INTRODUCTION

Chronic hand-based pain affects around 1 in 6 people in the UK (NHS, 2018). Current pharmaceutical interventions have been reported as minimally effective. 60% of patients report no improvement in pain after taking pain medications (Divkorkin et al., 2010), and surgical interventions are typically only offered to patients over the age of 60 (Perrot & Menkes, 1996) where 23 – 34% of patients report unfavourable outcomes (Beswick et al., 2012).

Due to ineffective current therapies, clear need to find non-pharmacological/non-surgical therapy options for chronic pain.

Multi-sensory (MS) illusionary finger stretching reduces pain in osteoarthritis (Preston et al., 2020). However, how this reduce pain is unclear. MS illusions are associated with oscillation changes in Theta/Gamma bands over frontal/parietal regions (Kanaizama, Haras & Kimura, 2021). Frontal Theta oscillations link to multisensory disintegration and parietal Gamma oscillations link to multisensory integration.

Aims: Investigate difference between multisensory (MS) and uni-modal visual (UV) illusions, to uncover neural underpinnings using EEG and assess validity of using UV illusions as treatment options.

Preregistered Hypotheses:
1. Illusion Strength will be greater in MS compared to UV, which will be greater than AS conditions.
2. Stronger parietal Gamma band power (30 – 60Hz) will be elicited during MS compared to UV conditions.
3. Greater frontal Theta band power (5 – 7Hz) will be elicited during asynchronous conditions (AS) compared to non-illusion conditions (NI).

METHODS

Power analysis using data from a pilot study showed a minimum sample size of 25 participants was required (6 = .82, power = .85, alpha = .05). Due to the pilot study having a small sample size (n = 9) and the current study using EEG, the sample size of 26 participants was approximately doubled.

48 participants (33.5% Female, 14.5% Male, 2% Non-Binary; Mean age = 21 years) were given visual and tactile manipulations to their right hand whilst wearing an EEG cap (see Figure 1).

Participants underwent 12 repetitions of 7 illusionary conditions (MS Stretch, MS Shrink, UV Stretch, UV Shrink, AS Stretch, AS Shrink, & NI) and were then asked to rate aspects of their illusionary experience on a likert scale (+3 Strongly Disagree, +3 Strongly Agree).

RESULTS

Hypothesis 1: Illusion strength was greater in MS compared to UV, and for participants who experienced an effective UV condition (UVP), illusion strength was higher in UV than AS (Figure 2).

Figure 2. A) Illusion Strength in Each Averaged Illusion Condition for the Full Sample. B) Illusion Strength in Each Stretching Illusion Condition for the UVP Sample (27% of Participants). Error bars indicate 95% confidence intervals.

Figure 3. (Left) Increased parietal Gamma in MS compared to UV, electrode TP7. (Right) Time frequency plot of difference between MS and UV for electrode with largest effect size (TP7).

Hypothesis 2: EEG data show increased parietal Gamma in MS compared to UV (Figure 3) & further analysis suggested that those who experience visual-only illusions (UVP Sample) demonstrate a different neural signature to those who do not (Figure 4).

Hypothesis 3: EEG data show increased parietal Theta in AS compared to NI, slightly contrasting our hypothesis (Figure 5).

Figure 4. Increased frontal Gamma in MS compared to UV for participants who experienced an effective UV condition, electrode F1 illustrated.

Figure 5. (Left) Increased parietal Theta in AS compared to NI, electrode M2 illustrated. (Right) Time frequency plot of difference between AS and NI for electrode with largest effect size (M2).

CONCLUSION

Our results support the importance of multisensory integration for illusionary changes in perceived body size. However, we also suggest that visual-only illusions can influence cortical body representations for a significant proportion of participants, which may have implications for the development of accessible visual-only chronic pain treatments.

Figure 1. (Left) Schematic of Augmented Reality System. (Right) Image of Participant in EEG cap undergoing Reaching Illusion. Scan to see video of finger stretching!