# Theoretical background

## Wrist-worn devices as a new approach to assess physiological measures

In recent years, there has been a growing interest in using wrist-worn devices as a non-invasive method for assessing various physiological measures [@hajj2023; XXX]. These devices, commonly referred to as "wearables," have become increasingly popular due to their portability, convenience, and ease of use. With advances in technology, these devices are now capable of measuring a wide range of physiological parameters, including HR, blood pressure, skin temperature, and physical activity.

→ Übergang

In teaching-learning contexts, physiological measurements such as HR provide researchers with an objective insight into teachers’ affectivity without interrupting the teaching process [@donker2018]. Thus, it is important to monitor HR accurately since this marker may be used to identify an individual’s level of experienced stress during an activity. Research on the reliability of wrist-worn devices for the measurement of HR showed that Fitbit watches are accurate in controlled settings [hajj2023; @fuller2020]. However, some studies indicate that fitbit watches do not meet validity criteria and show a significant decrease in accuracy, especially at higher exercise intensities [@jachymek2021; @jo2016]. @gagnon2022 concludes in his study, that Fitbit devices can be used in research to detect stress-induced HR variation, but they cannot replace an ECG machine when precision is of greatest importance.

## HR as an indicator for arousal

According to the biopsychosocial model, an increased HR is an indicator of a situation that is judged by an individual to be goal-relevant and that requires attention as well as overt or cognitive action which can be evaluated by the person and observers (motivated performance situations; @blascovich1996).

The HR is physiologically regulated and influenced on short-time intervals by the autonomic nervous system which is subdivided into two distinct components: the sympathetic and the parasympathetic nervous system [@pham2021]. An increase in the activity of the sympathetic, known as the “quick response” system, results in the HR being speeded up ("fight or flight"). On the other hand, an increased activity of the parasympathetic as the counterpart and known as the “relaxed response” system, has the effect of slowing down the HR ("rest and digest") [@battipaglia2015].

In addition to the autonomic nervous system and genetic factors, HR is influenced by numerous external factors such as social, personal, psychological, environmental and behavioral factors [@wang2022].

Exercise-induced excitation of the sympathetic nervous system results in activation of the cardiovascular system, which is why an increasing HR can be regarded as an indicator of increasing stress on the cardiovascular system [@junker2021; @kyriacou1978].

choose cardiovascular measures such as HR or blood pressure changes (i.e. reactivity) to index the arousal associated with stress - the higher the HR or blood pressure, the more stressed the individual. [@blascovich1996, 4)

HR differences in different intervals; siehe Junker, Kärner, 10min intervall Paper

## Stress in teaching profession

Facing a variety of stressors during the everyday work, the teaching profession is one of the most stressful professions compared to other occupational groups [@smith2000; @herman2020], which in turn leads to high turnover and premature retirement [@jalongo2006; @unterbrink2007; @aloe2014]. @kyriacou2001 defined teacher stress as "the experience by a teacher of unpleasant, negative emotions, such as anger, anxiety, tension, frustration or depression, resulting from some aspect of their work as a teacher." The response of negative affect is often accompanied by physiological and biochemical changes such as increased HR [@kyriacou1978]. Teacher stress is therefore an important aspect in the way teachers behave and react in the classroom. Considering stress as a biopsychosocial phenomenon [@blascovich1999], it includes in addition to motivational and cognitive components physiological aspects. There are multiple underlying causes of stress, which, however, can be systematized under the integrative framework of the transactional stress model [@lazarus1987; @obbarius2021]. Psychosomatic stress symptoms such as an increasing HR result from an interaction of situational stressors and person-specific available resources [@rotter2020]. The relevance of the issue is based on the fact that, if teachers are exposed to a stressful teaching-learning environment over a long period and do not have sufficient resources and coping strategies, it can lead to burnout [@fisher2011].

Previous research on teacher stress often focused on psychological experience of stress using self-report questionnaires with single item measures (“I find teaching to be very stressful‖”) [@chaplain2008; @goker2012] or questionnaires with multiple scales (e. g. Teacher Stress Inventory; @fimian1990; @liu2020]. There are only a few studies that investigated physiological indicators such as HR as an indicator of teacher stress [@junker2021; @donker2018; @runge2020].