Perceptual learning reduces the 2-point discrimination threshold – preliminary findings

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INTRODUCTION

- The 2-point discrimination threshold (2PDT) is often used to probe the integration of the sensory system, and is taken as a measure of spatial acuity.

- The 2PDT has been shown to change both during acute and chronic pain [1,2].

- A study has shown how perceptual learning may improve the spatial acuity [3]. Such an improvement may be able to restore some of the mal-adaptive neuroplastic mechanism involved in chronic pain.

- When investigating the 2PDT studies typically apply one of two methods – often referred to as the random and the staircase method. However, it is not known how the probing method agree in the initial assessment of the 2PDT nor if the methods are equally sensitive to detecting changes in the 2PDT.

AIM

The primary aim of this study was to investigate how the 2PDT changes based on perceptual learning (both supervised and non-supervised training). The secondary aim was to compare differences between the method used to determine the 2-point discrimination threshold.

METHODS

- 11 healthy subjects participated in this preliminary study
- The experiment consisted of three blocks with a 60 min pause between each block (Fig. 1).
- Within each block the 2PDT was determined using both the random and staircase method. The order of the methods was randomized.

2PDT estimation

- To determine the 2PDT a Vernier caliber with two blunted plastic probes (diameter 5mm) was used.
- The random method: stimuli were delivered with point distances from 0 to 100mm, in steps of 10mm in randomized order. 0mm correspond to a single point and served as control. Each distance was repeated three times, while 0mm was repeated ten times.
- The staircase method: the initial stimulation was a point distance of 100mm, then the distance decreased in steps of 20mm until only a single point was perceived for two consecutive stimuli. Then the step size was decreased to 5mm and the distance increased until two consecutive stimuli were perceived as two points. This decrease/increase continued until three peaks and three troughs were determined. Single point stimuli were added so that on average one in every four stimulus was a control stimulus.
- Following each stimulus the subject had to respond either 1 or 2 perceived points.
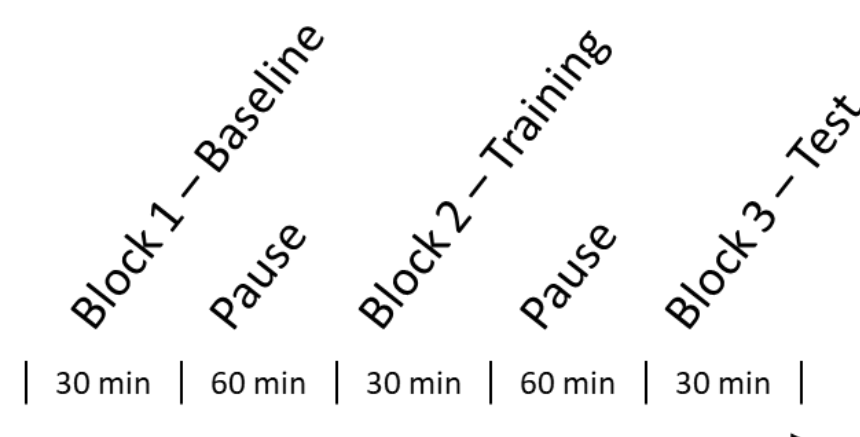

Figure 1. Experimental protocol
(Block 1 – Baseline, Pause, Block 2 – Training, Pause, Block 3 – Test; 30 min | 60 min | 30 min | 60 min | 30 min)

METHODS (CONT.)

Perceptual learning

- In block 2 subjects received either supervised or non-supervised training to cause perceptual learning of the 2PDT. Those who received supervised training were informed of the correctness immediately after their response (neutral response either 'Correct' or 'Incorrect'). Those who received non-supervised training was not informed of the correctness of their response.

Data analysis

- The 2PDT for the random method was determined by fitting the responses (1 or 2 points) to a sigmoidal curve. The 2PDT was determined as 50 % correct.
- The 2PDT for the staircase method was determined as the average of the last two pairs of peaks/troughs.
- To analyze the effect of perceptual learning based on both supervised and non-supervised training block 1 and 3 was compared.
- The analysis was both made per subject (Fig 2 and 3) and per group level (Fig 4 and 5).

Ethical

- The experiment was approved by the local ethical committee (VN-20190005). The experiment was conducted in accordance with the declaration of Helsinki.
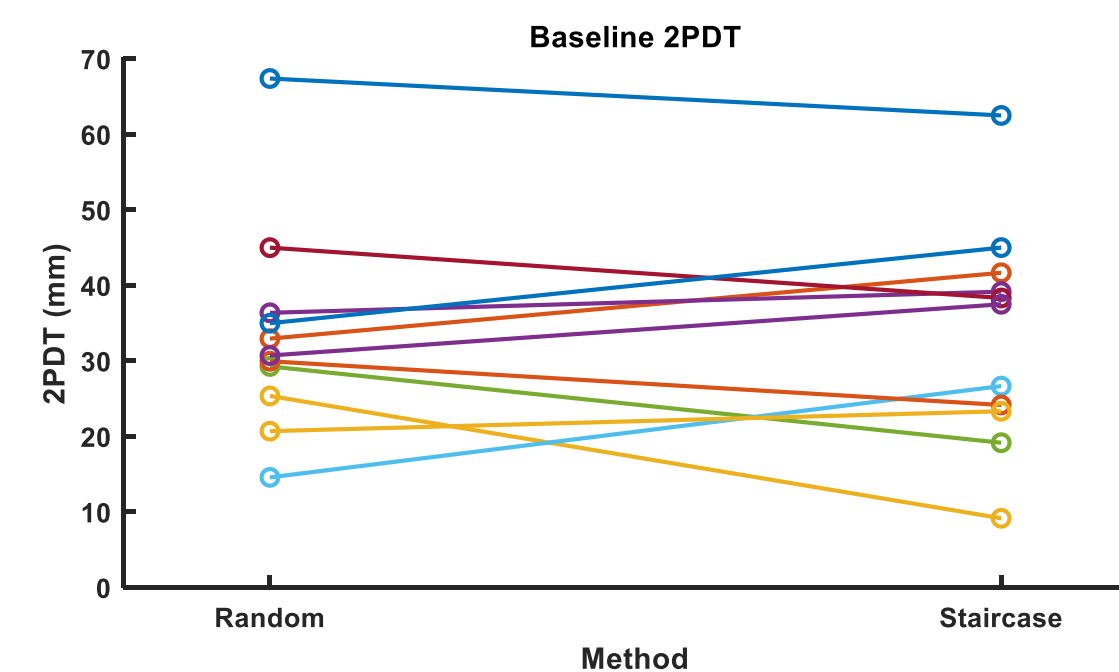
RESULTS

2PDT method comparison

Figure 2. Baseline comparison of the 2PDT assesed by the random and staircase method for each subject, irrespective of which training subjects would later receive. Each color represent one subject.

- For the random method: the average baseline 2PDT was 33.4±13.8mm (mean±SD).

- For the staircase method: the average baseline 2PDT was 33.3±14.6mm (mean±SD).

- The average baseline difference between the methods was 3.7 %.

RESULTS (CONT.)

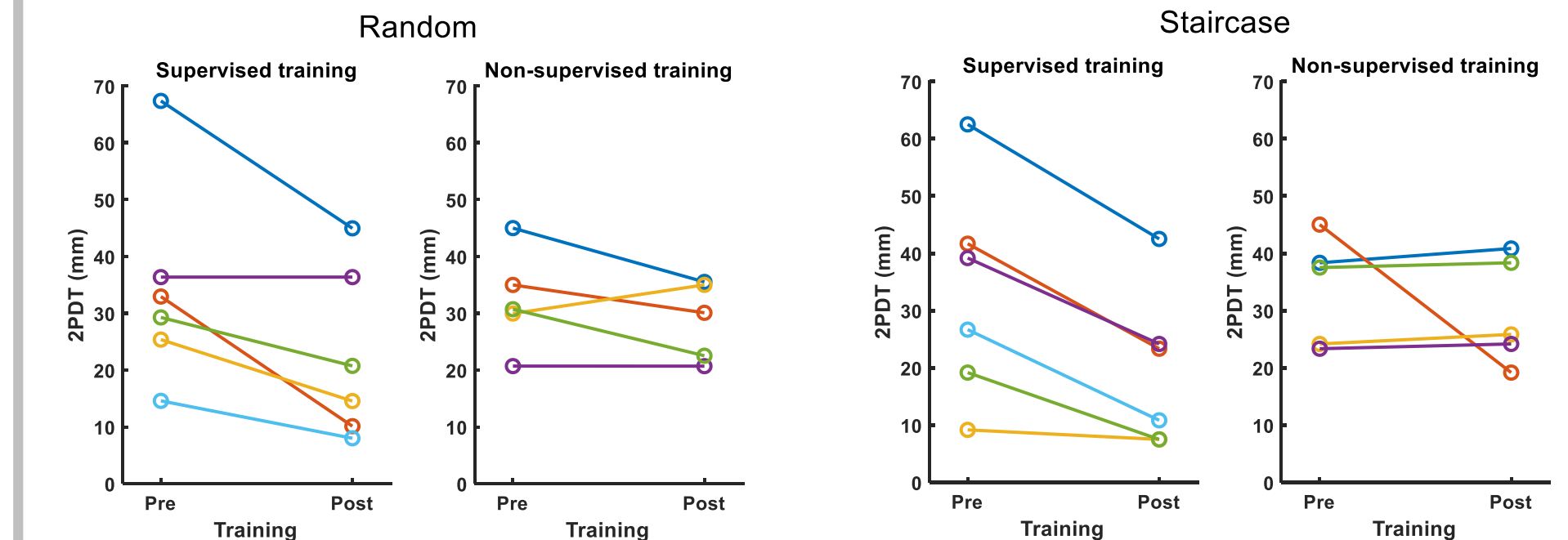**2PDT change following perceptual learning**

Figure 3. 2PDT for the random method for each subject. Each color represent one subject. Block 1 was the baseline, block 3 was the test block after perceptual learning.

Figure 4. 2PDT for the staircase method for each subject. Each color represent one subject. Block 1 was the baseline, block 3 was the test block after perceptual learning.

- For supervised training, the 2PDT was reduced from baseline to after training, in all but one subject. This was found for both the random and staircase methods.

- For non-supervised training there was no clear trend between pre and post training.

- The average 2PDT reduction for the random method for supervised training was 11.9 +/- 9.1 mm and for non-supervised training it was 3.5 +/- 6.0 mm.

- The average 2PDT reduction for the staircase method for supervised training 13.7 +/- 6.6 mm and for non-supervised training it was 4.0 +/- 12.2mm.

- Due to limited sample size the findings were not statistically significant.

CONCLUSIONS

- Perceptual learning appears to reduce the 2PDT.

- Supervised learning offers the greatest reduction in the 2PDT whereas non-supervised training only slightly reduces the 2PDT.

- Further studies are needed to investigate the long-term effect of perceptual learning.

- Overall, there was good agreement between the random and staircase method. Suggestion that results from the two methods may be comparable.

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