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Social rhythms of the heart

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ABSTRACT
A long-term research focus on the temporality of everyday life has become revitalised with new tracking technologies that allow methodological experimentation and innovation. This article approaches rhythms of daily lives with heart-rate variability measurements that use algorithms to discover physiological stress and recovery. In the spirit of the 'social life of methods' approach, we aggregated individual data ($n = 35$) in order to uncover temporal rhythms of daily lives. The visualisation of the aggregated data suggests both daily and weekly patterns. Daily stress was at its highest in the mornings and around eight o'clock in the evening. Weekend stress patterns were dissimilar, indicating a stress peak in the early afternoon especially for men. In addition to discussing our explorations using quantitative data, the more general aim of the article is to explore the potential of new digital and mobile physiological tracking technologies for contextualising the individual in the everyday.

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> In a place of collection of fixed things, you will follow each *being*, each *body*, as having its own time above the whole. Each one therefore having its place, its rhythm, with its recent past, a foreseeable and a distant future. (Lefebvre, 2004, p. 31)

The hypothesis of this article is that the human heart beats not only as part of the nervous system, but also as part of social life. We depart from the notion that the regular rhythms of everyday life, such as collective eating and resting times, result from millions of seemingly separate time fragments, moments and episodes. According to Lefebvre (2004), a rhythm analyst sees rhythms everywhere in society. Listening to the sounds of the human body, cities and buildings as if he were listening to a symphony orchestra, and putting all his senses to work on diverse data and different fields of science, the analyst learns to recognise the diversity, repetition and forms of everyday life (Lefebvre, 2004, pp. 21–31).

Time, and its measuring and scheduling, are continually being socially re-ordered and adapted, a phenomenon which Thompson (1967) suggests is primarily linked to the deepening division of labour in society. Recent practice-oriented research (e.g. Pantzar &

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Shove, 2010; Schatzki, 2010), on the other hand, has examined temporal regularities in terms of network-like interaction relations and feedbacks. Thus in addition to a focus on empirical time use, time-use research has increasingly become interested in the rhythms of everyday life (Gershuny, 2000; Pantzar, 2010; Ruckenstein, 2013; Southerton, 2003, 2006). As far as we know, physiological stress research and sociologically oriented rhythm analysis have not yet joined forces, although the research project discussed here specifically strives towards this end. The first endeavour is to describe the rhythms of everyday life through a novel means of visualisation, termed here the 'digital electrocardiogram', a goal that resonates with the manner in which the details and dynamics of a galloping horse or a running human were first successfully captured on film and identified 150 years ago (see Bender & Marinar, 2010). We present an experimental research design wherein we tried to identify and visually capture social rhythms, especially those of stress and recovery, by measuring variations in electrical heart signals among 36 Finnish people.

The second research objective was to explore the potential of physiological tracking technologies in viewing the human as a biosocial entity. We found inspiration for research into the social rhythms of the heart in Rose's (2013, pp. 19–20) assertion:

> [I]t is clear that links will not be in terms of the relations of 'body' and 'society' – those enticing yet illusory totalities – but at a different scale. Not in terms of 'the body' or 'the brain' as coherent systems enclosed by a boundary of skin, but of bodies and brains as multiplicities, of the coexistence and symbiosis of multiple entities from bacterial flora in the gut, to the proliferation of neurons in the brain, each in multiple connections with milieux, internal and external, inorganic, organic, vital, historical, cultural, human. Distributed capacities in milieux which vital organisms themselves partly create and which in turn create them and their capacities.

This emphasis on the coexistencies of the external and internal, with attention paid to the forces of vitality, resonates with the new materialist theory focusing on 'choreographies of becoming' (Coole & Frost, 2010, p. 10), which proposes that no definitive division or break exists between living and material systems. Significantly, digital tracking devices have made it possible to apply doctrines of vitality and becoming in empirical research. Self-tracking can link together phenomena that have previously been regarded as isolated, such as the use of time and physiological reactions. This may also enable us to go past and beyond the juxtaposition between the biological and the social because, importantly, as our study demonstrates, the rhythms of individual hearts and society coexist and resonate with each other.

The fact that solutions for monitoring human physiology and activities have recently been vigorously developed in different parts of the world (e.g. Lupton, 2012, 2015; Swan, 2012, 2013), opens a lot of room for methodological experimentation. In practice this can be seen as an attempt to combine very different kinds of data in research experiments, taking a general curiosity-driven approach (DeLyser & Sui, 2012) which challenges the line between qualitative and quantitative research. Somewhat paradoxically, the expansion of measuring technologies in the social sciences to new spheres of life may also mean a narrowing of space for evidence-based truths and instrumental positivism, meanwhile providing added momentum to the performativity and expressivity of quantified data (Ruppert, Law, & Savage, 2013; Savage, 2013). In the section below, we briefly examine the historical and medical foundations of understandings of stress in humans before exploring the most thought-provoking results of our quantitative study.

Defining and measuring stress

The first writings on the stress to humans caused by a rapidly changing society began to appear in the early stages of industrialisation in the late eighteenth century (Rosa, 2003) when pre-modern industrialisation and its effects on people's endurance were becoming a source of concern among doctors. At that time, the term 'stress' still mainly referred to the concept of fracture point in the field of physics, however, and it was not until the twentieth century that the concept became part of biological, psychological and cybernetic terminology. An understanding that emphasised the balance of the nervous system (homeostasis) gained ground after World War II, as doctors started to conceive of the long-term stress suffered by soldiers on the battlefront as the effects of imbalance in the nervous system (Hinkle, 1974; Kugelman, 1992; Selye, 1973).

Today stress regulation is seen as being based on network-like mechanisms and further work has been conducted on this theory by an extensive group of researchers who have tried to find a sufficiently general definition for stress through animal testing (Koolhaas et al., 2011). According to their findings, stress comprises a state where the requirements of the environment exceed the capacity of the homeostatic regulatory system of any organism. Consequently, the major causes and manifestations of stress are connected to situations of uncontrollability and unpredictability, meaning that it is also important to understand the environment and changes in living conditions, as well as internal dynamics, in a dialogical relation to lived life and physiological processes (Koolhaas et al., 2011). This observation inspires the extension of attention, among humans as well as animals, from biological processes to social processes. One could, on the one hand, say that increased complexity and developments in the division of labour have led to a situation where an individual's chances to affect the terms of her/his own existence have become too small (anomia/alienation), thereby leading to stress. On the other hand, stress can be produced when an individual has too many things to control and too little security (values, norms) to be able to produce order (Hinkle, 1974).

In current stress research, the prevailing theories emphasise interaction between the individual and the environment. Without homeostatic mechanisms (hormones, etc.), the balance is shaken and potential health risks are realised as illnesses. As Lefebvre has pointed out, regularly repeated rhythms, at individual and collective levels, are an expression of interlinked routines and practices. In our research design, we follow Lefebvre, working on the principle that people have to adjust to other people's rhythms, a process which involves tension, something that may be reflected on the stress data. As discussed below, our results do support the view that stress is connected to conflicting pressures in the environment and the shocks and surprises that life engenders: in a word, 'arrhythmia'. Stress is an essential part of life, comprising an adjusting mechanism in the human body, and not harmful as such. It can, however, be risky if the heart does not recover from that state. In the following sections, we briefly explore our research design based on heart-rate variability (HRV) measurement.

Methodological considerations

Our research was centrally affected by the fact that we found ourselves taking part in a pre-prepared and well-resourced technology research program that emphasised a normative view of the health behaviour of individuals, mainly aiming to demonstrate that self-tracking technologies promote behaviour change; thus parts of the research design were instrumental and solution oriented. Yet, as explained below, we were able to expand the aims of the research by gathering, along with quantitative stress data, personal accounts of stress and recovery connected to certain moments and activities, in both real time and afterwards, by interviewing our test subjects and discussing their diaries and HRV measurement data with them.

The measuring device used in the study, developed by a Finnish company, Firstbeat Technologies (est. 2002), utilises a technical calculation algorithm to measure stress and recovery based on heart beat and HRV. The key motivation for taking advantage of this type of technology for measuring stress in a research design such as ours is its ease of application compared to assessments based, for example, on measuring the levels of stress hormones in saliva (Semmer, Grebner, & Elfering, 2004) or by monitoring blood pressure (Heaphy & Dutton, 2008). The representation of stress has crucially changed due to new memory-equipped sensory technologies that measure and record HRV. HRV calculation is based on variation of time in milliseconds between two heartbeats and importantly, makes no separation between 'good' and 'bad' stress. Instead, HRV reveals movements and changes between physiological recovery and stress. A change in HRV addresses and reflects the ability of the heart to adjust to changes in external conditions (Acharya, Joseph, Kannathal, Lim, & Suri, 2006; Uusitalo et al., 2011): to put it very simply, the underlying assumption of HRV analysis is that the more stressed the heart, the less it reacts to external conditions, something which is of particular interest when the cause of stress is no longer present (Kettunen, 1999) – that is, when HRV is low yet the pulse is higher than is considered normal. After an athlete has over-trained, for example, or after the high consumption of alcohol, periods are often produced characterised by this state of hormonal imbalance in the nervous system.

The quantitative research data consists of heart-rate measurements among a voluntary test group, comprising healthy, urban and physically active subjects, most of whom were employed, and aged between 28 and 52. The material was gathered in March and May 2012, with each of the two rounds comprising an average eight days of HRV measurement.[1] In the first period we recruited 20 participants, adding a further sample of 20 for the second period. Four of the subjects took part in both rounds and the test results of one of the participants were corrupted, so the experiment culminated in 35 individual participants who were recruited through a number of channels: posting invitations on social media sites, contacting sports teams and snowballing. People with a systematic and disciplined relationship to sports and exercise, or an interest in self-tracking technologies, are particularly drawn to this type of research, and one-third of our total research participants were active in their chosen sports at least four times a week. For the second round, we deliberatively targeted subjects who were less engaged with exercise, inviting, for instance, artists, start-up entrepreneurs and mothers of small children to participate. The test subjects gave us their approval to analyse and present their individual data, but we have anonymised it nonetheless.

After the monitoring period, the subjects received an illustrated report based on Firstbeat HEALTH-software analysis of their HRV, including their own entries about everyday doings. The colours on the report represent stress and recovery measurements. We encouraged the participants to also write their own detailed diary entries during the monitoring period in order to provide a more contextual account of what the self-measuring data could reveal. The participants could freely decide whether they wanted to write in their diaries and what they wanted to share with us (see Ruckenstein, 2014). The Firstbeat report, additional diary entries and interviews after the monitoring period allowed the exploration of possible discrepancies between the HRV data and people's daily experiences of stress and recovery. Because of the many possible interpretations of stress and recovery represented in the report, we arranged sessions, with five to eight participants in each, in which the participants could discuss the stress peaks and recoveries depicted in the images (see Ruckenstein, 2014). These discussions brought to the fore that the information supplied both supported people's experiences of stress and recovery, but also departed from them. In order to understand better the possible discrepancies between reported measuring data and people's subjective experiences, we identified in people's self-reported diaries and interviews incidents (in our material a total of 169) that were characterised by an exceptionally high level of stress or recovery: with a predefined interest, these were the only kinds of incidents that we explored. We return in the end of the article to discuss findings based on those incidents, where stress or recovery was revealed in talk but not by the heart.

The physiological assumptions on which the Firstbeat summary is based rely on certain algorithms and therefore cannot be considered absolute in any way. We accepted Firstbeat Technology's algorithm, developed for measuring stress and recovery, as sufficiently valid for our research purposes, while remaining aware that scientific debate is still actively underway on the connection between HRV and stress. We did, however, diverge from Firstbeat's conventions of measuring stress: our follow-up period was longer than the company standard three days and we were not primarily interested in variations in states of stress at an individual level but, rather, in shared and collective times of stress and in recovery. Ultimately, our research project produced a matrix of tens of millions of observations, which would have been difficult to approach and analyse without the visual user interface, specially developed for the purpose, that enabled us to aggregate data and to compare different physiological states and individuals during different time periods. The crucial aspect of the developed visual tool was its capacity to depict alternative scenarios and events, and to produce numerous iterations for working with, and interpreting, the data.

By visually examining HRV within our test group, we deliberately emphasise the openness of our findings to interpretation (Andersson, Nafus, Rattenbury, & Aipperspach, 2009; Bender & Marinar, 2010; Edwards, Harvey, & Wade, 2010), while also following the conventions of representation in time-use research (Michelson, 2005), chronobiology (Foster & Kreitzman, 2004) and time geography (Ellegård & Vilhelmson, 2004), where visual analysis has traditionally played a central role. In the subsequent section, we examine some of the general features of physical and psychological stress in the weekly and daily rhythms of our test subjects. We also briefly reflect on reasons for the differences they exhibit by considering background variables that may affect stress levels. Following this, we reflect on the avenues that research results based on physiological measurement may open for social research.

Empirical findings

Daily and weekly stress rhythms

Daily stress calculated from the entire body of data, including both weekdays and weekends, was at its highest in the mornings and at around 8 pm in the evenings (Figure 1). On average, daily stress seemed to be at its lowest around 11 am and 5 pm. As we will later see, these times (which are possibly related to customary Finnish meal times) also stand out in the framework of recovery. A third stress peak in the day generally occurs in the afternoon, around 3 pm. It is noteworthy that daytime (on working days) appears, roughly viewed, to be less stressful among our test subjects than evenings. This conclusion is further confirmed when 15-minute intervals exceeding twice the average stress levels for this period of time are brought into focus. This calculative solution (emphasising highest stress levels) seems to work better when the starting point of the research is the common conception of stress as an especially strenuous period.

Thus, the average day of our test subjects seems to be divided by stress periods that occur in the morning, the afternoon and the evening. Could it be that transitions (e.g. to and from work) cause stress? Could stress in the evenings be connected to physical

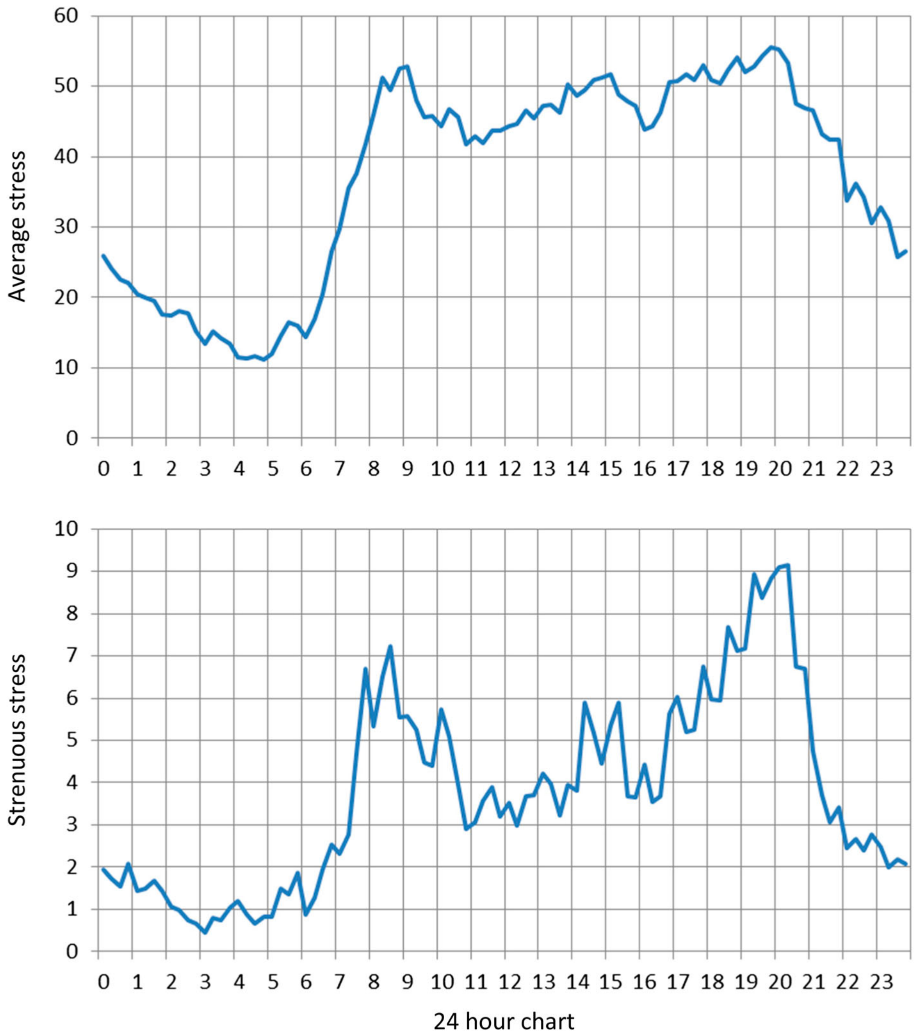

Figure 1. Daily stress. Upper: Average stress values for all the test subjects in 15-minute intervals (measured for each as the share of seconds that exceed the average in each 15-minute interval). Lower: percentage of seconds of stress more than twice as high as the average in 15-minute periods. The 15-minute interval of each test subject is compared to their personal average over approximately 10-day periods.

activity or the tensions of family life? In order to understand the underlying reasons for the results, we next remove the effect of weekdays from the figure, then briefly describe how the test subjects' background (gender, age) affects the stress profile.

As expected, the stress profiles for weekends and weekdays were different (Figure 2). In other words, stress peaks in the mornings and evenings are apparently connected to weekdays, while afternoon stress peaks seem to be connected to weekends. The significance tests also showed substantial variation in stress levels that correlated with the day of the week and the time of day. The overall picture becomes even clearer when we examine the weekly rhythm of stress among our test subjects by gender (Figures 3 and 4). Although the stress levels for both women and men were, overall, very low on Saturdays, there was a stress peak on Saturday afternoons, especially among the men.

To enable comparison, we divided the test subjects into groups of approximately the same size according the following criteria: age (24–33 and 34–52), body mass index (BMI) (19–23 and 24–32) and gender (female/$N = 20$, male/$N = 15$). In light of physiological research, it could be expected that, for example, age or poor physical condition might increase the average stress level (i.e. reduce HRV). Roughly assessed, however, the effects of age or BMI were rather small among our test group, though the impact of physical activity was more notable. Those of our test subjects who were more physically active experienced fewer extreme occasions of stress in the evenings, while extreme stress was divided equally throughout the day among the more sedentary people. We also assessed the effect of having children on the rhythm of stress by comparing those test subjects who had children ($n = 20$) to those who did not ($n = 15$), finding, on average, somewhat higher levels among those who had children, although variations in the stress level were higher among those without.

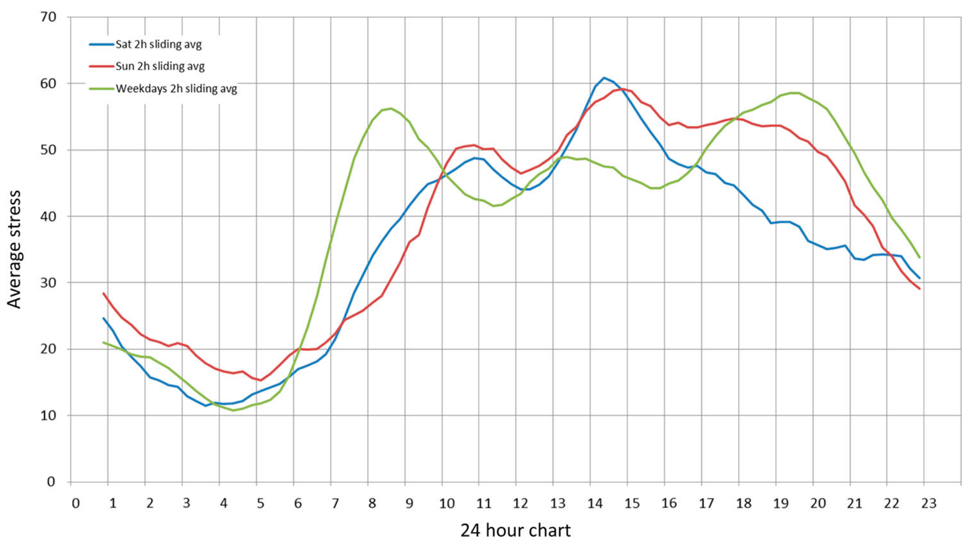

Figure 2. Stress during weekends vs. weekdays (share of seconds exceeding the stress average in 15-minute intervals.

Note: For example, from 8 am to 8.15 am, 53% of the observations per second were higher than the average.

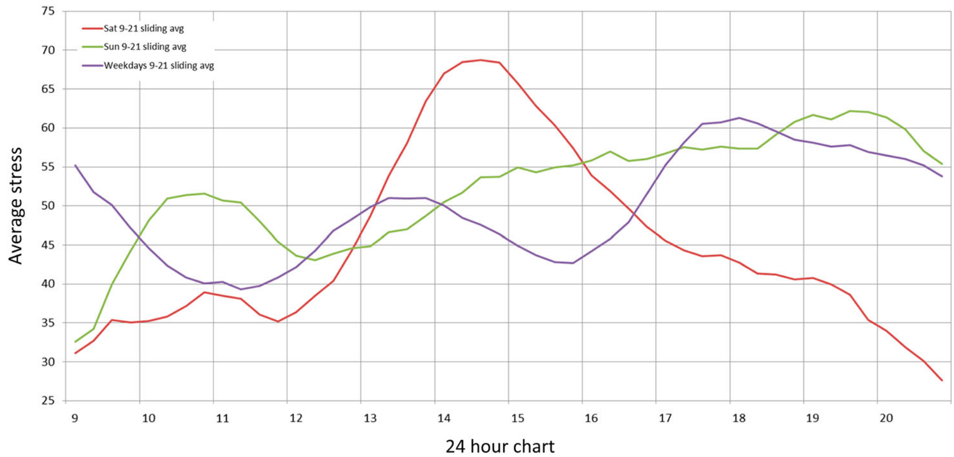

Figure 3. Stress on weekends vs. weekdays among male subjects (share of seconds exceeding the personal stress average in 15-minute intervals).

Daily and weekly rhythm of recovery

As could be expected, night time was the most significant period of recovery for our test subjects with only a little recovery taking place during the day, although the picture changes when we examine the recovery profile between 9 am and 9 pm (Figure 5). There is again a marked difference between weekends and weekdays. On weekdays, recovery seems to be concentrated around lunch and dinner times, and late evenings, while on Saturdays and Sundays, the late afternoon and especially evenings exhibit the most marked recovery periods. In common with the stress profile, recovery on weekends is at its lowest in the afternoon, around 3 pm. Overall, the day (and night) showing the highest recovery levels was Saturday.

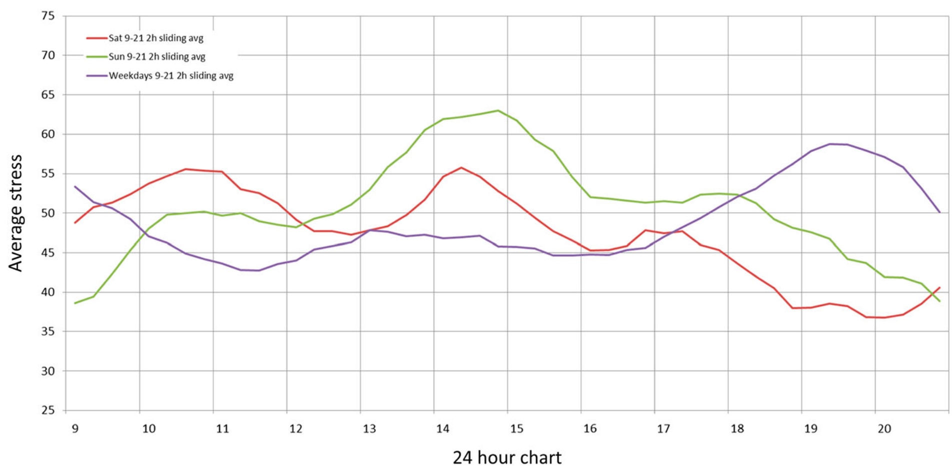

Figure 4. Stress on weekends vs. weekdays among female subjects (share of seconds exceeding the personal stress average in 15-minute intervals).

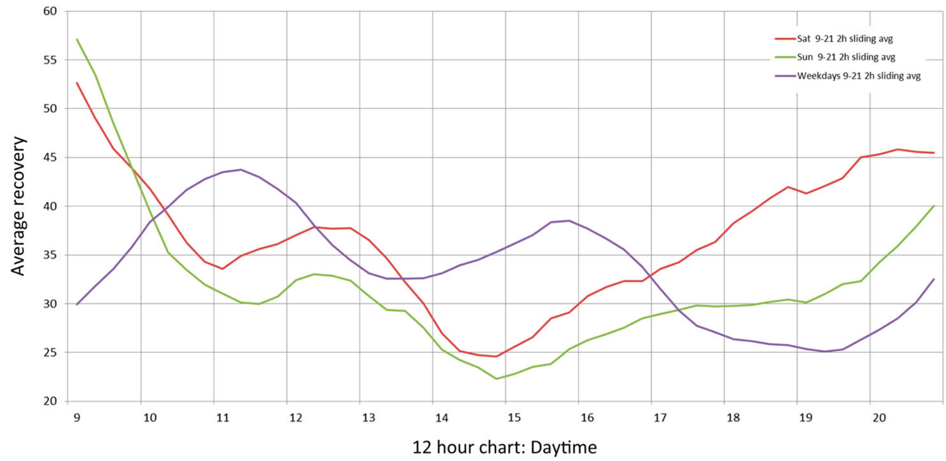

Figure 5. Recovery during the daytime (share of seconds exceeding the personal recovery average in 15-minute intervals).

Although our aim was not to study the data statistically or even to come up with generalisable conclusions, it is useful to examine individual differences in the observations. The greater the differences (deviation) between subjects, the more reason there is for us to believe that the observations are connected to individual factors. Looking at the figures for stress deviation (between subjects), night time appears to stand out especially clearly compared to daytime. Interestingly, in the small hours, around 4 am, the differences between the individual subjects' HRV are at their highest. In the so-called 'hour of the wolf' some of them are sound asleep, while others are apparently awake. The graph on daily deviations in recovery shows that the greatest individual differences are to be found during the daytime and even more so in the evenings.

The different profiles for stress and recovery raise the question of why deviance in stress among our test subjects is greatest at night time, while differences in recovery are greatest during the day. The additional observation that stress has a clear, collective, weekly and daily rhythm, which could not be seen as obviously in recovery, leads us to the main problem addressed by our research, that is, the social nature of the rhythms of everyday life. It appears that the stress rhythms are shaped by broader collective, social scheduling conventions concerning, for instance, sleeping times (see, e.g. European Commission, 2004). Could it be that stress (here measured in HRV) is connected more to the social practices shared by a large group of people (shopping times, times of physical activity etc.) while recovery is more dependent on individual resting habits, excluding sleeping times? If we had been studying entire families, it might have emerged that in families, too, the possibilities for recovery (e.g. naps) are socially determined.

When applying different methods of calculation, we came up with somewhat different results and interpretations. Overall, however, our data did show clear daily and weekly rhythms. In comparison to other weekdays, the stress and recovery profiles for both Saturdays and Sundays were unequivocal, as were the lowest recovery levels on Fridays. Nonetheless, it should be noted that some of our observations may be based on measuring mistakes in the gathering, calculation and interpretation of the data. For instance, we were unable to offer reasons for the stress peak on Saturday afternoon among the men.

We should also point out that we had largely to take the measures as given, and the patent-protected calculation algorithms were not made accessible to us, despite our requests. It is important in terms of a research design such as ours to take a critical view especially when it comes to the analysis of background factors, and perhaps see results mainly as a source of further questions. For example, why are the stress levels of physically active people lower during working hours? Could the answers lie in a strong sense of dignity that affects how people relate to disturbances in the daily rhythm, or in the effects of hard physical training on the functioning of the heart, nervous system and stress hormone?

Discussion

The 'social life of methods'

By iterating data consisting of millions of data points and applying many different calculation algorithms, we could conclude that alternative methods of representation, for example in the measurement intervals and scales, or different calculation approaches (standardising, aggregating, normalising) produced results that were open to interpretation, emphasising the heterogeneousness of both the data and the studied phenomenon. Mike Savage's recent discussion of the 'social life of methods' (2013) offers a reference point for our approach, as his article questioned research conventions and, for example, the strict distinction between qualitative and quantitative methods. Savage (2013, p. 18) emphasises a critical view of 'positivist practices' in empirical sociology, and is quite straightforward in suggesting that the decline of positivism can be seen in a critical attitude towards, for example, survey data and established statistical sampling methods.

Methodological experiments, politicisation of methods choices and an emphasis on historical specificity place importance on the continuously developing, interactive relationship between empiricism, theory and method, on the one hand, and varying ontological commitments on the other. In our case unstructured data led and forced us to continuously re-evaluate our thinking, and yet it is a question of more than a mere methodological transition or new track-and-trace technologies (e.g. DeLyser & Sui, 2012; Thrift, 2011). The conventions of presenting results, for example, are changing along with the emergence of real-time animation technologies. An experimental and innovative research orientation accepts inexact information; reality is always approached partially and imperfectly; and the results are often presented only in visual form instead of via statistical analysis (Simpson, 2012). In this perspective, the primary task of quantitative data is not to produce generalisable information on causal relations, but to place emphasis on the special nature of different phenomena and to reveal, for example, the mutual relations between various biological and social development trajectories that used to be regarded as isolated (e.g. Ruppert et al., 2013). This view also largely coincides with our perception of the significance of our research. The research design, which aimed at a descriptive analysis of collective rhythms, was critical with regards the research entity (to which we belonged) that emphasised a normative view of the health behaviour of individuals. In consequence of this, and as a result of the richness of measurements and data, we succeeded, to some extent, in deconstructing and reconstructing abstract and normative conceptions of stress and recovery, and also in questioning our own preconceptions concerning the value of established discourses of stress, recovery and rhythms of everyday life.

Frade (2013) has reasonably criticised the idea of sociologists 'getting their hands dirty' in new types of data and methodological plurality, noting that researchers are simultaneously taking part in the construction and renewal of a new kind of data-driven power-political agenda. We believe, however, that by collaborating in discussion among established sciences deploying new kinds of research designs one can also challenge dominant discourses and push for new interpretations. Our methodological experiments encourage participation in the diversification of means of measuring phenomena in everyday life by equally taking into account its conflicts, problems and silenced realities, including the problematic of recovery and rest. For instance, based on our participants' reflections, it emerged that subjective evaluation of stress differed from the data deduced from the heart. In this context, it is not possible to discuss the qualitative part of our research in more detail (Ruckenstein, 2014), but we offer few words about our findings in order to open them for further reflections.

How do the heart and mouth speak?

In the qualitative section of research, we identified periods among the test subjects which showed an exceptionally high level of stress or recovery, yet when we studied these moments, whether at work or at home, the heart-rate data and interview data sometimes produced conflicting information. In approximately every fifth identified incident, stress was revealed in talk but not by the heart. These situations were characterised by strong, culturally shared interpretations ('work stress') and strong emotions, such as recollections of personal relationships. In every tenth period under study, stress was expressed by the heart but not in talk. Activities typical of these periods involved transitions between work and leisure and different situations of preparation for upcoming events as well as consumption of alcohol.

Conflicts could also be observed in recovery. The periods where recovery was expressed in talk but not by the heart were characterised by the idea of 'forcing oneself to rest'. Every tenth period under study entailed this conflict. Those periods where recovery was expressed by the heart but not in talk were much more common. They were periods of, for example, routine activities like working at home or in the workplace and, generally, life devoid of surprises at large. Working life may perhaps be commonly experienced as more predictable than, for example, everyday life at home, which coincides with the viewpoint that underscores the 'minefield' of surprises and uncontrollability as a source of stress (Koolhaas et al., 2011). When we discussed these conflicted results with our subjects, they would occasionally offer their own perceptions of how they had found new worth for housework, including ironing or doing the dishes, because it was physiologically connected to recovery (Ruckenstein, 2014).

The results suggested that the heart recognises stress equally in daily life at home and in the workplace though, in public discussion, work stress receives much more attention than, for example, the everyday stress experienced by someone living alone or a stay-at-home parent. This is probably due to the dominance of economic talk in our society, which places more emphasis on the effective use of labour than on, say, good everyday life. Another observation we made with regards research could also be connected to this same phenomenon: research has paid little attention to recovery compared to stress. In both social research and in the physiological research of stress much more attention is given to the negative moments – stress, hurry and forced rhythm – than to moments of recovery and rest. In a similar vein, physiological research of stress has primarily focused on the attack-escape reactions of the autonomic (sympathetic) nervous system and other easily measurable activities. Much less interest has been given to the times, locations and practices of recovery and relaxation (Hinkle, 1974; Kugelman, 1992). This observation is all the more significant considering that stress is not life-threatening as such, whereas lack of recovery certainly is. Permanent deviations in biological rhythms usually signify a pathological condition. Problems with sleep, for instance, are correlated with various health problems including diabetes, overweight or depression (Foster & Kreitzman, 2004; Koukkari & Sothern, 2006). For these reasons alone, the forced and unforced rhythms of daily lives merit more attention in sociological health research.

Our research suggests that measuring technologies, such as the HRV device, can not only overcome problems connected with observing activities, but also with inactivities; for example, bodily movement could offer a new way of identifying 'passivities' (Löfgren & Ehn, 2010) and overcoming the difficult problem of how questions of 'passive activity' are articulated. This could promote new kinds of research designs in the field of health and medicine where activities such as watching TV are typically perceived purely and solely as something negative, correlating to lifestyle diseases (Pantzar, 2010).

What can we learn from rhythms of everyday life?

Biotemporal rhythms and especially variations within a day are a consequence of the network-like structure of the human body and nervous system. In the past, sociological time-use research has been more interested in socio-temporal rhythms (and cycles) which also often involve complex feedbacks (e.g. Zerubavel, 1981); along with new body monitors, however, novel hybrid disciplines can emerge, such as chronobiology, that integrate the empirical research of bio- and socio-temporal rhythms. Chronobiology has identified a large number of biotemporal rhythms in animals (including humans), from microscopically short cycles to those that extend over the entire lifespan (e.g. Foster & Kreitzman, 2004; Koukkari & Sothern, 2006), often with different hormonal (biotemporal) feedbacks to be found in the background. For example, with human beings the levels of the so-called stress hormone, cortisol, vary within the day, reaching their highest in the morning and becoming increasingly lower in the course of the day (Semmer et al., 2004). Rhythms of stress and recovery can therefore be seen as products of the coupled effect of human physiology and cultural processes.

It is also known from time-use sociology that conflicted expectations and the need to 'juggle' different rhythms of everyday life seem to increase an individual's experience of stress (e.g. Southerton, 2006). Such critical moments could consist, for example, in preparing for a vacation or a party. In a study carried out by Southerton (2003) based on interview data, times in a person's life appear to be experientially divided into 'red moments of stress' and 'blue moments of recovery'. In this example, the red moments are linked with preparing for events such as the weekend, a work trip or Christmas, while the blue moments represent the pleasure of enjoying the fruit of preparations.

Focusing on the physiology of the heart offers a clear contrast to the sociology of everyday life, where the phenomenological or constructivist aspects have had a prominent role. Contrary to the views propounded by many theorists of everyday life (e.g. Gouldner, 1975), the heart does not make a distinction between, say, a 'disalienated' lifeworld and 'official' systems (for the distinction, see Highmore, 2002). A notable conflict that we came across in our research was that the heart (body) and mouths (culture) of our test subjects were not always 'speaking the same language'. In other words, HRV and subjective interpretations of stress were sending mutually contradictory messages. For this reason alone, it would be useful for social scientists to become better acquainted with human biology, and medical doctors with the social sphere.

In the future, combining, for example, time-use research and 'cardiograms' might produce a whole new kind of insight into the conditions and consequences of human everyday activity. Tools that have initially been developed for professional use will establish themselves as a natural part of individuals' everyday life and self-monitoring practices (Pantzar & Ruckenstein, 2014; Ruckenstein & Pantzar, 2015). This means, on the one hand, that medical interpretation and vocabulary will gradually approach the sphere of 'ordinary people' (Beaudin, Intille, & Morris, 2006), while, on the other, 'personalised medicine' (Swan, 2013) will present its own challenges to the medical profession, as people become 'lay experts' on health conditions. Closely corresponding with this, the scope and focus of methods used in social research should also be widened.

Conclusions

With our research project, with its aim of describing and visualising the rhythmic movements of stress and recovery, we wish to contribute to a wider biopolitical endeavour and a turn towards New Materialism to recognise the social dimension and performance of the human body, especially the heart. Our study forced us to evaluate measuring practices and the value of digital data from multiple perspectives. The quantitative and qualitative results supported each other to a certain extent, while also splitting out in different directions.

The quantitative results offer a new kind of access to human life, continuing the history of conquering unknown regions by opening the pulse of human physiology, in this case the heartbeat, for inspection (Haraway, 1998). As a practice, this type of measurement means chopping and breaking everyday life into parts, rendering particular slices of human life visible, and thus requiring us to take a stance on them. This approach to measuring is also an intervention, because it produces information by sketching out unforeseen dimensions. However, instead of pursuing the goals of universal applicability or reproducibility, our research design strove to reveal the conditions of research of this type, paying attention to what they restrict and enable.

With such a difficult, challenging and laborious research project the learning curve was considerable. Inspired by the discussions that have been raised by the approach outlined in Savage's article on the social life of methods (2013), we want to underline how by 'getting one's hands dirty' one can critically assess the established and rigidified epistemological and ontological commitments linked to health research. We also discovered how methods constrain research participation: some people are eager to quantify their existence by even the most peculiar and strenuous means, while others would under no circumstances subject themselves to measurement of their everyday, intimate lives.

When we started our study the hypothesis was that the human heart beats not only as a part of the human nervous system but also as a part of human social life. We ventured to study social rhythms by using body monitors developed in the field of sport physiology, having to take a lot as given, both when it came to measuring technology and interpretation of the calculation algorithms. Despite different methods of calculation and failures therein, our initial perception was confirmed as the research project proceeded. Recognising the connection between the cyclical processes in the human body and states of balance or imbalance in the metabolism or heart beat can be problematic in science in terms of a division of labour. In highly simplified terms, the 'autonomic' or 'sympathetic' nervous systems have not been a matter of concern for social scientists any more than the causes of daily stress have been for the medical profession. Yet, human biology has come to the fore in recent years in the social sciences along with developments in medical science and new theories on corporeality (Coole & Frost, 2010; Freese, Li, & Wade, 2003; Rose, 2013). The development of data and storing technologies has, and will continue to have, an essential impact on this development. What is happening is not merely a question of a 'sensory revolution' (Swan, 2012) or a new 'age of data' (Bowker, Baker, Millerand, & Ribes, 2010) but of a more profound change which will hopefully find a more solid place for the human body and nature in the social sciences. The essential thing is to recognise not only the opportunities provided by new mobile and digital instruments but also the preconditions they entail. For social scientists, this calls for a curious and unprejudiced attitude and a commitment to becoming involved with and affected by new types of data and research methods.

Note

1. The HRV monitor (electrodes) was attached directly to participants' chests at two points: the device needs to be removed only during water sports and when showering.

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No potential conflict of interest was reported by the authors.

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