(Chronic) non-specific low back pain (LBP) remains one of the most important health disorders of our Western society. Despite an abundance of research over the last decades, prevalence rates, disability levels, and societal and healthcare costs associated with LBP keep increasing. The fact that non-specific LBP is a multifactorial pain syndrome, but often is not addressed as such, might be one explanation for the difficulties regarding effective assessment and treatment. Therefore, the current dissertation aimed at further unraveling the nature of non-specific LBP from a multifactorial perspective. The overall aim of this dissertation was to increase the knowledge regarding several factors that were hypothesized to have an influence on both peripheral and central measures for movement preparation prior to (sensori)motor control tasks, since alterations in movement preparation previously have been related to LBP recurrence/chronification. Additionally, possible synergies between peripheral and central mechanisms in movement preparation were examined as well. The factors examined were fatigue and experimentally manipulated cognitive-affective states (fear) in different stages of clinical non-specific LBP chronification.

In this dissertation a gradual, progressive, biopsychosocial and multi-factorial research line was developed to further examine the aforementioned factors in LBP. This amounted to five studies, which were discussed in three chapters.

Chapter I. Theoretical background.
In the first chapter two systematic reviews were conducted in order to summarize the current standings regarding the overall objective of this dissertation, to point out gaps in current literature and opportunities for future research, and to gather and analyze methodological aspects which could be applied in the experimental designs of chapters II and III.

The first review (part 1) explored up-to-date literature regarding functional electroencephalography (EEG) alterations related to LBP, and found limited to moderate evidence for several functional brain alterations in chronic low back pain (CLBP) sufferers compared to healthy people. The functional EEG-alterations that were found in this systematic review reflect more attention-demanding postural strategies, presence of central sensitization processes, and altered decision making and maladaptive learning processes in CLBP sufferers when compared with healthy people. The most important finding of this study is, however, that there are still very few EEG-studies conducted in this domain. Hence, more research to further substantiate these findings, as well as research concerning other functional tasks and more diverse groups of LBP sufferers could lead to a vast expansion of the knowledge in this matter.

The second review (part 2) explored a broad biopsychosocial perspective in LBP by synthesizing all relevant literature regarding the influence of two important cognitive-affective factors, i.e. catastrophizing and fear, on the wide-ranging concept of movement-related outcomes. Furthermore, it aimed at comparing these parameters between different types of non-specific LBP, i.e. acute (ALBP), recurrent (RLBP) and CLBP populations. This review provides limited evidence for muscle-dependent alterations in trunk muscle timing, activity and diminished endurance, whereas for trunk muscle strength results were unclear or non-significant in association with fear and catastrophizing. Task-dependent functional performance impairments in relation with higher levels of catastrophizing and fear in LBP were also described. Implementation of bio-psychosocial assessment and treatment seems valuable for LBP patients with disturbed motor control, trunk muscle endurance, mobility, and lifting performance. However, these inferences need further experimental exploration as most are based upon single studies. High quality studies comparing ALBP, RLBP and CLBP with use of experimental paradigms besides questionnaires for the study of catastrophizing and fear on movement-related outcomes are required to examine causal relationships.
Chapter II. The influence of physical and cognitive exertion on movement preparation in healthy adults.

In the second chapter the influence of fatigue on movement preparation was examined through two experimental studies performed on healthy adults. Fatigue has a high relevance with regards to day-to-day living, because of its possible relation with injuries, changes in movement performance, and LBP. However, it was not yet clear whether and how fatigue might affect movement preparation and whether differential effects of fatigue could be expected for different types of fatigue-inducing exertions, more specifically physical versus cognitive exertion. Therefore, movement preparation for a rapid arm movement task following physical and cognitive exertion was assessed both on a peripheral muscle level (trunk muscle onset timing, part 1) and on a central brain level (cortical movement preparation, part 2) in healthy adults. In this way, possible effects of fatigue could be controlled for when performing the clinical study of chapter III. The two experimental studies discussed in this chapter hold similar conclusions, since no evidence for effects of physical and cognitive exertion on both central and peripheral measures of movement preparation for rapid arm movements in healthy adults were found. Therefore, it is hypothesized that the influence of fatigue on movement performance, which was described in previous research, might not be through altered motor control, but rather by reduced motivation. However, the possibility that fatigue might influence other mechanisms, which contribute to trunk motor control and were not assessed here, cannot be excluded and needs further examination. Based on the current findings, the rapid arm movement task used in this chapter is deemed suitable to measure peripheral and central movement preparation of gross motor movements, without being affected by learning effects, and physical or cognitive exertion. However, these results cannot yet be generalized to other populations, such as LBP sufferers. Hence, similar research in such patients is recommended.

Chapter III. A biopsychosocial perspective on the influence of fear on movement preparation in healthy people, RLBP and CLBP patients.

The third and final chapter aimed at examining the influence of experimentally altered cognitive-affective states, i.e. pain-related fear and expectations, on both central (cortical movement preparation) and peripheral measures (trunk muscle timing) of movement preparation, and this for healthy people, as well as RLBP and CLBP sufferers. In this way the in previous literature proposed moderating role of cognitive-affective factors on LBP chronicification through alterations in (sensori)motor control could be further elucidated. Furthermore, a hypothesized continuum of gradations in presence of maladaptive cognitive-affective factors and disturbed movement performance associated with different stages of LBP chronicification (healthy-RLBP-CLBP) could be explored. This study found larger Contingent Negative Variation amplitude (cortical movement preparation) in preparation of rapid arm movements, regardless of LBP presence or degree, with pain-related fear, suggesting an attentional redirection towards more effortful movement strategies when under threat of pain. Trunk muscle onset timing in relation to rapid arm movements was not affected by pain-related fear, but group differences were eminent, indicating that different peripheral movement preparation mechanisms are at play for RLBP and CLBP patients. We hypothesized that the similar trunk muscle onset timing that was found in RLBP compared to healthy people might reflect an adaptive motor control mechanism which contributes to recovery from pain flares. In contrast, the delayed timing which was seen in CLBP might indicate a failure of such adaptive systems and therefore might impede recovery and might contribute to the persistence of the LBP complaints. This novel insight also highlights the importance of separately examining both LBP groups when studying trunk muscle onset timing, which in previous research was not always done accordingly. Furthermore, trunk muscle onset times and cortical movement preparation did not systematically relate to each other in this study. Hence, both are considered as two distinct mechanisms in movement preparation.

The insights of this dissertation contribute to the multi-faceted knowledge of mechanisms and processes related to LBP and its chronicification process. However, further, mainly longitudinal research in line of the current work is still needed to further unravel this complex disorder.