

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

Raymonde Scheuren^a, Stefan Duschek^b, André Schulz^a,
Stefan Sütterlin^c, Fernand Anton^a

^a Institute for Health and Behavior, Research Unit INSIDE (FLSHASE), University of Luxembourg;

^b Institute of Applied Psychology, Medical Informatics and Technology, UMIT–University for Health Sciences, Hall in Tirol, Austria;

^c Section of Psychology, Lillehammer University College, Norway; Department of Psychosomatic Medicine, Division of Surgery and Clinical Neuroscience, Oslo University Hospital, Norway.

Introduction

Thermal grill illusion of pain (TGI)

(Thunberg, 1896)

paradoxical pain

(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

1

 Personality
 Traits
 N = 54 :

	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.

Introduction

Psycho-
physiological
aspects

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

	B	S.E.	Wald	df	^a p	Odds Ratio	95.0% C.I. for Odds Ratio	
							Lower	Upper
<i>Predictors for pain intensity sensations:</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) + paradoxical pain sensitivity
 - Baroreflex sensitivity (BRS)

(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



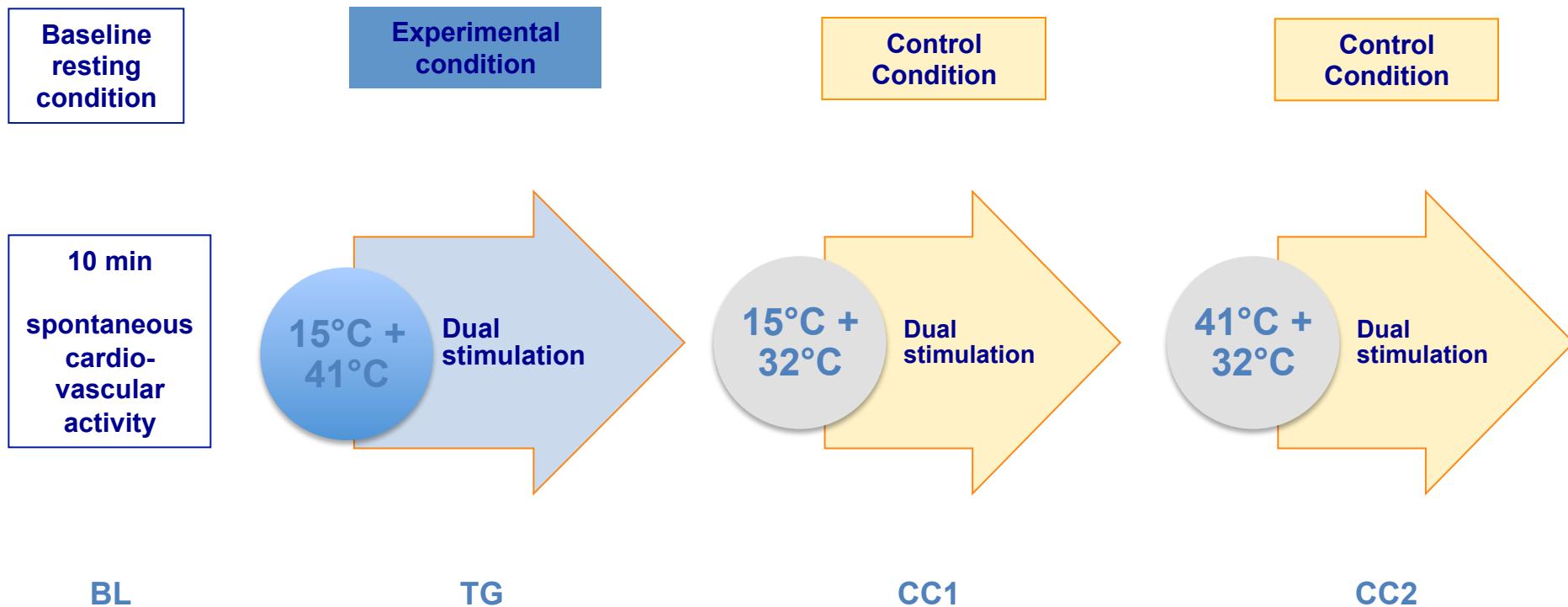
Measures :

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

Psychophysiological: Heart rate and blood pressure recordings

Methods

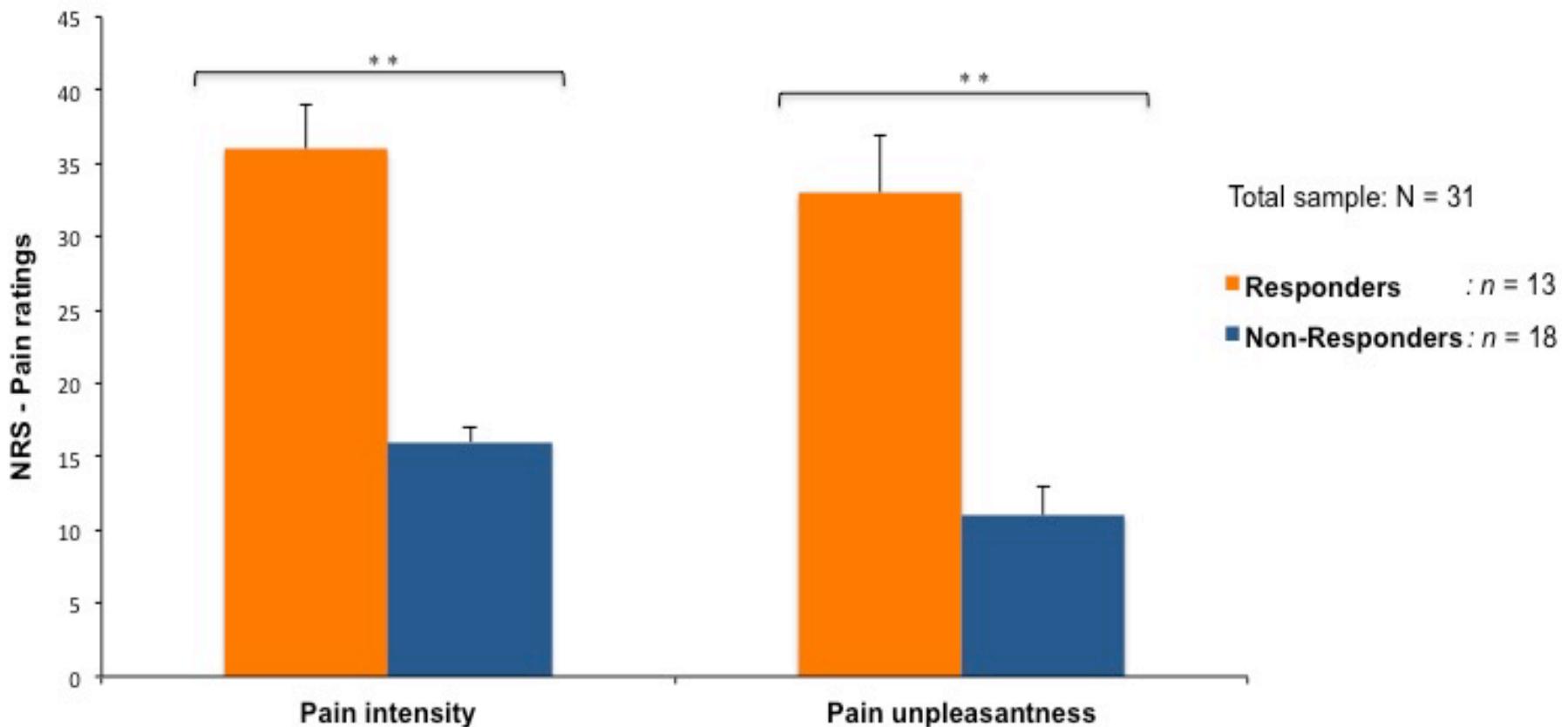
Protocol and thermal grill stimulation procedure:



NRS pain ratings every 15 seconds during 1 minute stimulation phases

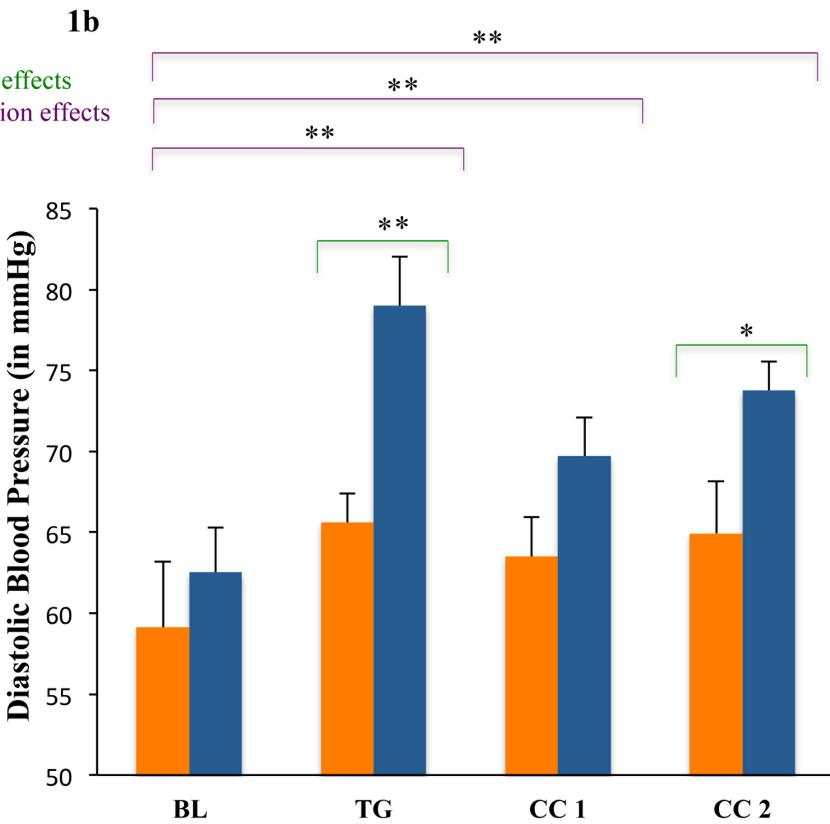
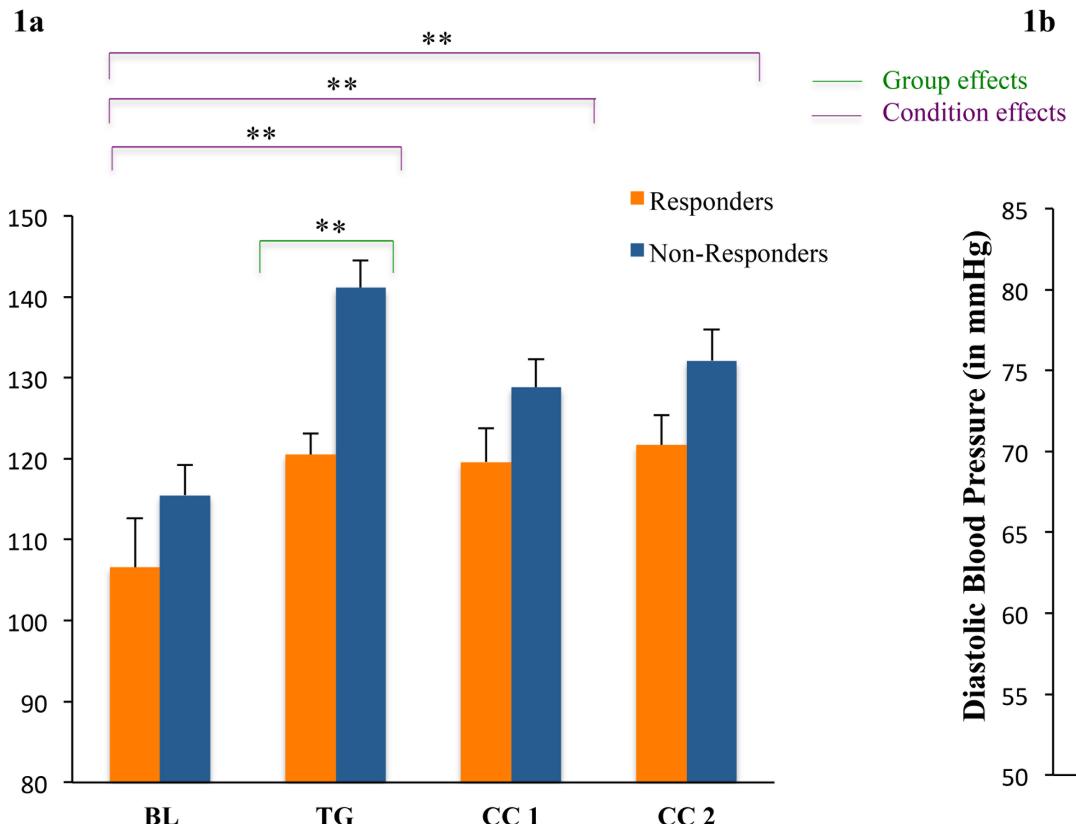
Results

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 (N = 26)	-.61**	-.53**
	TG 2 (N = 31)	-.30	-.18
	TG 3 (N = 30)	-.38*	-.27
Mean DBP ^a	BL	-.08	-.10
	TG mean	-.59**	-.09
	TG 1 (N = 24)	-.64**	-.44*
	TG 2 (N = 29)	-.33	-.05
	TG 3 (N = 28)	-.27	-.11

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

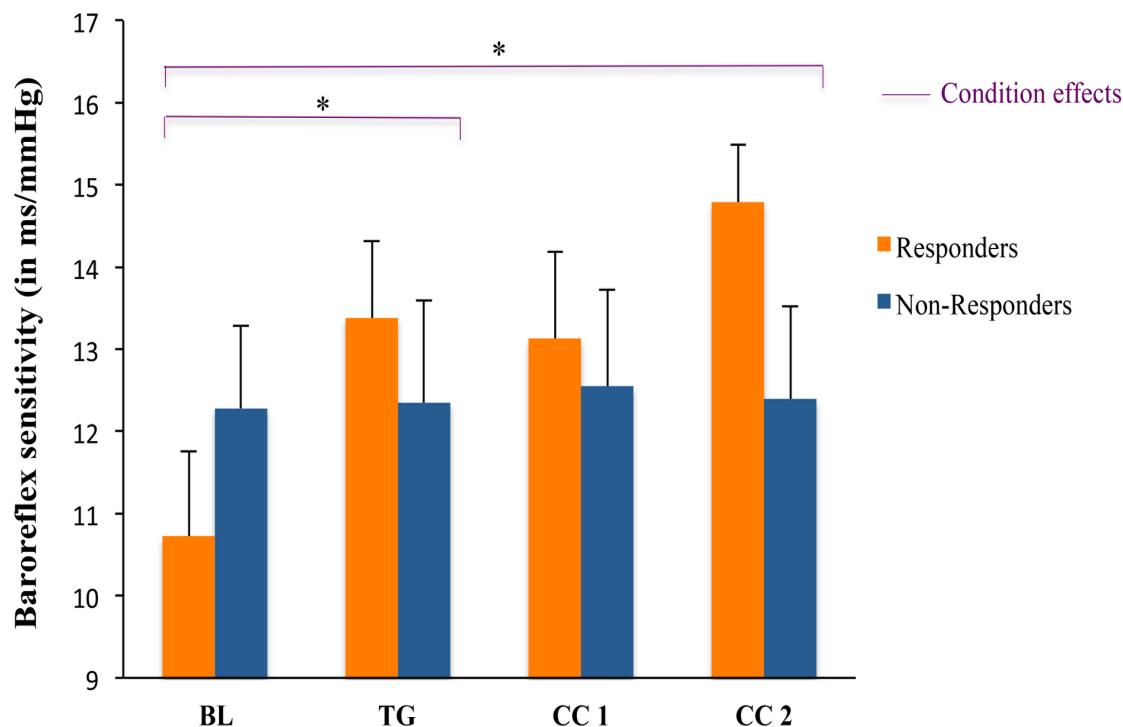
^a Mean systolic blood pressure (SBP) and diastolic blood pressure (DBP).

^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



Fernand Anton



Stefan Duschek



Stefan Sütterlin



André Schulz



Thank you