

# Stress and pain in muscles and brain

## Citation for published version (APA):

Luijckx, R. (2016). *Stress and pain in muscles and brain: developing psychophysiological paradigms to examine stress and pain interactions*. Maastricht University.

## Document status and date:

Published: 01/01/2016

## Document Version:

Publisher's PDF, also known as Version of record

## Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
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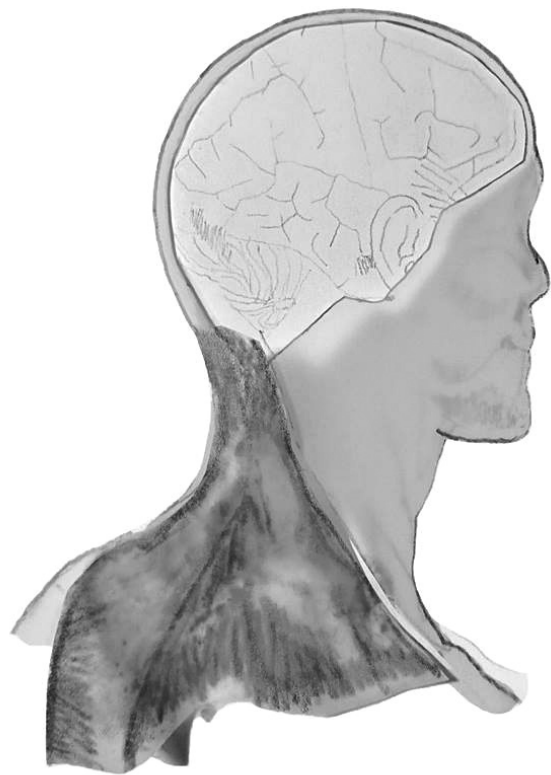
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All research leads to new conclusions, no matter how large or small the findings are, and the results can lead us in new directions to further elaborate the topic. The aim of this thesis was to examine the concepts of stress and pain by exploring the effects on psychophysiological measures. The results of the research presented here have yielded new insights in the underlying mechanisms of stress and pain, and more specifically, provided new information on interactions between psychological factors and pain- and stress-related psychophysiological activity. All results are discussed in the corresponding chapters. Broader clinical implications are reflected on in the general discussion chapter. Here, the implications of this thesis are discussed in an extensive context, and a more general view, in order to expound the societal relevance of the research presented in this thesis.

## **SOCIETAL RELEVANCE OF THIS THESIS**

As mentioned earlier, pain and stress are common phenomena to all of us. Alongside commonly experienced daily hassles, many of us also experience (serious) adverse life events, either in childhood or later in life, which can have an enormous impact. Acute pain and acute stress are essential in our lives, allowing us to survive. When it comes to long-lasting or recurrent pain, however, the impact on the subject as well as the psychosocial circumstances (personality, work, family, society etc.) may create the perfect scenario for progression into chronicity. In this case, pain seems not to serve any goal. Prolonged exposure to stress makes us vulnerable and predisposes us to mental disorder and stress-related health problems.

The prevalence of chronic pain, chronic pain syndromes, prolonged exposure to stress and stress-related health problems is high in modern society. The economic burden is therefore extensive. Over and above the medical costs, a large share of the economic burden is caused by non-medical costs, such as work absenteeism and unemployment benefits. Furthermore, it creates personal suffering, which influences both the subject as well as his or her environment. The results presented in this thesis reflect the inter-individual differences in experience of stress and pain on a psychophysiological level. They suggest the possibility to broaden the personalization of medicine by offering possible *tailor-made* interventions. The paradigms used in this thesis, concerning both stress and pain reactivity, allow us to detect risk factors that increase vulnerability. If these risk factors can be distilled, interventions could be applied where needed. For example, it would be interesting to screen for childhood adversities during the treatment of mental illnesses or stress-related illnesses. When identified, interventions, such as myofeedback or cognitive behavioral interventions, can be implemented. Applied in such way, these interventions can be fast and cost-effective, and can increase the prognostic values. The present research can be viewed as the first steps toward clinical appliance.

## **INNOVATIVE TECHNIQUES**

With ongoing innovation in IT, some former limitations are no longer an issue. Even during the past few years, while conducting this research, improvements in statistical software have allowed us to use better fitting statistical techniques. Additionally, advances in computer hardware have enabled us to perform more sophisticated statistical analyses. Researchers should exploit these new possibilities and choose the best fitting statistical technique to examine their data, to approach the essence of the matter of interest. In all studies presented in this thesis, multilevel random regression analysis was used in order to unravel the complex structure of the data. The results showed the benefit of using this advanced statistical technique, presenting additional and more specific information in comparison with conventional techniques. Multilevel analysis techniques offer great potential in the examination of natural psychophysiological processes, both at group level as well as at the level of the individual.

## **FUTURE DIRECTIONS**

Although the population of interest for this thesis was a (relatively) healthy, general population, without any diagnosed illnesses/diseases, this research has nevertheless provided evidence that interaction effects on psychophysiological measures are present, for both stress-related diseases and pain-related problems. The research presented in this thesis can therefore be viewed as a proof of principle. In future research, clinical populations can also be included, providing more in-depth insight into the constructs of stress and pain and, above all, into transition processes of chronicity. Populations of interest are patients with chronic pain and patients with stress-related diseases, such as PTSS and fibromyalgia. Also, this proof of principle can be used in the examination of neck pain, possibly resulting from computer usage, smartphones etc. Furthermore, although the focus of the present research was the trapezius muscles, the techniques used can be applied in the examination of the activity of various muscles or muscle groups. Thus, other clinical populations can become the subject of interest, e.g. populations with chronic back pain, orofacial pain, headaches etc. In conclusion, foundations have been laid for the use of a new experimental paradigm, including a multilevel analysis protocol, enabling the examination of diverse populations and specific problems.