

Blood pressure and the perception of the thermal grill illusion of pain

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Introduction

Thermal grill illusion of pain (TGI)

paradoxical pain



(Thunberg, 1896)

(Fruhstorfer, 1984)

(Campero et al., 2009)

*“ the percept of the thermal grill is not simply pain – it can be understood as a metaesthetic percept
at the transition from heat to pain”*

(Bach et al., 2011)

Introduction

Central disinhibition theory (Craig & Bushnell, 1994):

TGI is elicited when the simultaneous warm stimulation

- reduces the activity of the myelinated A δ -fibres (carrying cold), thus
- disinhibiting polymodal C-fiber channels (responsible for warmth).

Thermal grill = fundamental tool in the investigation of central pain processing:

paradoxical and neuropathic pain processes share common neural substrates

(Craig, 2008; Kern et al., 2008)

Introduction

Inter-individual differences in the perception of the TGI

Responders and Non-Responders



(Bach et al., 2011; Boettger et al., 2011; Bouhassira et al., 2005; Defrin et al., 2008)

Introduction

Psychological
characteristics

Table 2: Significant predictors of pain intensity and pain unpleasantness perceptions during thermal grill stimulation

	B	S.E.	Wald	df	^a p	Odds Ratio	95.0% C.I. for Odds Ratio	
							Lower	Upper
Predictors for pain intensity:								
Rumination	3.58	1.39	6.59	1	.01*	35.86	2.33	551.67
Interoceptive Accuracy (IA)	3.01	1.23	5.93	1	.01*	20.19	1.80	226.81
Interaction Terms:								
State Anxiety x Rumination	.51	.21	5.75	1	.02*	1.67	1.10	2.55
Pain Expectancy x Rumination	.46	.20	5.40	1	.03*	1.48	1.04	2.13
Pessimism/Optimism x Rumination	1.03	.36	8.13	1	.004**	2.81	1.38	5.70
IA x Rumination	.53	.20	7.38	1	.007*	1.71	1.16	2.51
IA x Pain Expectancy x Rumination	.10	.04	6.49	1	.01*	1.11	1.02	1.20
Predictors for pain unpleasantness:								
Rumination	3.42	1.62	4.45	1	.03*	30.72	1.28	738.85
Suggestibility (WSS):								
Intensification Test – Concentration	-.88	.45	3.71	1	.05*	.42	.17	1.01

^aP-values < .05 (two-tailed) were considered significant and values < .005 (two-tailed) as highly significant.

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Personality
Traits
N = 54 :

Introduction

Psycho-
physiological
aspects

Heart rate variability (HRV) at rest – index of vagal activation ($N = 52$):

	<i>B</i>	<i>S.E.</i>	<i>Wald</i>	<i>df</i>	<i>a</i> <i>p</i>	<i>Odds Ratio</i>	<i>95.0% C.I. for Odds Ratio</i>	
<i>Predictors for pain intensity sensations:</i>							<i>Lower</i>	<i>Upper</i>
Respiratory Sinus Arrhythmia (RSA)	2.68	1.31	4.18	1	.04*	14.58	1.12	190.29
RMSSD	-.12	.06	4.42	2	.03*	.88	.79	.99
pNN50	.15	.06	6.38	2	.01*	1.16	1.03	1.31

Indicator of dispositional self-regulation ability

(Appelhans & Luecken, 2006; Segerstrom & Solberg Nes, 2007, Thayer et al., 2009, 2012)

Introduction

Psycho-
physiological
aspects

- Inverse relationship between cardiovascular activity and pain sensitivity
- Analysis of relationship between
 - Blood pressure (BP)
 - Baroreflex sensitivity (BRS)+ paradoxical pain sensitivity

(Bruehl et al., 1992; France, 1999; Ghione, 1996; 1994; Myers et al., 2001)

Methods

Participants:

$N = 31$, 16 males + 15 females; age: $M = 24.2$ years, $SEM = 1.17$, range: 19–51

Material:

Custom-built, water-bath driven **thermal grill** device

- 8 alternating cold and warm tubes
- made of borosilicate glass
- locating surface: 20 x 10 cm



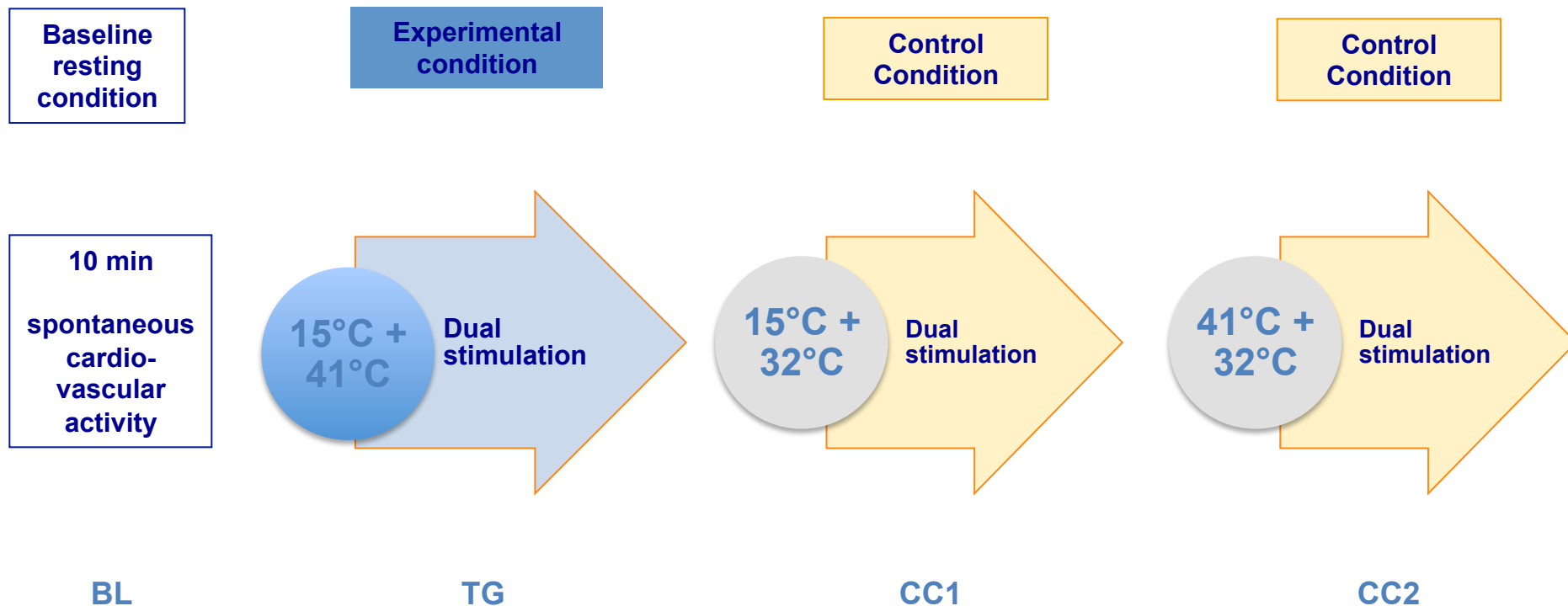
Measures :

Psychophysical: 0–100 NRS pain intensity and pain unpleasantness ratings

Psychophysiological: Heart rate and blood pressure recordings

Methods

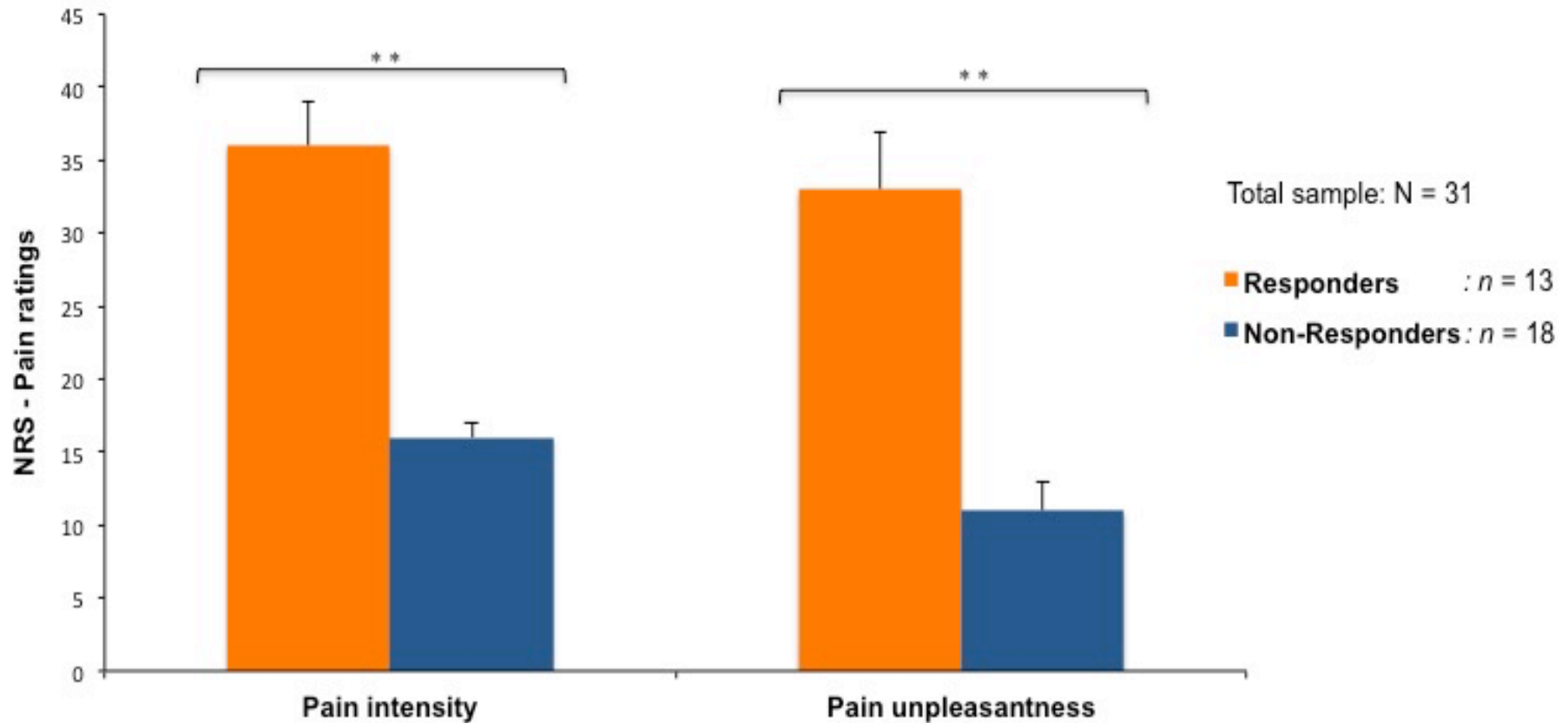
Protocol and thermal grill stimulation procedure:



NRS pain ratings every 15 seconds during 1 minute stimulation phases

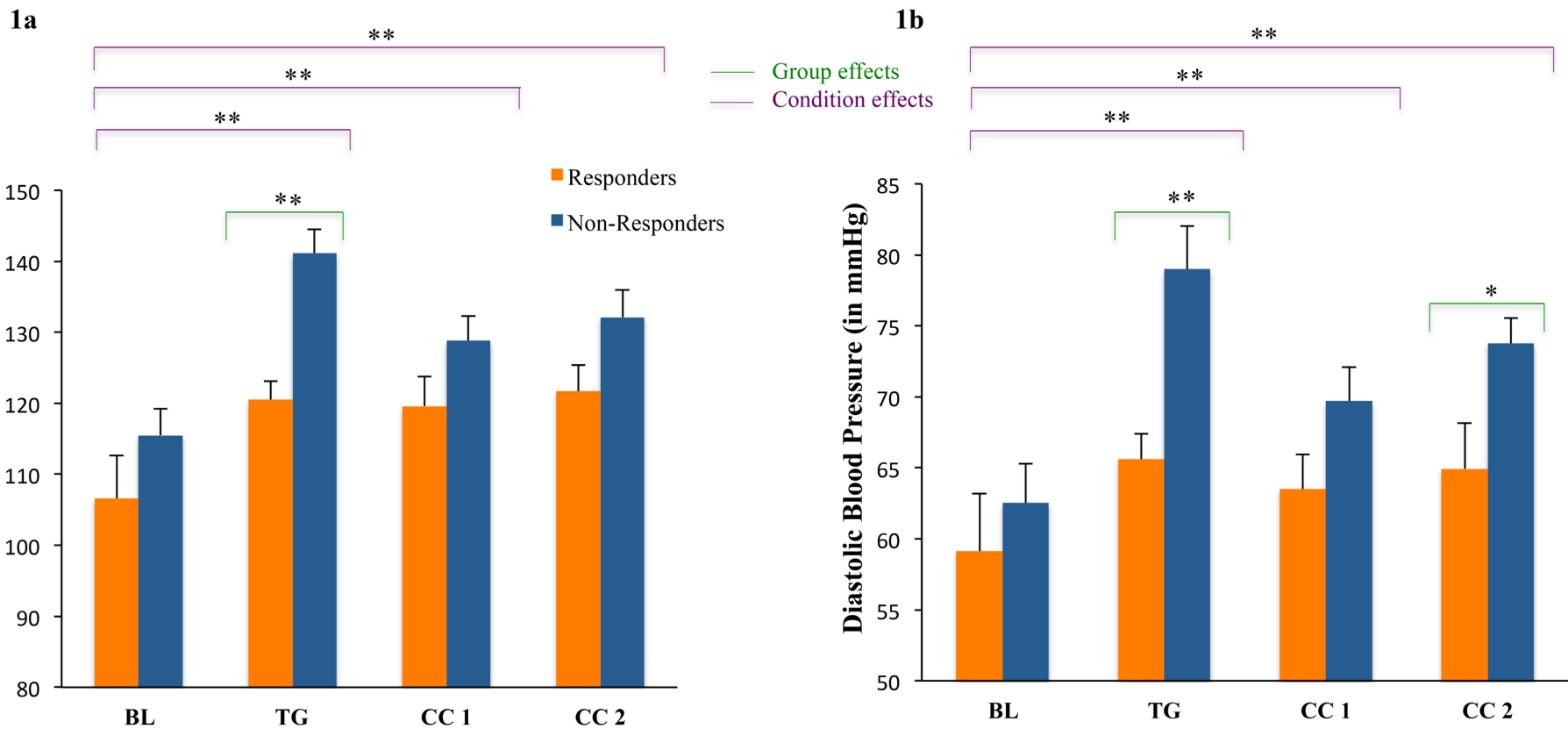
Results

Figure 1: Pain ratings of responders and non-responders:



Results

Figure 2: Group and condition effects for SBP and DBP



Results

Table 1: Correlations between pain ratings and blood pressure:

	Condition	NRS sensory	NRS affective ^b
Pearson correlation coefficient		<i>r</i>	<i>r</i>
Mean SBP ^a	BL	-.06	-.16
	TG mean	-.42 [*]	-.33
	TG 1 ^c (<i>N</i> = 26)	-.61 ^{**}	-.53 ^{**}
	TG 2 (<i>N</i> = 31)	-.30	-.18
	TG 3 (<i>N</i> = 30)	-.38 [*]	-.27
Mean DBP ^a	BL	-.08	-.10
	TG mean	-.59 ^{**}	-.09
	TG 1 (<i>N</i> = 24)	-.64 ^{**}	-.44 [*]
	TG 2 (<i>N</i> = 29)	-.33	-.05
	TG 3 (<i>N</i> = 28)	-.27	-.11

^{**} $p < 0.01$, ^{*} $p < 0.05$ (2-tailed).

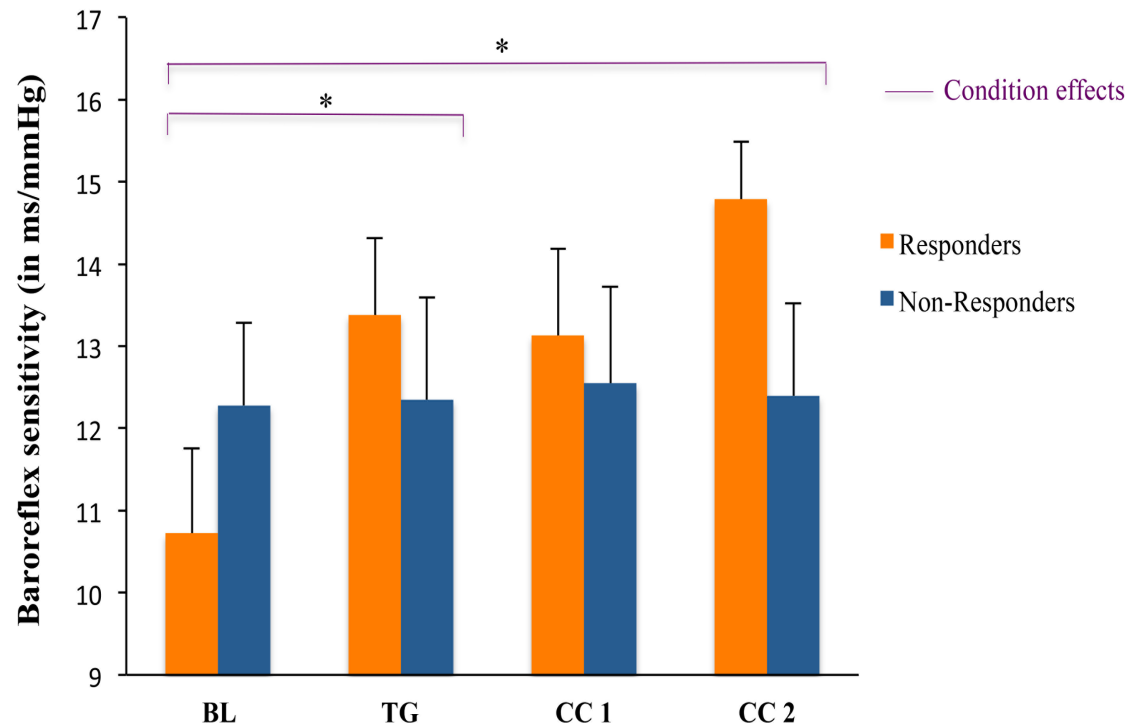
^a Mean systolic blood pressure (SBP) and diastolic blood pressure (DBP).

^b Mean NRS-related pain intensity and pain unpleasantness ratings assessed at 15 sec intervals in three separate 1-minute thermal grill stimulation phases.

^c First thermal grill stimulation phase. etc.

Results

Figure 3: Condition effects for BRS



Conclusion

- **Hypothesis** of a BP-dependence of paradoxical pain sensitivity = **confirmed**
- Close **inverse linear association** between BP responses to TG stimulation and sensory/affective pain ratings
 - => In line with findings of studies with experimental noxious stimulation
 - => Inter-individual differences in BP related to inter-individual differences in the perception of the TGI
 - => Interaction of cardiovascular and pain regulatory systems
 - in the processing of pain elicited by noxious input
 - in the processing of non-noxiously elicited illusive pain



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Thank you

