Cognitive modulation of spinal nociception assessed via the nociceptive withdrawal reflex

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Introduction

- The nociceptive withdrawal reflex (NWR) is a polysynaptic reflex that serves defensive purposes in humans [1, 2]. As an objective correlate of pain perception, it can be used to assess spinal nociception.
- The skin area from which the NWR can be elicited is called the Reflex Receptive Field (RRF) [3]. Spinal cord circuitry integrates simultaneous stimuli via spatial summation even when stimulating two different RRFs [4].
- Spinal processing is under descending control.

Aim

To investigate whether cognitive tasks (distraction/attention) modulate spinal spatial integration of simultaneous stimulation, affecting the magnitude of the elicited NWR with single and double stimulation.

Methods

Subjects: Fifteen healthy volunteers participated in the study. Written informed consents were obtained.

Stimulation: Electrical stimulation in the sole of the foot via two stimulating electrodes in the Medial (M) and Lateral (L) side of the sole of the foot (Fig.1A). Five repetitions of each of three types of stimuli were delivered: single in M, single in L and simultaneous in both (15 stim total in each condition).

NWR quantification: EMG was acquired in Tibialis Anterior and Biceps Femoris using a double differential configuration (Fig. 1B.) NWR quantified by the RMS value in the reflex window (80-150ms post stimulus), the five repetitions were averaged.

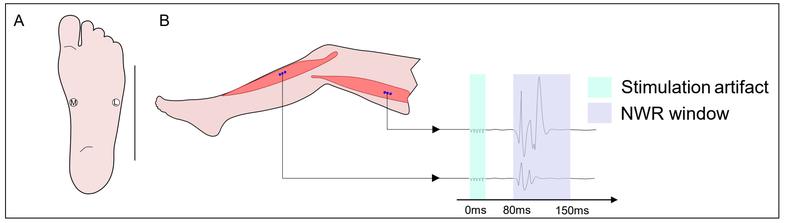

Figure 1: Stimulation and recording experimental set-up. A) Two stimulation electrodes were mounted in the medial (M) and lateral (L) side of the sole of the foot. B) Superficial EMG recorded over TA and BF muscle. NWR quantified as the root mean square value of the EMG signal in the reflex window (80ms-150ms post-stimulus).

Methods (cont.)

Experimental protocol

- Control session: control for performance of the cognitive tasks (number of errors)
- Attention and Distraction session: 15 stimuli during baseline conditions and while performing the cognitive task.
- Stimulation intensity (Si) varied as indicated in Fig. 2.

CONTROL		ATTENTION		DISTRACTION	
Localization Test	Stroop Test	Baseline	Localization Test	Baseline	Stroop Test
Fifteen stimuli Si = 2xDth # Errors	No Stim # Errors	Fifteen stimuli Si = 1.5xNWRth EMG	Fifteen Stimuli Si = 1.5xNWRth EMG # Errors	Fifteen stimuli Si = 1.5xNWRth EMG	Fifteen Stimuli Si = 1.5xNWRth EMG # Errors

Figure 2: Experimental protocol consisted in three sessions: Control Attention and Distraction, performed in random order with 10 minutes break between them. Control session to control for the performance of the cognitive tests (Localization and Stroop), Attention and Distraction sessions included recording of EMG and NWR quantification during baseline and during the respective cognitive task. Si: Stimulation intensity. Dth: Detection threshold

Cognitive tasks

- Attention: Localization test to identify the stimulated location: M or L (Fig.1A).
- Distraction: A modified version of the stroop color and word test.

Data and statistical analyses

- Quantified NWR during each cognitive task compared to baseline measures: Wilcoxon signed rank test (* in Fig. 3).
- Comparison between Attention and Distraction: Wilcoxon signed rank test (ø in Fig. 3).
- P-values < 0.05 were considered significant.

Results

- Number of errors of the cognitive tasks did not differ significantly between sessions.
- Attention task did not significantly affect the magnitude of the NWR.
- Distraction task significantly modulated the size of the NWR, regardless of the stimulation type (single in M, L and simultaneous) See Fig 3.
- The degree of summation due to the Distraction task was larger when stimulating in L (blue bar in Fig. 3) than with the other two stimulus types (in M and simultaneous).

Results (cont.)

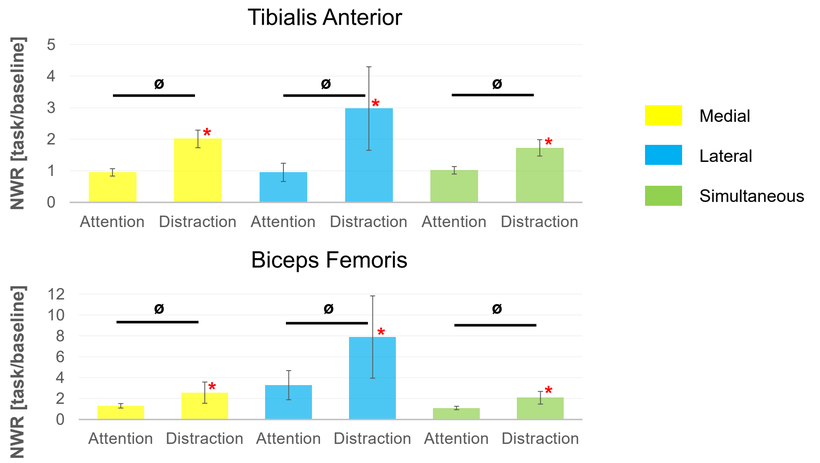

Figure 3: Results showing magnitude of the NWR normalized by dividing to baseline measures. The color of the bars indicates stimulation type (yellow: single in M; blue: single in L; green: simultaneous). * compared to baseline with a p<0.05. ø comparison between cognitive tasks with a p<0.05.

Conclusions

- During the distraction task, RRF likely expand to include the lateral area of the sole of the foot (area normally not part of the RRF for TA and BF). This may explain why the stimulation in the lateral side was the most affected by the distraction task.
- The attention task did not modulate the magnitude of the NWR. Likely a limitation of the localization test with only two sites to localize.
- The lack of differential modulation between proximal and distal muscles suggests that the observed descending modulation affect the entire spinal system with no discrimination of spinal segment.

References

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