Stimulation modality and noxiousness affects the 2-point discrimination threshold

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Introduction

- **Spatial acuity is often probed by determining the 2-point discrimination threshold (2PDT).**
- **Previous studies have somewhat disagreed on how the 2PDT differ between noxious and innocuous stimuli [1,2,3,4]. However, most studies apply different stimulation modalities to compare noxious and innocuous intensities.**
- **Thus, it may be hypothesized that both stimulation modality as well as noxiousness could modulate the 2PDT.**
- **These data have recently been published in Experimental Brain Research [5].**

Aim

The aim of this study was to investigate how the 2PDT depends on different stimulation intensities (noxious or innocuous) and different stimulation modalities (thermal and mechanical).

Methods

- 19 healthy subjects (6 females) participated in this study (age 24.6 ± 4.2 years).
- The 2PDT was determined in the volar forearm for four different combinations of stimulation modality and noxiousness (thermal-innocuous, thermal-noxious, mechanical-innocuous and mechanical-noxious). The order of the combinations was randomized.
- The mechanical stimuli were delivered using two custom-made Vernier calibers (Fig. 1). For innocuous stimuli the probes were blunted plastic filaments (Ø: 5mm), for noxious stimuli the probes were weight-loaded (60 grams) blunted needles (Ø: 200µm).
- The thermal stimuli was delivered using a CO_2 laser with an advanced scanner head [3,4], allowing stimulation of two points simultaneously. The skin temperature was monitored using an infra-red camera (Agema 900).
  For innocuous stimuli, the stimulation temperature was adjusted 41.6±1.5°C, and for noxious stimuli the stimulation temperature was 48.6±1.8°C.
- The point stimuli were delivered with separation distances ranging from 0 to 120 mm, in steps of 10mm. 0mm corresponds to a single point, and serves as a control. Each distance was delivered twice in random order. 0mm was delivered four times.

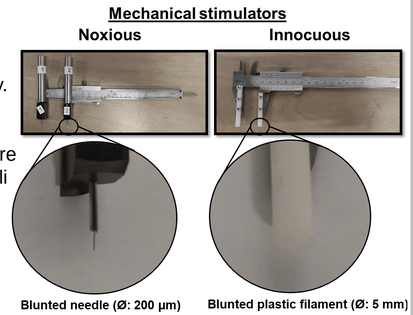

Figure 1. Mechanical stimulators.
Left: noxious, right: innocuous

Methods (cont.)

- After each stimulation, subjects had to indicate the perceived number of points (1/2) and the perceived intensity (NRS, 0: no perception, 3: pain threshold, 10: maximum pain).
- To find the 2PDT the data was fitted to a sigmoidal curve [3,4], for each fit the 95 % confidence interval (CI) was extracted as well.
- To analyze differences in the NRS data a 3-way ANOVA was used, with factors set as point distance, stimulation noxiousness and stimulation modality.
- The experiment was approved by the local ethical committee (VN-20190005). The declaration of Helsinki was respected.

Results

2-point discrimination threshold (2PDT)

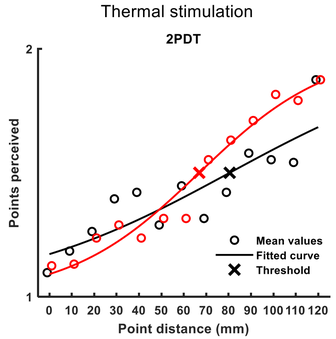

Figure 2. 2PDT of thermal the stimulations.
Black: innocuous, red: noxious

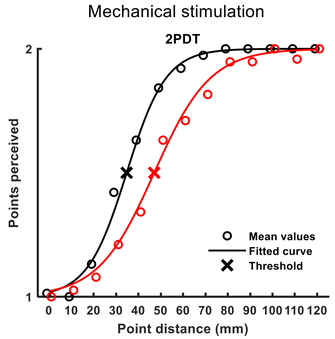

Figure 3. 2PDT of the mechanical stimulations.
Black: innocuous, red: noxious

Table 1. Calculated 2PDT and 95 % CI for each combination of stimulation modality and noxiousness.

	2PDT (mm)	95% CI (mm)
Thermal innocuous	80.5	65.0 - 96.0
Thermal noxious	66.9	61.4 - 72.4
Mechanical innocuous	34.7	33.4 - 36.1
Mechanical noxious	47.1	45.0 - 49.1

Results (cont.)

Perceived intensities

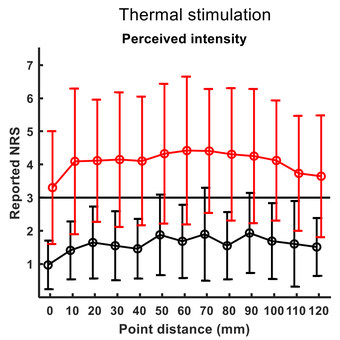

Figure 4. Perceived intensities of the thermal stimulations (mean±SD). Black: innocuous, red: noxious. NRS = 3 indicate pain threshold.

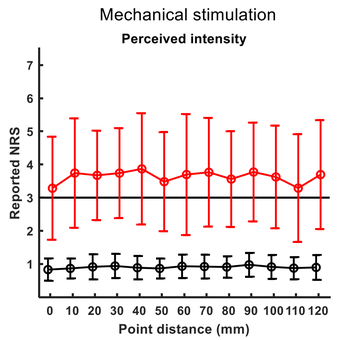

Figure 5. Perceived intensities of the noxious stimulations (mean±SD). Black: innocuous, red: noxious. NRS = 3 indicate pain threshold.

Table 2. Average perceived intensities (NRS) for each combination of stimulation modality and noxiousness (mean±SD). NRS = 3 indicate pain threshold.

	NRS (mean±SD)
Thermal innocuous	1.6±1.1
Thermal noxious	4.0±2.0
Mechanical innocuous	0.9±0.3
Mechanical noxious	3.6±1.6

- The NRS was significantly higher for noxious stimuli (ANOVA, $p<0.001$). The NRS was significantly higher for thermal stimuli (ANOVA, $p<0.001$). There was no difference in NRS in relation to the point separation distance.

Conclusions

- The 2PDT appear to depend both on the modality and noxiousness of the stimulation.
- The noxiousness modulates the 2PDT differently for each modality.
- Noxious intensities are discriminated better for thermal stimuli, whereas for mechanical stimuli innocuous stimuli are discriminated better.

References

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