Portable technology in mental health care

Mobile technology such as smartphone applications is gradually making its entry into health care. At the moment, the purpose of these 'apps' is often prevention. For instance, they allow the general public to quickly and easily fill in self-report questionnaires, or access information or tailor-made help at the moment it is actually needed. This specific form of e-health (abbreviation for electronic health), i.e. the use of mobile computers, medical sensors and communication technology for health care, is referred to as m-health (mobile health) (Istepanian, Jovanov, & Zhang, 2004).

Portable technology is a specific category within m-health and recently its development and commercialization is really taking off. The term portable technology includes the whole range of sensors and devices (such as the currently popular wristbands) that can be worn by a user. These are known as 'wearables'. The purpose of wearables is to collect physiological data in a manner that is reliable but as non-invasive as possible. There are compact and non-invasive devices to perform an electrocardiogram (ECG) and an electro-encephalogram, to register heart rate variability (HRV) and frequency of respiration, to measure skin conductance and to register movement. These devices have been in use for some time in various settings. Hospitals monitor ambulant patients with them (Moy, Mentzer, & Reilly, 2003) and specialized centres use them to support top athletes (Michahelles & Schiele, 2005). In recent years, moreover, wearables have become more accessible because they are now easier to use and cheaper. The evolution has made it possible, for example, for individuals to use this portable technology to quantify their lives – also known as the 'Quantified Self' movement – the aim being to use the data obtained to monitor and ultimately improve the quality of their daily lives (Swan, 2013).

Logically, the question to arise is whether and how this rapidly emerging technology can play a role in mental health care. The use of portable technology in this sector is relatively uncharted territory. The aim of this article is to provide a picture of the current opportunities and pitfalls of wearables within mental health care. Special attention is given to the role of clinical psychologists in this context. We conclude with a vision for the future, with some of the applications being described to illustrate what portable technology could mean for clinical practice in the relatively short term.

Opportunities for wearables in mental health care

For some time now, wearables have been playing an increasingly significant role in gathering physiological data in scientific psychological research (Yerkes, 2004). Existing studies can give an overview of the current possibilities. Data gained from an accelerometer, for example, provide information on the movement patterns of the wearer. The National Health and Nutrition Examination Study (2005-2006) used this approach to obtain a snapshot of the physical activity status in more than 4000 adults (Song, Lee, Baek, & Miller, 2012). Participants wore a small device on their right hip for one week and were asked only to keep the device dry and remove it just before they went to bed. Otherwise, no specific action was needed. On a minute-to-minute basis, the physical activity of the wearer was monitored, which enabled the investigators to divide the activity of the participants into four categories: (1) sedentary, (2) mildly intensive, (3) moderately intensive and (4) highly intensive. Next, people with mild (n=564) and moderate to severe (n=227) symptoms of depression were compared with participants with minimal depressive symptoms (n=3267). The results show that there were no differences between the groups in relation to sedentary and highly intensive physical activity, but that participants with mild to severe depressive symptoms performed significantly worse in the area of light and moderate exercise compared with participants with minimal symptoms. The data from the accelerometers were also able to show that, independent of a

number of control variables (age, gender, race, income, relational status and self-reported health), moderate physical activity had a significant effect on depressive symptoms: a person who was moderately physically active for at least thirty minutes a day, three days a week (which is recommended in the guidelines for physical activity laid down by the Centres for Disease Control and Prevention) had 28% less chance of having symptoms of depression than one who was not.

The usefulness of other types of data for psychology, such as the HRV, is maybe less evident. However, there are possibilities, such as combining ECG monitoring to measure HRV with a smartphone application to manage stress. In a study by Morris and Guilak (2009), students in higher education managed to reduce their stress levels in this way. On the basis of the registered HRV during moments of stress, the app provided interventions for moderating cognitive behaviour, including breathing exercises and cognitive re-evaluation techniques. The effect of these interventions was registered immediately and given as feedback to the participants in the form of visualization of their breathing. Finally, in another study, Villarejo, Zapirain and Zorrilla (2012) chose a non-interventional approach with sensors to measure skin conductance. They were successful in distinguishing between different situations and tasks (feeling relaxed, carrying out mathematical calculations, breathing rapidly and speed reading) where participants did or did not experience stress. Psychological research thus shows that wearables now have the capacity to measure symptoms in a more reliable and valid way. Furthermore, they allow extra physiological data to be collected, so that the effects of supportive measures and treatment can be better assessed. And, finally, they also offer the opportunity to give feedback to clients at the right moment and in the right place.

Limitations and challenges
It goes without saying that the current generation of wearables cannot be integrated into clinical practice just like that. The challenges lie in both the technology and adapting to the practical situation.

The technology now has four types of challenges. The first challenge is the quality of the acquired data. In 2013, for instance, significant differences were still found in the accuracy of the different commercially available wearables, which all claimed to calculate the exact energy consumption of the wearer. Prototypes of new devices, however, are constantly improving and now succeed in estimating the energy expenditure of the user with an accuracy of up to 90% (http://www2.imec.be). A second, greater, limitation is the problem of 'big data'. Continuous monitoring generates enormous amounts of information. It is a great challenge to correctly analyze and interpret this enormous quantity of data and present it in a clear and accessible manner. Statistical techniques to identify patterns from complex data are currently in full development. A complicating factor is, however, the large intra- and inter-individual variability, as was shown by a study in the physiological detection of emotions (Bulteel et al.,2014). Besides methodological and statistical support, the development of specific software to achieve the full potential of the wearables forms a third challenge. On the one hand, software programs are necessary to analyze and visualize the data, so that the information can easily be interpreted. On the other hand, there is a need for mobile applications which, based on the data, can give direct feedback to the user if required. A final challenge lies in the fact that the technological solutions still need to show their added value in clinical practice. The fact that wearables prove to be reliable and useful in controlled study settings does not necessarily mean that the same also applies for their daily use by clinical psychologists.

When introducing wearables into the practical situation, all manner of barriers may be encountered. At the moment, clinical psychologists are insufficiently familiar with portable technology and do not have the background knowledge or the tools to integrate these new applications in their traditional

methods. Although clinical psychologists do acquire the basic skills from the current training programs, in the future it will be necessary to further expand the courses offered or give continuing education in order to be able to respond to these new technological developments. The competences that need further development are on the one hand of a technical nature, such as the question of acquiring knowledge on the valid and reliable use of wearables and on the hardware and software side. And on the other hand, they are also related to the content: the neuropsychological and physiological knowledge that now holds a prominent place in the current curriculum must at least remain at the same level. In addition, there is a need to accommodate the implementation and interpretation of such physiological measures into clinical practice, in the same way as tutorials where students learn how to perform diagnostic tests.

Scenarios for the future

In the near future, various applications for portable technology will become possible. The following illustrations are based on a scenario in which the clinical psychologist employs a wearable that performs multimodal measurements: heart rate variability, movement and breathing frequency. The data from the wearables do, of course, form an additional source of information, next to self-reporting and contextual information, which could also be registered in a mobile application.

One use is the preventive screening and management of burn-out in the workplace. Individuals who want to get more insight into their stress-related symptoms than by just filling in a self-report questionnaire can wear a wristband for a few days. If the therapist is of the opinion that more support is needed, other options can also be used: (1) working on coping with these symptoms in weekly group sessions or one-to-one consultations and (2) personalized exercises. This type of short-term intervention is not only a way of helping people with work-related problems, but it can also serve as a means to make them more aware of the danger of stress at the workplace and the importance of attention to their mental health.

A second application could be monitoring clients with depression during their treatment. It is a great challenge to keep clients focused on their mental health outside the weekly sessions with the clinical psychologist (Helbig & Fehm, 2004). A wearable with an accompanying mobile application can provide a solution here. This application gives clients regular feedback about their HRV by text messages on the smartphone. Also, the built in accelerometer provides insight into the activity levels of the individual. If, on the basis of these data, negative patterns are detected such as long periods of inactivity both the client and the clinical psychologist will be made aware of this. During the weekly sessions, they could look together at the completed questionnaires and at the data from the wearable and compare this with the individual's personal experiences. All this would be embedded in the normal consultations.

A third application focuses on the treatment of panic disorders. Patients with this problem say that an episode is often completely unexpected. Yet, research has shown that up to an hour before the attack subtle changes occur in the HRV and breathing frequency (Meuret et al., 2011). The wearable can detect these changes and send a signal via the mobile application to the client. Using exercises provided by the clinical psychologist, the client can try to calm down and avert the imminent panic attack. In the next consultation, the clinical psychologist can use the data and the person's experiences to discuss the situation in detail and to adjust and optimize the support and treatment needed. A final use is focused on the treatment of people with a binge eating disorder. Their stress levels appear to be the provoking trigger for binge eating. In addition, avoidance coping strategies are predictive for future pathological eating behaviour (Freeman & Gil, 2004). Monitoring HRV using a wearable can anticipate both mechanisms and is thus an important supporting tool for the individual. For example, based on the data, a mobile application gives a timely alert that the person is

entering a period of risk that may lead to binge eating. Moreover, at that moment concrete problem-solving strategies are offered to help prevent the bingeing. At the next session with the clinical psychologist, there is a thorough debriefing of these crucial moments and a discussion about the possible reasons for the success or failure of the solutions that were offered. Based on the data and the experiences of the client, the treatment can be further adjusted.

Conclusion

The applications explored above are simplified examples based on possible future developments and it is important to bear in mind the challenges associated with the various scenarios considered. Nevertheless, they show the potential of portable technology for clinical practice. Such technology is less invasive and multimodal: devices are getting smaller and smaller and are gathering more and more data, for instance by combining different types of measurements. If these data are presented in a clear and accessible manner, psychologists will undoubtedly be able to use them to further optimize their support and treatment strategies. Such an innovative approach fits well with the concept of stepped care, where the least intensive and least restrictive treatment is chosen based on the characteristics of the individual, that is: minimal care when possible and maximal care when necessary (Bower & Gildbody, 2005). All this means that valuable new options are becoming available for the current mental health care model in Flanders, where up until now psychopharmacology was usually called in to deal with psychological problems.

This will, however, require eff ort and commitment from clinical psychologists: they will have to abandon their traditional approaches and respond with an open mind to the opportunities this technology can offer. It is only a matter of time before the present technological thresholds are crossed and there will be a great need for competent care providers who are able to and dare to take the plunge.

This article provides an introduction to this new technological world. It is also an appeal to be critical when considering these innovations but also enthusiastic in examining the possibilities they may provide in the future.

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References
Bower, P., & Gildbody, S. (2005). Stepped care in psychological therapies: access, effectiveness and efficiency. *British journal of psychiatry, 186*, 11-17.

Bulteel, K., Ceulemans, E., Thompson, R. J., Waugh, C. E., Gotlib, I. H., Tuerlinckx, F., & Kuppens, P. (2014). DeCon: A tool to detect emotional concordance in multivariate time series data of emotional responding. *Biological psychology*, *98*, 29-42.

Freeman, L. M. Y., & Gil, K. M. (2004). Daily stress, coping, and dietary restraint in binge eating. *International Journal of Eating Disorders, 36*, 204-212.

Helbig, S., & Fehm, L. (2004). Problems with homework in CBT: Rare exception or rather frequent? *Behavioural and Cognitive Psychotherapy, 32*, 291-301.

Istepanian, R. S., Jovanov, E., & Zhang, Y. T. (2004). Guest editorial introduction to the special section on m-health: Beyond seamless mobility and global wireless health-care connectivity. *IEEE Transactions on Information Technology in Biomedicine, 8*, 405-414.

Meuret, A. E., Rosenfield, D., Wilhelm, F. H., Zhou, E., Conrad, A., Ritz, T., & Roth, W. T. (2011). Do unexpected panic attacks occur spontaneously? *Biological psychiatry*, *70*, 985-991.

Michahelles, F., & Schiele, B. (2005). Sensing and monitoring professional skiers. *IEEE Pervasive Computing, 4*(3), 40-45.

Morris, M., & Guilak, F. (2009). Mobile Heart Health: Project Highlight. *IEEE Pervasive Computing*, *8*(2), 57-61. doi:10.1109/MPRV.2009.31

Moy, M. L., Mentzer, S. J., & Reilly, J. J. (2003). Ambulatory monitoring of cumulative free-living activity. *IEEE Engineering in Medicine and Biology Magazine, 22*(3), 89-95.

Song, M. R., Lee, Y.-S., Baek, J.-D., & Miller, M. (2012). Physical Activity Status in Adults with Depression in the National Health and Nutrition Examination Survey, 2005–2006. *Public Health Nursing, 29*, 208–217. doi: 10.1111/j.1525-1446.2011.00986.x

Swan, M. (2013). The quantified self: Fundamental disruption in big data science and biological discovery. *Big Data, 1*, 85-99.

Villarejo, M. V., Zapirain, B. G., & Zorrilla, A. M. (2012). A stress sensor based on Galvanic Skin Response (GSR) controlled by ZigBee. *Sensors*, *12*, 6075-6101.

Yerkes, R.M. (2004). Physiology and psychology. *The Journal of Comparative Neurology, 14*, 511-514.