

#### Rheumatology key message

- Illusory body distortions might contribute to pain reduction in chronic OA.

**Fig. 1** (a) A healthy participant having her finger stretched using MIRAGE; examples of arthritic hands after being stretched (b) and shrunk (c) and (d) the percentage pain reduction after manipulation for painful and non-painful body parts. A direct comparison between painful and non-painful areas was only possible in a subset of participants ( $n=10$ ) due to many having multiple painful sites covering the hand from the fingers to the wrist.



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**Catherine Preston<sup>1,2</sup> and Roger Newport<sup>2</sup>**

<sup>1</sup>Division of Psychology, School of Social Sciences, Nottingham Trent University and <sup>2</sup>School of Psychology, University of Nottingham, Nottingham, UK

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Correspondence to: Catherine Preston, Division of Psychology, School of Social Sciences, Chaucer Building, Nottingham Trent University, Goldsmith Street, Nottingham NG1 5LT, UK.

E-mail: catherine.preston@ntu.ac.uk

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