Health Self-Management Applications in the Workplace

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SPRINT@Work

Project description

SPRINT@Work is a project that focused on sustainable employability and specifically on investigating how to keep the aging population healthy and employable until and even beyond their expected retirement. To realise sustainable employability, workers were made aware of their condition by (1) objectively monitoring their cognitive and physical workload and capacity and (2) providing interventions to alter their behaviour to improve their work capacity or lower the workload. Moreover, sensor technologies were developed to enable monitoring, and interventions were created. All of these innovative technologies were validated in controlled laboratory studies, as well as in real-life working situations. Multiple aspects related to workload were investigated, such as cognitive and physical demands, individual responses to these exposures and feedback responses. The project was split into four PhD trajectories:

1. User requirements and needs assessment (Public and Occupational Health, University Medical Center Groningen)
2. Physical workload (Rehabilitation Medicine, University Medical Center Groningen)
3. Cognitive workload (Experimental Psychology, Behavioural and Social Sciences, University of Groningen)
4. Feedback effects and optimisation (Operations, Faculty of Economics and Business, University of Groningen)

SPRINT@Work comprised a broad consortium that included five knowledge institutes, 13 companies involved in the development of sensor technologies and seven pilot companies with workers and employers wishing to maintain a healthy working situation and willing to test the developed sensor and intervention technologies.

Outcomes

According to the needs assessment for workplace health promotion, several workers pointed out that priority should be given to monitoring fatigue, occupational heat stress and exposure to physically demanding jobs using sensor technologies (Spook et al., 2019). Mental fatigue negatively influences productivity during regular working activities.

One way to detect productivity deteriorations in the office environment is by monitoring computer usage, for instance, by monitoring typing behaviour. Therefore, a study was performed to investigate whether typing indices can monitor deteriorations in attentional and memory processes by monitoring changes in neural activation (de Jong et al., 2018). This study was performed in a lab setting. The results showed that both younger and older participants became slower over time, which was reflected in the interkey interval. Moreover, younger adults became less accurate with prolonged task performance. However, they partly corrected for their mistakes using the backspace key. Such changes in the typing indices were correlated with changes in neural activation; that is, those who showed larger deteriorations in attentional and memory processes also showed larger deteriorations in typing performance.

The next question was whether the markers that were found to be susceptible to the effects of mental fatigue in the a lab setting can also describe the behavioural dynamics in the work environment. To answer this question, typing performance data from a real-life office environment were analysed (de Jong et al., 2020). The results showed that the workers' typing speed decreased over time, which was reflected in a larger interkey interval. In addition, the workers used the backspace key more often. Interestingly, these effects of prolonged task performance interacted with the effects of time of day. That is, in the morning, workers were able to perform at a constant speed, with an increase in backspace keystrokes, whereas in the afternoon, both the typing speed, measured by the interkey interval, and accuracy, measured by the percentage of backspace keystrokes, decreased. These results suggest that even though these workers take precautions to counteract the effects of mental fatigue during the day (e.g. drinking coffee or taking breaks), the effects of prolonged task performance accumulate over the day.

A different study investigated how consuming caffeinated beverages may help counteract the effects of mental fatigue (van den Berg et al., 2020). The results showed that, besides its general arousing effects, caffeine can enhance attention towards relevant information, which is specifically helpful in the work environment, where it is important to pay attention to specific tasks.

To monitor the energetic workload of physically active workers as a parameter of physical fatigue, a portable breathing gas analyser was developed and validated (patent pending; Roossien et al., 2021). The proof of concept of this analyser was found to be more valid than heart rate monitoring and more practical than indirect calorimetry with a mouth mask. Its users reported that the headset is more comfortable and more usable than mouth-mask systems. This proof-of-concept version is not yet as good as mouth masks; however, it has potential and provides opportunities for further professionalisation. This headset will be further developed and validated in a follow-up study together with a company specialised in breathing analysis, with the aim of making this system available not only for a large target group of workers, but also for rehabilitation and sports applications.

To monitor occupational heat stress, a wearable core thermometer was developed and validated against a commercially available wearable thermometer. Despite the good usability of these thermometers, they are not yet suitable for measuring the core temperature while performing physically demanding jobs (Roossien et al., 2020). In a follow-up project, a new technology will be developed to fulfil the need for such a device. A suit equipped with sensors was used to investigate the exposure of physically demanding jobs. This suit monitored work postures and related back muscle activity and automatically calculated the net moment of the lower back with a specially developed artificial neural network based method. This technology was validated on different types of workers, and its function was also demonstrated. However, both the sensor system and software require further development before validating the function of the system in an operational work environment. A smart chair equipped with sensors was used to measure the physical load of office workers. Although the feedback signal did not improve the sedentary behaviour, this smart chair was a useful non-obstructive tool for monitoring the sitting behaviour of office workers (Roossien et al., 2020). Indeed, these systems and technologies will be further developed and validated in follow-up studies and will be made available for workplace health promotion.

To allow workers to benefit from such sensor and intervention technologies in the workplace, the effectiveness and effects of such technologies on employee autonomy were studied in two experimental field studies. The first study investigated the effects of real-time actionable feedback on workers' sitting and typing behaviour, in which the typing behaviour is considered a measure of fatigue. If a worker receives feedback messages on fatigue, they alter their typing behaviour almost immediately. However, if they receive feedback on their sitting behaviour, they alter their sitting behaviour only in the long term. This difference is explained by the fact that workers are considerably able to estimate their sitting bouts but hardly able to assess their level of fatigue. These findings show that workers are willing to alter their behaviour if they receive new information, as in the case of the typing behaviour. However, if they can self-monitor their behaviour, as in the case of the sitting behaviour, they show a learning effect over a longer period of time (Bonvanie, 2021).

The second study examined the effects of workers' use of health self-management applications in the work environment on their perceived autonomy in self-regulating their health-related behaviour. The results showed that workers experience a decline in their perceived autonomy either at home or at work or even both, depending on the type of feedback that they receive, and that this effect is strongest for employees with a high body mass index (BMI). Employees with a high BMI experience more negative emotions when they receive feedback pertaining to not reaching the given norm for physical exercise, and they become more aware of their work environment limitations that prevent them from altering their daily behaviour.

During SPRINT@Work, a context-sensitive perspective was used to contextualise ethical issues in both the development and implementation of sensor and intervention technologies for the work environment. The results of this context-sensitive analysis of ethics showed that the current legal framework for the privacy of workers limits the employers' opportunities to take full responsibility for the workers' health. This can, however, be solved using an agency-based approach, in which specific employees with clear roles (agents) have the power to use the personal data of other workers for specific reasons. Additionally, the autonomy of workers using sensor and intervention technologies is affected when the workers are not by default enabled to uphold their own norms and values but rather perceive the norms inherent to the design of these sensor and intervention technologies as pressing. These insights show that applying a context-sensitive approach of ethics may enhance the position of both workers and employers and provide valuable input for future research regarding technologies aimed at health improvement in the workplace.

Contribution to journals

The following scientific contributions are the current result of SPRINT@Work.

Journal publications and patents

Roossien, C.C., Krops, L.A., Wempe, J.B., Verkerke, G.J. & Reneman, M.F. (2021). Can we analyze breathing gasses without a mouth mask? Proof-of-concept and concurrent validity of a newly developed breathing gasses analyzing headset. Applied Ergonomics, vol. 90, pp. 103266.

De Jong, M., Bonvanie, A.M., Jolij, J. & Lorist, M.M. (2020). Dynamics in typewriting performance reflect mental fatigue during real-life office work. PloS ONE 15(10):e0239984.

Van den Berg, B., de Jong, M., Woldorff, M.G. & Lorist, M.M. (2020). Caffeine boosts preparatory attention for reward-related stimulus information. Journal of Cognitive Neuroscience, 1-15.

Bonvanie, A., Broekhuis, H., Maeckelberghe, E., Janssen, O. & Wortmann, J.C. (2020). Health Self-Management Applications in the Work Environment: the Effects on Employee Autonomy. Frontiers in Digital Health, 9:2.

Roossien, C.C., Heus, R., Reneman, M.F. & Verkerke, G.J. (2020). Monitoring core temperature of firefighters to validate a wearable non-invasive core thermometer in different types of protective clothing: concurrent in-vivo validation. Applied Ergonomics, vol. 83, pp. 103001.

Spook, S., Koolhaas, W., Bultmann, U. & Brouwer, S. (2019). Implementing sensor technology applications for workplace health promotion: A needs assessment among workers with physically demanding work. BMC Public Health, vol. 19, pp. 1100.

Roossien, C.C., Verkerke, G.J. & Reneman, M.F. (2019). Patent: Instrument, system and method for use in respiratory exchange ratio measurement, application number: EP19189792.5.

Riethmeister, V. (2019). Sleep and fatigue offshore. PhD thesis.

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Roossien, C.C., Reneman, M.F. & Verkerke, G.J. (2018). Werkbelasting meten met sensortechnologie (Dutch). Fysiopraxis, vol. 3, pp 18-20.

Roossien, C.C., Stegenga, J., Hodselmans, A.P., Spook, S.M., Koolhaas, W., Brouwer, S., Verkerke, G.J. & Reneman, M.F. (2017). Can a smart chair improve the sitting behavior of office workers? Applied Ergonomics, vol. 65, pp.335-361.

Other work

Roossien, C.C., Hodselmans, A.P., Heus, R., Reneman, M.F. & Verkerke, G.J. (submitted). Evaluation of wearable non-invasive thermometer for monitoring deep body temperature in performing physically demanding occupations.

Roossien, C.C., Bonvanie, A.M., de Jong, M. & Maeckelberghe, E.L.M. (submitted). Ethics in Design and Implementation of Technologies for Workplace Health Promotion.

Bonvanie, A.M. (2021). Real-time, actionable feedback and office workers' sitting behaviour and mental fatigue: An experimental field study. Thesis chapter.