

Enhancing wellbeing through psychophysiology

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Inaugural lecture
Prof. Joyce Westerink
June 24, 2016



/ Department of Industrial Engineering & Innovation Sciences

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Technische Universiteit
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Enhancing wellbeing through psychophysiology

Where innovation starts

Inaugural lecture prof. Joyce Westerink

Enhancing wellbeing through psychophysiology

Presented on June 24, 2016
at Eindhoven University of Technology

Psychophysiology & wellbeing

Psychophysiology is concerned with the link between the inside and the outside person, or rather between the mind and the body. Psyche – the mind – was a Greek king’s daughter who was in love with Love itself, and although that was euphoric at times, it was not always easy, and her mind was tormented for quite some time. Physis – the body – on the other hand, is the Greek word for nature and natural function. It is concerned with things that you can see, that are observable. I like the word psychophysiology a lot because it unites both elements, the body and the mind, and describes how the status of the mind is reflected in changes in the body.

Folk wisdom has always underlined this link between body and mind. We all know sayings that express this relationship, for instance: my eyes opened wide in amazement, my heart jumped for joy. Eastern religions have advocated the mutual influence between the two as well. They have become more and more popular also in our western culture, even though that has traditionally tried to separate body from soul, and reason from emotions. Personally, I like this unified view on humans, which combines body and mind, since I believe that it will ultimately help us to improve our wellbeing. This belief is linked to a few trends in society and technology where I think psychophysiology can help to improve our lives.

Trends in society

If one compares our present society with how things were let’s say a hundred years ago, there is no doubt that most of us would agree that we have made enormous progress meanwhile. Children stand a better chance of reaching the age of 10, men and women live longer, and in general we work less and in better circumstances. Hans Rosling (2009) is known for his inspiring and entertaining TED talks making this point among others. Nevertheless, we all also agree that the present society, more than at any time before, puts unwaning pressure on most of its members, exacting them to be alert and contribute on a 24/7 basis. This is what Emile Aarts (2013) referred to in his inaugural lecture a few years ago as ‘always on’. There is constant pressure in daily life, and there are substantial numbers of people with mental disorders, including stress and depression, also in developing countries (Wittchen et al., 2011; APA, 2015, IHME, 2016). In addition,

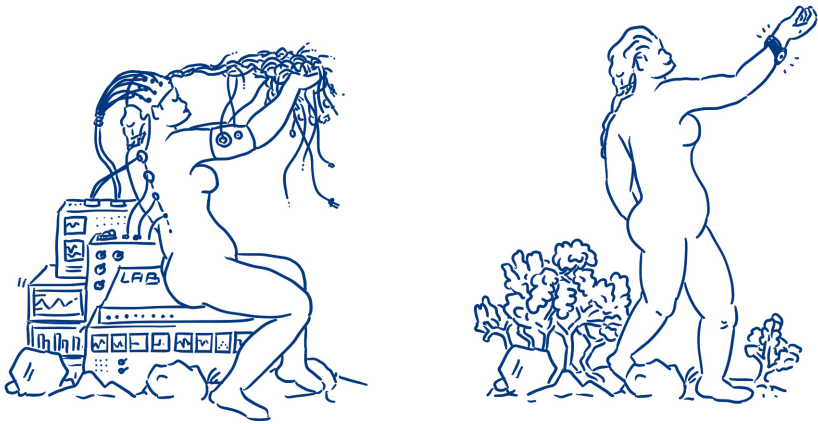
medical science has succeeded in giving us longer lives, sometimes by turning lethal diseases into chronic ones, demanding us to manage and mentally deal with the burden of disabilities. All in all, we can identify people's mental wellbeing as a topic of concern in our lives today.

So when we intend to support the optimization of wellbeing, one of the first steps is to be able to measure it, preferably in an objective and unobtrusive way (Westerink et al., 2011). This is exactly the domain of psychophysiology. While physiology in general investigates any changes in our body, psychophysiology is only concerned with those that are related to changes in our mental state. And of those, by and large, two types exist: cognitive and affective aspects. Our cognitive – thinking – processes can indeed be reflected in our physiology, for instance when one is very focused on a difficult task, and we squint our eyes. Our affective processes have to do with emotions and moods. Also they are reflected in our physiology, for instance when our heart pounds from fear, or our jaw drops in surprise. A nice illustration is the work on emotional film clips with Egon van den Broek (Van den Broek, 2009), in which we showed that the waxing and waning of emotions is reflected in the activity of, for instance, our facial muscles.

These affective aspects are important for our wellbeing, that is, how positive and balanced we feel. Diener et al. (2009) define subjective wellbeing as 'a person's cognitive and affective evaluations of his or her life [...], including experiencing pleasant emotions, low levels of negative moods, and high level life satisfaction.' Thus wellbeing is related to both variations occurring throughout the day – moments of joy or anger or disgust – as well as to more stable manifestations, such as when we feel happy or depressed. Links to many other aspects of wellbeing have been made. To eudemonia for instance, when 'one has a sense of purpose and a positive engagement with life' (Heller et al., 2013), but also to the opposite state of stress and burnout (De Vente et al., 2015): All seem to have an impact on (or are themselves impacted by) the physiology in our body. Thus psychophysiology can support our quest to improve wellbeing by measuring it in an objective way (Westerink et al., 2012).

Trends in technology

Traditionally psychophysiological measurements need dedicated equipment, often with electrodes attached to your skin, and wires between those electrodes and the device. This used to be a setting that restricts psychophysiology measurements to the lab, or to an occasional ambulatory measurement in the real world. But recent advances in technology have made it possible to measure one's heart beat or



sweat level in daily life situations. Optical heart rate technology has become available that allows us to measure heart rate by means of a wristband, and the same holds for the monitoring of skin conductance. This not only allows us to do research in real life instead of in the lab, but it also promises that we can deploy the psychophysiological measurements in wellbeing applications that people can bring into their home, for instance when monitoring their wellbeing levels themselves. It will generate a lot of data, not only for the individual, but certainly also for society as a whole. This links to the trend of big data, where objective physiological measurements of wellbeing will not only inform the individual but also support the generic understanding of wellbeing, and of ways to improve it.

So this is the big picture: present advances in technology allow us to gather real-life data of various body signals, these signals reflect, to some extent, how we feel, and knowledge about this mental state is the basis of any attempt to try and improve our wellbeing. In the remainder of my talk, I will draw your attention to four application areas I foresee, four little pictures if you want, that each in their own way attempt to deploy psychophysiological measurements to enhance wellbeing.

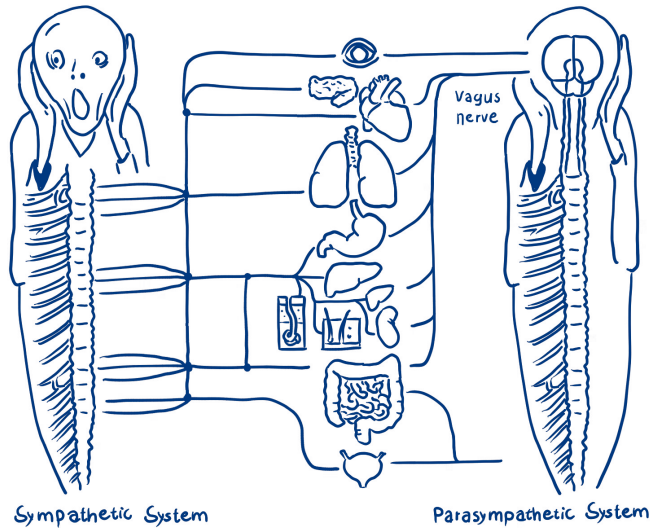
Stress awareness through monitoring

“The fact is that man can be intoxicated with his own stress hormones. [...] To watch our stress-level is just as important as to watch our critical quota of cocktails” Selye, 1950, p.265

Stress is one of these states of non-wellbeing that most of us complain about from time to time. We use the word stress to mean several different concepts: stress as a feeling or mental state, stress as the external cause of this feeling, and stress as a biological reaction (Vingerhoets, 2008). It is important to make a clear distinction between stress on the one hand, and a stressor on the other hand: a stressor basically constitutes a situation that is perceived to be demanding, like a lion on your doorstep, a deadline that needs to be met, but also the anticipation of a speech to be given. Stress then, in its turn, is the state of body and mind in reaction to a stressor, how one may feel nervous or shaky.

There is also a distinction between short-term stress and chronic stress. Short-term stress is the temporary reaction of our body and mind to a demanding situation, a stressor (McEwen, 1998). It is basically a good thing because it recruits resources to deal with the problem at hand: it helps us to escape from the lion, to finish the report on time. But these periods of short-term stress should be alternated with sufficient periods of relaxation, otherwise our body and mind will adapt to our stressor-rich way of life, and this adaptation reduces our capabilities. This adaptation is a process termed allostasis by McEwen (1998), a sort of homeostasis, but then at another, less optimal working point. The result is what is called chronic stress, leading to burnout, and certainly something that should be avoided.

There are two main regulation pathways in the body that are related to stress. One is termed the HPA axis, and it constitutes the chain of endocrine reactions that involves hormones, like cortisol and adrenocorticotrophic hormone (ACTH), generated at the Hypothalamic, Pituitary and Adrenal glands (Pariante, 2003). Measurement of the activity of this HPA pathway still requires laboratory assays, and those do not allow real-time measurement in everyday life yet. Therefore the focus will be on the other stress-regulation pathway, the Autonomic Nervous



System (ANS). It consists of all the nerves that innervate our organs, from the tiny sweat glands in our skin, to our hearts and lungs. Two innervation systems are distinguished. The first is called the sympathetic nervous system, and it can be considered our gas pedal: it is related to the so-called fight-or-flight stress response of our body, and prepares all organs for immediate action if needed. This is why our hands get sweaty under emotions and stress, why our heart starts racing, and our breath shortens. The second system is constituted by the parasympathetic or vagal nerve. This system is commonly referred to as our brake pedal, since it stimulates moments of relaxation in what is called a rest-and-digest reaction. Most of our organs are innervated by both systems, and it is the interplay of sympathetic and parasympathetic systems that determines to what extent these organs are active, e.g. whether our heart beats fast or slow.

Stress monitoring

At Philips, my colleague Martin Ouwerkerk and our team have developed the Discreet Tension Indicator (DTI), a wearable device that measures one of these sympathetic parameters, namely the sympathetic activity in your sweat glands (Ouwerkerk et al., 2013; Westerink et al., 2009). This parameter is measured as the conductance of your skin, for instance at your wrist. Skin conductance has been proven in numerous laboratory studies to be related to emotional arousal, and for this reason we assume it might be able to reflect the arousal component in short-term stress as well. An example of such a skin conductance pattern as

tracked during the day is a recording of an afternoon off as I went to the dentist and later decided that I needed to snoop into my teenage son's stuff. As expected, at both moments there were clear skin conductance peaks (Westerink et al., 2014). But what surprised me afterwards were their relative sizes, which gave me a clear insight that my conscience was bothering me more than the visit to the dentist. Tracking the moments of stress during the routines of one's week could therefore give people insight in the causes of their stress, and a hint at what they could change in order to manage their stress levels.

In cooperation with Natalia Sidorova (TU/e) and her team we investigated in a sample of teachers at a vocational school whether the DTI could serve this purpose. Skin conductance measurements were analyzed after a recording period of 7 weeks, and they revealed that several activities were more stressful than others. When presented with this analysis, the participants indeed indicated it made them more aware of moments and causes of stress in their schedules, and also of the beneficial effect of certain remedies, like a clear lunch break (Kocielnik et al., 2013). Also with Kristina Höök (SICS) and her team we cooperated in investigating whether skin conductance monitoring could bring about stress awareness. In this case, though, we did not present stress-interpretation data at the end of the experiment, but instead we presented real-time skin conductance data without further stress interpretation. In order to facilitate the interpretation by the users themselves, we provided the option of annotating any peaks or events with a short description. Also in this case, some of the users were enthusiastic about the results, sharing their daily patterns through Flickr and Facebook with friends.

While these experiences clearly show potential, they also indicate a few areas that warrant further research. One of them is the question to what extent precisely these physiological signals can capture perceived stress? While the link between skin conductance and emotional arousal has been established, that does not necessarily imply that the relation with stress is of a similar nature. This is easily understood by considering that emotional arousal can be positive or negative in nature, that is, it is independent from valence, while stress is always perceived as negative. A similar question applies to other psychophysiological measures like heart rate, and heart rate variability (the variation in individual heart beat lengths), which are both described as being linked to stress as well. Literature about the accuracy of stress estimations from these signals give varying results, depending on aspects like the number of classification categories (the fewer the easier) and the ecological validity (measurements in the lab have less noise). In a



stress experiment we did at our own lab, using a combination of skin conductance and heart rate signals, my colleague Gert-Jan de Vries was able to classify three stress categories with 88% accuracy (De Vries et al., 2012). In this particular case the categories were based on the tasks we required the participants to do, but it would be even nicer if we could relate the psychophysiological parameters directly to the level of stress people feel, for instance, as assessed with standardized questionnaires. In this case we take the subjective, perceived stress in the mind to be the ground truth, and we search for a combination of objective physiological parameters in the body to accurately reflect it. One could argue this implies that we put more trust in the truth of our minds than in the truths in our bodies. This is basically a reflection of Descartes adagium ‘cogito, ergo sum’, highlighting the importance of the rational mind. Damasio tried to correct this view, with his book ‘Descartes’ error’ (1994), by emphasizing the relevance of emotions and their bodily reflections.

Stress awareness

Stress detection accuracies of 95% would be great as an achievement, but it is the question whether a product would be useless if the stress detection was not always correct. I think the crucial element here is that the stress indications given by the system have to be in line with what a person thinks, or recognizes, at least in a certain percentage of the cases: often enough to build user trust in the output of the system so as to take its measurement seriously. It is an interesting research

question, which percentage is still acceptable as a minimum. But the paradox is that if the algorithm were to be correct a 100% of the time, there would be no difference between the output of the stress monitoring application and the judgments of the user. In that case, the application can only tell the user what he already knows. That might be handy for automatic tracking purposes, but it would hardly generate any additional insight.

Another question that pops up is whether this awareness is actually a good thing in itself. It is believed that knowledge of the personal patterns of stress over the day might bring insights that allow the user to adapt his routines. This reasoning fits in the Stage-based Personal Informatics model (Li et al., 2010), which is applied to the gathering of any form of information for personal introspection and subsequent action. With PhD student Els Kersten – van Dijk we have established that although there is ample evidence for the effects of monitoring, and although these effects mostly are positive, there is little proof yet that it is insight itself that is mediating these changes. And the case of stress could be the exception, since one could easily imagine that repeatedly confronting users with the fact that they are stressed, or are getting stressed, will only stress them even more. So further research is warranted to prove that monitoring stress indeed helps users to manage their stress levels, and also to establish whether this improvement – if it does exist – is generated through insight or through another mechanism. In any case, laboratory tests on stress have shown that monitoring psychophysiological parameters does indeed have an influence on the perception of stress: the correlation between a person's measured heart rate and his self-reported estimate of his stress level is not that high, but it increases if the person is given his heart rate measurement as a feedback (Van Dijk et al., 2015). This happens independently of whether it is presented as a simple heart rate measurement or as a measure of stress.

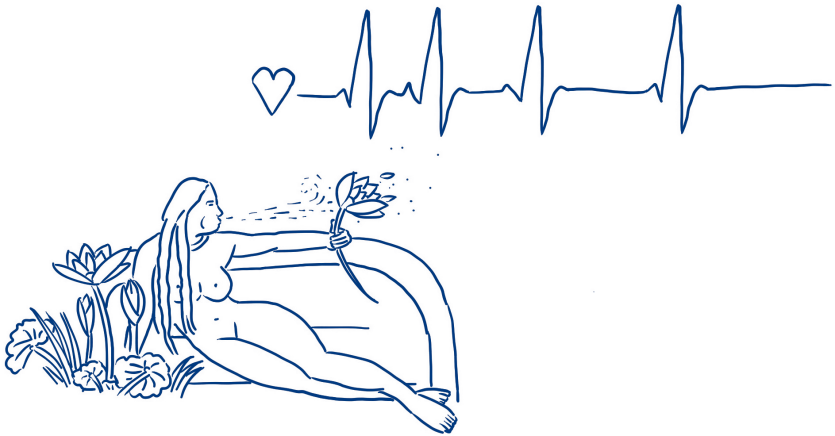
So while measuring the arousal in our body is becoming feasible, we still need to deepen our understanding of what this means for stress, and whether stress awareness in itself can help us to bring more balance in our lives.

Mental fitness through biofeedback

Whether stress-aware or not, wouldn't it be nice if we could train our mental wellbeing as if we were in the gym? In the last few decades, the field of positive psychology has indeed focused on the positive and normal mind states, rather than on the exceptional disorders (Seligman & Csikszentmihalyi, 2000). Simple things, like writing a letter of gratitude to someone you appreciate, prove to have a positive influence on your wellbeing (Toepfer et al, 2012). Also the field of mindfulness (Kabat-Zinn, 1994), a technique of being aware of the present moment only without worrying about the future or the past, has brought significantly less stress and pain to those who practice it. These examples serve to show that the concept of training your wellbeing has gained full recognition as a possibility to enhance life.

Breathing exercises

Also in the field of psychophysiology there has been attention to bodily exercises that enhance your mind. One of the few ways in which we can influence our autonomous nervous system is through breathing. While our breathing is normally under the control of the ANS, we can regulate our breathing pattern – within certain limits – by paying conscious attention, and then the rest of the body reacts to it. For instance, when we breathe at a regular slow pace of for instance 6 breaths per minute, our heart rate will vary in exactly that pattern (Vaschillo et al., 2006): when one breathes in, the pressure on the chest increases, and the heart reacts by ejecting just a little early, thus increasing the heart rate – when breathing out, the reverse happens. In this way, the variability in our heart rate can be increased, at least temporarily. Now it is known that a high heart rate variability is a sign of good health (e.g. Tsuji et al., 1994), and it is understood as allowing an optimal cooperation of sympathetic and parasympathetic nervous systems in demanding situations (Lehrer et al., 2000). And indeed, paced breathing has been found to be beneficial to people with various diseases, including hypertension and mental ones like stress and anxiety (Cernes & Zimmlichman, 2015; Meier & Welch, 2015; Clark, 1990).



Paul Lehrer has taken paced breathing to the next step of HRV biofeedback, exploiting the measurement of the heart beat signals to optimize the breathing pattern (Lehrer et al., 2000). When the user can see that his heart rate is at a minimum, he can take this as an indication to breathe in again, thus carefully bringing the cardiovascular system in resonance, and achieving maximum heart rate variability. Lehrer has found that this resonance frequency is different for everyone, and stable over time, suggesting it is indeed a characteristic of one's body. Usually the optimal breathing frequency is found to be between 4 and 7 breaths per minute.

Theoretically, it is not necessarily the case, even if the physiology of the body reflects the mind, that the improvement of that physiology will then lead to an improvement of the mind. Nevertheless, several studies with HRV biofeedback have shown that indeed HRV improves after a few weeks of 10 or 20-minute HRV sessions daily, and with it people indicate they feel better. Moreover, mention is made of some form of retention, which makes the positive effects last a few months after the last exercise (Wheat & Larkin, 2010). Literature on this is still relatively scattered, and could do with more replications in controlled studies.

And then, of course, there is the question how easy it is to comply with the strict schedule of daily exercises, even if they take only a few minutes of your time. We investigated to what extent paced breathing would be effective and adhered to in real life. This research was done in the context of a dedicated wrist watch, called the Vitality Bracelet (Westerink et al., 2014), which could, among other things, pace a fixed breathing pattern. Participants were offered a similar paced breathing

application, and they were informed that doing daily 10-minute exercises would relax them and be beneficial to their health. Nevertheless, it appeared that in the 6-week test period an exercise was only done every two days on average, with only one of the twenty participants reaching full adherence (Van Beek et al., 2012). Possibly as a consequence, no positive effects of the sloppy practice of these exercises on blood pressure were found. This stresses not only the need for additional evaluations in practical situations but it also underlines the importance of making these exercises pleasant and attractive in their own right, and preferably also instantaneously beneficial.

All in all, paced breathing and HRV biofeedback exercises have the potential to improve our wellbeing, but they need to be incorporated into one's lifestyle, and adherence is not achieved easily.

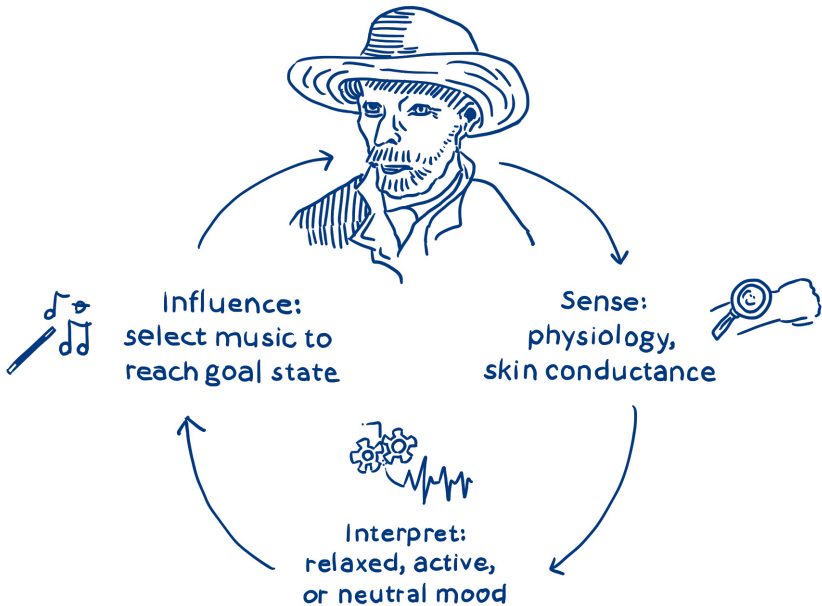
Effortless mood improvement

A step beyond awareness and biofeedback exercises would be if we could improve our moods automatically and effortlessly, not requiring any exercises that need to be adhered to, yet under our full control. One idea is to regulate one's mood as good engineers in the form of a closed feedback loop (Van den Broek et al., 2015). It is different from traditional biofeedback, in that the biofeedback requires a person's attention in order to be effective, whereas the closed loop does not. One only needs to indicate in advance in which direction the loop should guide one's mood, most likely towards a more positive state. In order to be effective, a closed loop system does require a parameter that measures our current mood or mental state. Both the current state and the goal state are expressed in terms of this parameter, and the system compares them to see whether the goal state has been reached already. If not, then a certain stimulation is chosen, of which it is expected that it will help to bring the user's mood further towards the goal state.

Closed loop with music

In order to implement such a closed loop, a first step is to identify a psychophysiological parameter that is capable of reflecting our mood state. The skin conductance signal that has been present in the preceding applications is known to be especially linked to arousal, that is, the level of (positive or negative) excitement of a person. When taken as a steering parameter, it can be expected to direct the arousal level of a user, not necessarily making him feel more positive or negative, but at least making him calmer or – the opposite – more excited. In addition to that, a way to influence someone's mood has to be selected, and music is a good candidate: Most of us regularly use music deliberately to bring ourselves in a different state of mind.

The principles of such a system have been investigated with PhD student Marjolein van der Zwaag; we called it the Affective Music Player (Van der Zwaag et al., 2013). One of the crucial components appeared to be the personalization of the music choice: what I personally might consider to be stimulating music might be put aside as sleep-provoking by some of the members of the younger generation. For each song the user listens to, the system measures and records the associated change in skin conductance level, and multiple presentations of the



same song are averaged to generate a most likely result of any future presentation of that song. It divides the user's personal music library into songs that will mostly increase his skin conductance level, and those that will mostly decrease it. Because of the averaging procedure, this classification is robust against external disturbing factors. Thus the effects of these songs can be measured in real life, even if this means that every now and then the skin conductance is also influenced by other things than the song only, like an outside stimulus that interrupts the listening experience. The Affective Music Player concept was put to the test in a real-life experiment, using the participants' own personal music databases, and their normal office work and environment as a test-bed. Songs selected as more exciting indeed produced higher skin conductance levels in comparison to the songs selected as less exciting and, what's more, participants also indicated they felt more aroused and excited afterwards, thus proving that the closed loop principle can work.

Even nicer would be an Affective Music Player 2.0, if it could adapt your mood to become more positive when you feel down. In order to do so, a physiological parameter is needed that reflects valence, that is whether one feels positive or negative. With PhD student Thérèse Overbeek we compared a number of psychophysiological measures for their ability to reflect the valence of various

emotions (Overbeek et al., 2012). As expected, the electrical activity of the Zygomaticus muscle, the laughing muscle, is a very good indicator of how happy or positive we feel. Unfortunately, electrodes are needed for measurement – right in the middle of one’s face, probably not a way to really make people feel better. Therefore, it was also investigated whether heart rate changes could indicate valence, since heart rate can be unobtrusively measured with a wristband or a patch on your chest (Parak & Korhonen, 2014; Lobodzinski & Laks, 2012). Unfortunately, heart rate variability did not appear to show any link to emotional valence.

Closed loop with direct stimulation

Another avenue that might lead to effortless mood enhancement is through direct stimulation of the body. This dates back to the century-old argument between James & Lange on the one hand and Cannon & Bard on the other (Dalglish, 2004): whether emotions are born in the brain and subsequently propagated into bodily changes, or whether the bodily changes appear first, and the awareness of an emotion only results as they are perceived. Nowadays, the consensus is that both views have their merit, and that at least the emotional experience is modulated by awareness of bodily changes, thus suggesting that it is possible to influence one’s emotions by inducing bodily changes. While everyone knows that people tend to smile when they feel happy, it is interesting to note that also the reverse is true: people who force their lips and jaws into a smile, for instance by clenching a pencil between their teeth, indicate they feel more positive than a control group (Strack et al., 1988). It is along such lines I am waiting for the first products of the kickstarter Doppel project, which promise relaxation by constant



vibrational stimulation at a low heart rate at the wrist (Doppel, 2016), the idea being that through feeling a low heart rate, one is convinced one is relaxed. Indeed, Anishchenko et al. (2000) have found that it is possible to entrain one's heart rate through external stimulation, in his case by means of audio-visual stimulation. However, the range over which entrainment can be done effectively is only small, between $\pm 5\%$ of one current heart rate. Nevertheless, this would allow for a slow continuous adaptation to ever lower heart rates, at least within the boundaries of physiological variability.

These examples show various routes to effortless mood improvement, well worth further research and optimization for a range of use scenarios. As implications for long-term use have not been touched upon yet, and as it is important that user control is clearly implemented in these applications – especially since no human effort is needed –, continued investigations in this field will be very interesting.

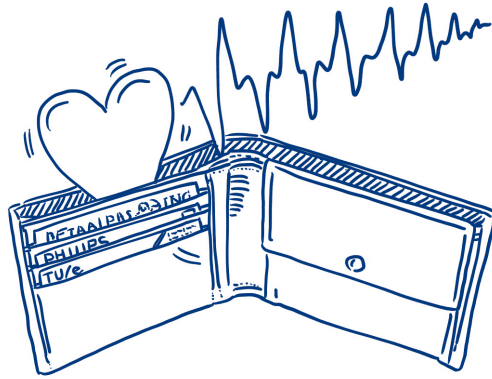
Psychophysiology in communication

“Fill your paper with the breathings of your heart” Wordsworth, 1812

While we have so far discussed how psychophysiological technology might support individual persons in enhancing their wellbeing, it is also useful to see which role psychophysiological signals can play in a social context, or more precisely, in communication between people. After all, social interactions can substantially determine our moods and emotions, sometimes in a positive, sometimes in a negative way. The World Health Organization accordingly identifies the social aspect, in addition to mental and physical health, as a third component in our wellbeing (Grad, 2002).

Conveying psychophysiological signals

Important element in our social interaction are our emotions, as expressed in our face and in our body language (Ekman & Rosenberg, 1997; Kleinsmith & Bianchi-Berthouze, 2013). They allow us to gauge the reactions of our conversation partner, and we can deploy this information to optimize our communication. Along this paradigm, Rosalind Picard, the godmother of the field of Affective Computing, has provided autistic persons with emotion estimates from facial expressions of their conversation partners, helping them to interpret their emotional state (Madsen et al., 2008). With PhD student Joris Janssen, we made a comparison between the ability of humans and computers to detect emotions from the face and words of another person (Janssen et al., 2013a). If this person speaks in a language one doesn't master, human emotion recognition is not flawless: the five emotions Sad, Angry, Happy, Relaxed, and Neutral can only be correctly recognized in 31% of the cases on average. Obviously, this gets better if both persons speak the same language, up to a correct recognition accuracy of 58%. Computers, using audio and video signals as input, and using Support Vector Machine (SVM) classification, appeared to perform comparably at 65%. However, if the computer has access to physiological signals of heart rate, skin conductance and skin temperature, the accuracy is slightly higher (78%). This suggests that if we gave a computer access to our psychophysiological signal, it would be at least as accurate as a human in its understanding of our emotions.



It was also explored what benefits humans would experience if they would get access to someone else's psychophysiological signals, in particular heartbeats. Hearing the heartbeat of another person is normally something quite intimate, and we wondered whether this would also be the case if we would hear the heart beat through a loudspeaker. In an experiment in a Virtual Reality world, participants were asked to walk up to a person some 3 meters away, and stop at the distance they would feel comfortable for half a minute (Janssen et al., 2010). When the participants heard the heartbeat of the other person, they kept more of a distance than in silence. They also indicated that the sound of the heartbeat brought more intimacy with this unknown person, for which they compensated by keeping a larger distance. We conclude that heart beat sounds can at least bring a feeling of intimacy. Also when romantic couples are given the opportunity to see the heartbeat of their partner visualized on a display, they indicate it brings them a feeling of presence, like a living version of a photo in your wallet (Slovák et al., 2012)). On the other hand, they also indicate that it is difficult to interpret the changes in heart rate if their partner is not around, because of the lack of context, as is the general credo of my colleague Yvonne de Kort (2015). Even though they would generally interpret an emotion as more intense if the heart rate is higher (Janssen et al., 2013b), in real-life use, there is a lack of certainty that a heart rate increase is indeed caused by an emotion, and not by for example fitness exercises.

Comparing psychophysiological signals

While in the above examples the processing of the psychophysiological signals is still applied to individuals, other research has attempted to directly compare the signals of two or more persons. It has been reported that in interactions between people, their physiological signals tend to be in synchrony to a certain extent (e.g.,

Henning et al., 2001). This was observed, for instance, for married couples discussing their marriage and relationship problems, and synchrony appeared to be better if the discussion was more heated and intense (Levenson & Gottman, 1983). Also Marci et al. (2007) found a clear synchronicity between the skin conductance signal of a patient and that of his psychiatrist, but here the level of synchronicity was related to the extent to which the patient had liked the contact with the psychiatrist during the session. Since this empathy is important for the effectiveness of the therapy, Marci et al. suggest that measured synchronicity could be used to train therapists. We could even think of a feedback system, showing them the synchronicity level, and thus allowing them to synchronize to their patients. Also Elkins et al. (2009) have measured physiological synchronicity in combat teams, training in a virtual reality for a weapon detection task in a military setting. Here, too, it was found that teams that perform best in these virtual reality combat tasks are the ones that show most synchronicity in their heart beat signals.

In summary, we see that various reports suggest that certain aspects of interpersonal relations can be captured in physiological correlations and physiological synchronicity. But these reports are still scattered in that they use and prefer different psychophysiological signals, and deploy different algorithms and different timescales for the measurement for this synchronicity. With Josette Gevers (IE&IS) we are currently setting up a project to apply this concept of synchronicity to teams. Research questions are whether team synchronicity can be reliably measured in a physiological way and especially whether this brings enough accuracy to use it for team coaching. After all, good communication in teams is expected to improve their results, which in turn is beneficial for the wellbeing of the team members, and maybe even of their bosses...

Concluding remarks

“The challenge of affective computing is formidable and not without risk, but it stands to move technology [...] toward embracing the spark that makes us truly human” Picard, 1997, p.252

If nothing else, I hope you have heard my enthusiasm for the area of wellbeing and psychophysiology. I strongly believe it can bring many benefits to society, and that various paths to valorization are open. In the healthcare domain, the current view on patient health acknowledges the important contribution of how the patient feels. Monitoring a patient’s mood can give valuable information to therapists and medical staff, both for inpatients and outpatients. Employers these days are very concerned about the wellbeing of their employees, offering monitoring options as well as dedicated training to help their people live a balanced life while meeting their commercial targets. And also in the consumer domain, the proliferation of smart wristbands anticipates the interest of the general public in tools that help them optimize their personal resources. These are all areas in which psychophysiological measurement might offer a solution to at least part of the puzzle.

Another part of that puzzle includes the ethical aspects of new products, as it applies to anything new conceived in research labs. Psychophysiological technology is usually praised for the fact that it contributes to a person’s wellbeing without the need for drugs or medication. While this is good in itself, it does not necessarily mean that it does not affect your body and mind: if we are happy to accept that these techniques can change your body and mind for the better, we should acknowledge the possibility of the opposite as well. We could debate whether would it be a problem if we were to become dependent on them, like most of us have become dependent on the pair of glasses on our noses. These are ethical issues, like the privacy problem of the data generated, which do warrant our reflection, even if society is keen to embrace the opportunities.

I also think psychophysiology is a topic that fits with this university (and given my appointment, I presume the University agrees with me ☺): mental wellbeing is an important element in one’s health, and therefore directly related to the TU/e focus

area of Health. Also, psychophysiology deploys technological innovations to achieve this wellbeing, and as such the area fits very well in the new TU/e Center for Humans & Technology. Moreover, I hope to have shown that the domain has links with various areas of TU/e expertise, and I very much look forward to further cooperation in the future. The reason why Human-Technology Interaction and wellbeing & health are important topics within the TU/e, is because we know them to be very relevant in society as well: thus human-focused engineers will be needed to optimize innovation, and I feel happy and honored to be able to contribute to their education.

So this is the story I wanted to tell you: it started with a scene from Greek mythology, highlighting the importance of both psyche and physis. But then it very soon became a tale of the future, if not real Sci-Fi, then at least real Ψ - Φ . I hope that you did not think I was telling you a fairy tale too good to be true, but with all the wellbeing involved, I sincerely hope we will live more happily ever after...

A letter of gratitude

As many others, I see my development and career up till now as a journey. Some people have functioned as signposts along the way, and I am very grateful for their input and concern.

My parents have instilled an appetite for learning and thinking that has been the basis for anything that followed. Whenever I had hurt my knees as a little kid, my father's gentle advice was: 'Don't cry – you won't be able to see, or to hear, or to think.' Admittedly more Descartes than Damasio, but teaching me to think and look forward whenever possible nevertheless. My mother set a pragmatic example by embracing life as it comes, and her never ending endeavor to make the best of it. I am very happy that my mother has been witness to this step in my career, and I am sure she is proud for the both of them.

Teachers at school and at the university – I still know their names – have introduced me to the world of reason and logical thinking. Once I had graduated and was at the Institute for Perception Research, my promoters Jacques Roufs and Herman Bouma oversaw my first steps into the worlds of human-technology interaction and academic science. They taught me the responsibility and satisfaction of sharing my research results in publications, a lesson which lasted long after I had spread my wings to neighboring fields. Ultimately, I arrived in the field of psychophysiology, and it is with kindness that I remember the role of Paul Ackermans, who suggested it as a domain worth investigating. Then, as a last step, I am grateful to Wijnand IJsselsteijn and Cees Midden for pointing my focus to the TU/e again – they know how much I enjoy this.

And then there were the people who travelled with me for part of my journey. Friends from high school and university years, my colleagues at the Institute for Perception Research – in those days we still had time for intense, delightful discussions on all sorts of relevant and irrelevant topics. Then, gradually, actual work needed to get done, but also that was fun, and I thank Philips Research, and recently also the HTI group, for fostering a cooperative atmosphere in which teamwork and team spirit prevail. Colleagues, PhD students, national and international contacts, it was great to work together in various projects.

But most of all, my travel companion for already almost 40 years has been Berry. We have discussed our career plans since we were 17, and you have always tacitly supported mine. You have truly shared the care for our kids – or at least almost – and you brought a real-life perspective whenever needed. Behind this new professor, there is a great husband...

Ik heb gezegd.

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Curriculum Vitae

Prof. Joyce Westerink was appointed professor on Wellbeing and Psychophysiology in Human-Technology Interaction at the department of Industrial Engineering and Innovation Sciences at Eindhoven University of Technology (TU/e) on May 1, 2015.

Joyce Westerink (1960) was originally trained as a physicist at Utrecht University. Afterwards she expanded her horizon towards human-technology interaction at the Institute for Perception Research (IPO), a cooperation between TU/e and Philips. Her research focused on psychological topics in a technological context, such as human factors & user interfaces, and visual perception & image quality (PhD @ TU/e, 1991). This general theme was continued at Philips Research, where her research shifted to psychophysiology in the context of emotions, wellbeing and affective computing. In all of these domains, her role has been to bridge the worlds of academic and industrial research, fostering direct usefulness for stakeholders as well as the distillation of generic knowledge. This approach is also apparent in the various European projects she has co-initiated and participated in, in a series of conferences and symposia she has organized around wellbeing and technology, and in written output in the form of patents as well as academic publications.

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