The Emo&Pain Project: Facilitating physical activity in chronic pain

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EMO&PAIN | Goal

To develop technology that supports people with chronic pain (CP) in remaining physically active
**CHRONIC PAIN | What it is?**

- Pain that lasts more than 3 months past healing phase or in the absence of physical cause.

- Due to changes of the central and peripheral nervous system resulting in amplification of pain signals and overactivity in pain pathways (Tracey & Bushnell, 2009)
CHRONIC PAIN | Scale of the problem

• LBP accounts for 20% of the UK’s total health expenditure (Pain, 2000)

• 7.8 million people in the UK live with chronic pain
• £584 million is spent on prescriptions for pain
• 25% of people with chronic pain lose their jobs
• 16% feel their chronic pain is so bad that they sometimes want to die.

CMO: Chief Medical Officer (2008)

Clinical resources are unable to meet demand and many people do not get the help they need.
Physical activity is the main therapy

- Protects against weakening and stiffness.
- Inhibits the spread of pain.
- Increases confidence in functioning .... and physical activity is in everyday functioning

But pain leads to avoidance of movement

- Fear of increased pain or injury
- Altered proprioceptive system
- Low self-efficacy and Depression

Resulting in further physical, psychological deterioration and social isolation
“my proprioception is poor with my back because of fear. And even though the fear is very real, it’s not even a conscious fear; it’s something that’s definitely ever-present.”
FINDINGS | Strategies to facilitate physical activity

- Real-time **structured** sonification of movement and breathing
- Developing positive awareness of movement
- Augmenting pleasurable sensations
- Slow incremental building of capabilities
- Taking control of rehabilitation
- Self-directed calibration of sonification mapping

Singh, et al. Motivating People with Chronic Pain to do Physical Activity: Opportunities for Technology Design. Proc CHI ’14,
DESIGN | Sonification of movement

**Smartphone**

![Smartphone application screen showing settings and options for sound effects. Options include Xylophone, Piano, Do not change balance/volume, Check leaning left/right1, Check leaning left/right2, Check speed, No Sound, Flat Sound, Wave Sound, Random, Back & Forth, and Use breathing detection.]

- Maximum angle: 13.66°
- Capture 1: 66.42°
- Most Comfortable: 8.32°

**Movement sensor**

- Controlled by a hand controller.
Singh, et al. Motivating People with Chronic Pain to do Physical Activity: Opportunities for Technology Design. Proc CHI '14,
SONIFICATION FRAMEWORK | An example

Anchor Point <--------> Inform where body is in the space to overcome psychological barriers

Self calibration
for transfer of control
“With the shape sound, it seems like I was climbing a mountain ..... After passing the top position, I would know that I have passed a certain level and it just encouraged me that I might be able to do a bit more than that. But without the sound, you have no idea [where you are]”.

“to focus on something other than what you are doing. With the up and down sound, I can hear more clearly how I am doing.”
EMO&PAIN | Automatic detection of pain-related emotions


### Prediction in Stretch Forward

<table>
<thead>
<tr>
<th>Ground Truth</th>
<th>Control</th>
<th>Low-Pain</th>
<th>High-Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>17 (89.4%)</td>
<td>1 (5.3%)</td>
<td>1 (5.3%)</td>
</tr>
<tr>
<td>Low-Pain</td>
<td>0 (0%)</td>
<td>13 (86.7%)</td>
<td>2 (13.3%)</td>
</tr>
<tr>
<td>High-Pain</td>
<td>0 (0%)</td>
<td>3 (20%)</td>
<td>12 (80%)</td>
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</tbody>
</table>

### Prediction in Full Flexion

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<th>Low-Pain</th>
<th>High-Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>6 (100%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Low-Pain</td>
<td>0 (0%)</td>
<td>6 (100%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>High-Pain</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>6 (100%)</td>
</tr>
</tbody>
</table>

### Prediction in Sit-to-Stand

<table>
<thead>
<tr>
<th>Ground Truth</th>
<th>Control</th>
<th>Low-Pain</th>
<th>High-Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>24 (61.5%)</td>
<td>4 (10.3%)</td>
<td>11 (28.2%)</td>
</tr>
<tr>
<td>Low-Pain</td>
<td>6 (14.0%)</td>
<td>33 (76.7%)</td>
<td>4 (9.3%)</td>
</tr>
<tr>
<td>High-Pain</td>
<td>11 (28.2%)</td>
<td>5 (12.8%)</td>
<td>23 (59.0%)</td>
</tr>
</tbody>
</table>
Sense of Body and the Sensing Body

The sense of our physical body is crucial for our interaction with our environment, being tightly linked to action-awareness and self-esteem.

This sense of body is acquired through sensing and acting.
The Hearing Body Project (led by Ana Tajadura Jimenez) (CHI’15)
In collaboration with Nic Marquardt and the Centre for the Study of the Senses (O. Deroy)
Ana Tajadura-Jiménez
ESRC – Future research Leader: 2012-2015

Sonic shoes change the way you walk
THE MAGIC SHOES | Results on altered body perception

CONCLUSIONS

• Interesting opportunity in physical rehabilitation
  – It’s not enough to measure physical progress ... psychological progress is even more important
  – Sonification has a way to represent movement devoid of pain
  – Self-calibration to learn self-management skills

• Important modality for affect recognition
  – The face doesn’t say everything ---
  – Good recognition performance on naturalistic body expressions

• Wearable vs kinect-like games
  – Supporting physical activity throughout the day
  – Transferring to functioning
Thanks

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