Summary

Habitual behaviour is often hard to change because of a lack of self-monitoring skills. Digital technologies offer an unprecedented chance to facilitate self-monitoring by delivering feedback on undesired habitual behaviour. A broad range of feedback solutions are currently available: wearable activity trackers give us feedback on whether we walk or sleep enough; smart devices track our eating habits; an app can warn us about situations in which we are likely to smoke a cigarette, and a growing number of devices tell us (and others) what emotions we experience in cases where we are unable to do so ourselves. Unfortunately, there has been relatively little research into whether all this feedback on health behaviour is as effective as we implicitly presume.

This thesis contributes to answering the question whether feedback through digital technology is effective to change habitual behaviour. To do so, Chapter 2 of this thesis provides a review of the current literature and an analysis the results of 72 recent studies in which feedback from digital technology attempted to disrupt and change undesired habits. A vast majority of these studies found that feedback through digital technology is an effective way to disrupt habits, regardless of target behaviour or feedback technology used. However, methodological issues limit our confidence in the findings of all but 14 of the 50 studies with quantitative measurements in this review; more well-designed research into the efficacy of feedback in disrupting habitual behaviour can increase our confidence in these findings. In our review, only 4 studies tested for (and only 3 of those 4 found) sustained habit change, so the current scientific state of the art is not sufficiently developed to draw a conclusion about whether feedback from digital technology can durably change detrimental habits. Furthermore, it remains unclear how feedback from digital technology is moderated by receiver states and traits, as well as feedback characteristics such as feedback sign, comparison, tailoring, modality, frequency, timing and duration.

Based on the results of this review, this thesis zooms in on two urgent research questions: Is feedback through digital technology an effective way to sustainably change habitual behaviour, and is feedback through digital technology effective for each user in every context (or are there intrapersonal (e.g. character traits,
psychological states such as motivation) or interpersonal (contextual or systemic) moderators? To do so, the thesis presents an evaluation of two existing interventions for behaviour change that provide feedback on undesired habits. Both interventions (or its successors) are currently available in the consumer marketplace. The first intervention, a wearable activity tracker, can provide insights into which intrapersonal or interpersonal determinants increase the chances of sustained engagement with the intervention. The second product, a ‘smart’ fork that measures eating rate and gives feedback when its user eats too fast, can provide insights into whether feedback can durably change a deeply engrained, rigorous detrimental habit.

In Chapter 3, I report a longitudinal study into potential determinants of the sustained use of a wearable activity tracker. Feedback from activity trackers has the potential to encourage daily physical activity and decrease detrimental sedentary habits. To date, little research is available on the natural development of adherence to feedback technology, in this case: activity trackers, or on potential factors that predict which users manage to keep using their devices during the first year (and thereby increasing the chance of healthy behaviour change) and which users discontinue using their devices after a short time. The aim of this study was to identify the determinants for sustained use in the first year after purchase. Specifically, we look at the relative importance of demographic and socioeconomic, psychological, health-related, goal-related, technological, user experience–related, and social predictors of feedback device use. Furthermore, this study tests the effect of these predictors on physical activity.

A total of 711 participants from four urban areas in France received an activity tracker (Fitbit Zip) and gave permission to use their logged data. Participants filled out three Web-based questionnaires: at start, after 98 days, and after 232 days to measure the aforementioned determinants. Furthermore, for each participant, we collected activity data tracked by their Fitbit tracker for 320 days. We determined the relative importance of all included predictors by using Random Forest, a machine learning analysis technique. The data showed a slow exponential decay in Fitbit use, with 73.9% of participants still tracking after 100 days and 16.0% of participants tracking after 320 days. On average, participants used the tracker for 129 days. Most important reasons to quit tracking were technical issues such as empty batteries and broken trackers or lost trackers. Random Forest analysis of predictors revealed that the most influential determinants were age, user experience–related factors, mobile phone type, household type, perceived effect of the Fitbit tracker, and goal-related factors.

Chapter 4 introduces the 10sFork, which provides feedback to raise awareness of eating rate in order to help people eat more slowly. It records behaviour and provides real-time haptic feedback on individual eating rates. Eating rate is a
basic determinant of appetite regulation, as people who eat more slowly feel sated earlier and eat less. As a result, fast eating rate may contribute to overeating and weight gain, and also to a range of debilitating conditions such as diabetes II, gastro-intestinal disease and some types of cancer. Unfortunately, without assistance, eating rate is difficult to modify due to its highly automatic nature. This chapter reports an evaluation of the 10sFork for usability. Eleven participants (three male, eight female) used the fork both in a laboratory setting and at home. All participants indicated having high eating rates. We interviewed them on perceived efficacy, acceptability, comfort, accuracy, motivation, and sustained use of the fork. Participants feel the 10sFork is an acceptable tool to decelerate their eating rate. The fork is generally seen as comfortable and sufficiently accurate. Participants were more aware of their eating rate but did not always feel this awareness led to (perceived) behaviour change. The vibrotactile feedback worked as expected, but the visual feedback largely remained unnoticed. Sustained motivation to use the fork was limited because participants did not see themselves as the product’s target group.

In Chapter 5, I describe the results of a laboratory study on the effect of eating with the 10sFork in a single meal setting. A total of 114 participants were randomly assigned to a Feedback Condition (FC), in which they received vibrotactile feedback from the 10sFork when eating too fast (i.e. taking more than one bite per 10 seconds), or a Non-Feedback Condition (NFC) in which they ate with the fork but without feedback. Participants in the FC took fewer bites per minute than did those in the NFC. Participants in the FC also had a higher success ratio, indicating that they had significantly more bites outside the designated time interval of 10 seconds than did participants in the NFC. A slower eating rate, however, did not lead to a significant reduction in the amount of food consumed or level of satiation. These findings indicate that real-time vibrotactile feedback delivered through an augmented fork is capable of reducing eating rate.

The long-term effectiveness of this form of feedback on satiation and food consumption is the subject of Chapter 6. This chapter reports a field study in which we assessed the effects of eating with the 10sFork on participants’ eating rate and body weight over a 15-week period. To do so, we conducted a three-armed parallel group randomised controlled trial. A total of 141 participants with overweight or obesity were randomised to either one of two intervention groups (VFC, VFC+) or a control group (NFC). In VFC, participants received direct vibrotactile feedback from an augmented fork when eating too fast during a four-week training period. In VFC+, participants received the same vibrotactile feedback, but also had access to an online web portal with retrospective visual feedback on eating rate. In NFC, participants ate with the augmented fork without any form of feedback. Eating rate (i.e., success ratio (the percentage of bites with a sufficiently long pause between
them) and bite rate) and body weight were measured at baseline (T1), directly after the four-week training period (T2) and at a follow-up after eight weeks (T3). Participants in both intervention groups had a significantly higher success ratio than those in the control group directly after the intervention. This effect persisted after an eight-week break. Bite rate only changed significantly directly after the intervention for those in VFC. Participants in both intervention groups lost significantly more weight than those in the control group after the intervention with no rebound after eight weeks. This study showed that the use of an augmented fork to decrease eating rate may be an effective tool to reduce eating rate and promote weight loss.

In Chapter 7, I discuss the findings presented in this thesis. All in all, this thesis shows that feedback from digital technology indeed has the potential to durably change (at least some kinds of) undesired behaviours. Furthermore, this thesis shows that when people use digital technology to provide them with feedback, they will show greater engagement with the technology than we could assume from previous literature.