Exploring Nonconscious Behaviour Change Interventions on Mobile Devices

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Abstract
Modern cognitive psychology theories such as Dual Process Theory suggest that the source of much habitual behaviour is the nonconscious. Despite this, most behaviour change interventions using technology (BCITs) focus on conscious strategies to change people's behaviour. We propose an alternative avenue of research, which focuses on understanding how best to directly target the nonconscious via mobile devices in real-life situations to achieve behaviour change.

Author Keywords
Behaviour change; persuasive technology; designed persuasion; mobile; context-aware; dual process theory; nonconscious; habit.

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H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous;

Introduction
Many deaths are caused by bad habits or patterns of behaviour: the World Health Organisation (WHO) estimates that the risk factors of alcohol & tobacco use, high blood pressure, BMI, cholesterol and blood glucose, low fruit and vegetable intake and physical

inactivity account for 61% of cardiovascular deaths world-wide [45]. Cognitive psychology theories such as dual process theory contend that the underlying cognitive limitation responsible for such behaviour is that habits are not consciously motivated, chosen or monitored. Given the widespread use of mobile devices with sophisticated sensors (e.g. UK smartphone ownership is at 69% of the population [16]), there is a clear opportunity to use these context-aware mobile technologies to address this limitation.

In this position paper, we draw on theoretical and empirical evidence to outline two broad categories of nonconscious intervention strategies for mobile BCITs: firstly, to repeatedly prime the required behaviour and secondly to alter the nature of the underlying cognitive constructs that result in the unwanted behaviour.

Theoretical grounding

Dual process & habit theory

Dual process theories commonly assume that human decision-making structures are comprised of two sets of processes (see [10] for a review). Firstly, the nonconscious system is a set of fast, heuristic, associative, contextual, automatic, parallel processes. Secondly, the conscious system is a rational, slow, rule-based, abstract serial process with limited resources.

Our definition of a habit for this paper is that it is a learnt behaviour (or Response) that is frequently repeated, has a high degree of automaticity and is performed in response to stable contextual cues (or Stimuli) [18,27], where the cues may include cognitive variables like mood [17]. "Automaticity" here refers to habits residing in the nonconscious system, encoded as Stimulus-Response links in the associative memory, such that they are triggered—and may also be carried out—with minimal conscious awareness or intent [48]. Habits crudely encode previous adaptive behaviours by ceding control of repetitive behaviours to contextual cues, freeing up scarce cognitive resources to deal with unexpected events or other behaviour requiring conscious control [14].

Breaking & making habits

Since habits reside in the nonconscious system, how might we break bad habits? Wood & Neal [48] suggest that unwanted habits should be controlled by controlling habit cuing: either break the Stimulus-Response link by inhibiting the Response in the presence of Stimulus (e.g. through the use of vigilant monitoring [30] and self-control), or avoid the Stimulus. The problem with these approaches is that the former is cognitively costly [23] and therefore not available at all times, whilst the latter is difficult to achieve without corresponding life disruption (e.g. moving house [42]).

An obvious approach for BCITs targeting the conscious is to use mobile context-aware technology to determine the current context at a sufficient level of detail, and detect and anticipate behaviour (e.g. [29]). These two aspects could be combined to provide the relevant behavioural prompt. For habit formation, the mobile device could direct the user to perform a given behaviour when a stable context is detected (and avoid prompting users to perform the required behaviour when they have already done so). For habit breaking, the mobile technology could try to determine which stable habit cue is responsible for triggering the unwanted behaviour and either suggest that the user

avoid the cue or interrupt the user in the presence of the cue to remind them to not perform the unwanted behaviour. However, as we outline below, the implementation of such conscious strategies is not straightforward.

Issues with conscious interventions

A common approach for BCIT apps is to focus on tracking, goal setting and reminders to suggest that a user perform a given Response [38]. However, the cyberpsychology [25] of mobile BCITs, specifically how users react to being told what to do by their devices, is still an under-researched area. Do context- and behaviour-aware devices provoke the "personalisation paradox" [3], where users react negatively to the use of personal information? To what extent and why do 'just in time' prompts fail to promote lasting behaviour change [15]?

Users may also react adversely because of reactance: the phenomenon of people reacting to perceived loss of freedom of behaviour by acting to restore the freedom [6]. Reactance has been identified as an issue in BCITs using artificial social agents [33], but the boundaries of its effects on mobile BCITs is unclear. In a worst-case scenario, a user might uninstall or game the system in response to a BCIT telling them how to act.

Users may also ignore device prompts. Interruption research shows that the average response-to-interruption is more than 10 minutes [28], and repeated interruptions generate antagonism. Additionally, interruptions can deplete self-control resources [11] and may therefore be self-defeating.

Regardless of the intervention strategy, a target behaviour may never become habitual if it is not repeatedly performed in the presence of stable context cues. Yet context analysis is a relatively little-used BCIT technique [38], although there is some related research in the quitting smoking domain [24]. This is perhaps not surprising, given that it is difficult to accurately detect both contextual triggers and user behaviour: UbiComp has somewhat failed to deliver on its promises [32]. For example, a mood that might act as a contextual trigger is difficult to capture even with physiological sensors [5]. Further, some behaviours (e.g. smoking) are much more difficult to track than others (e.g. physical activity).

Targeting the nonconscious system

Our suggested solution to these issues is to target the nonconscious system instead. We propose two broad strategies: firstly, to prime the nonconscious system to behave in the desired way; and secondly to retrain the nonconscious system such that the user is more likely to behave in the desired way.

Priming the nonconscious

TRIGGER INSTINCTS

There are several pre-existing 'instinctive' cognitive paths which may be exploited to prime behaviour change. Examples include the effects on eating behaviour of auditory [36] or other environmental cues [43].

This area has received some research and commercial attention: the Zombies, Run! game [49] uses fear as a cue for running, while the TripleBeat system [26] targets audio cues for exercise. Such instinct-trigger systems could support other BCIT strategies, especially

in the domain of healthy eating [43], and even provide intervention opportunities where other conscious strategies have failed.

CUEING NONCONSCIOUS GOALS (NONCONSCIOUSLY!)

Research indicates that goals can be activated nonconsciously [1] and may operate nonconsciously [2]. These 'automated' goals require pre-intervention training sessions so a representation of the goal is stored in the participant's associative memory and is therefore primeable.

Since dual process theory predicts that negation does not affect the nonconscious system [47] (e.g. non-smoking signs triggering people to smoke [9]), we suggest that identifying a new behavioural goal to mask the existing unwanted habitual behaviour is a better strategy than asking users to not perform the bad habit.

Nonconscious goal priming on mobile BCITs has received little research attention. A weaker version is "glanceable persuasion" [19], although the conscious level of attention on goal feedback was not measured. Other research has explored the interaction between nonconscious and conscious goal motivations [37] in laboratory settings and not on mobile devices.

Psychology labs often use supraliminal tasks with concealed aims to prime nonconscious goals—e.g. participants complete a word search where answers prime a goal of "performing well" [4]. This approach has two drawbacks: firstly, it is a very general goal, and goal setting theory (GST, [22]) indicates that more specific goals are more effective; secondly, word search tasks are not well suited to small-screened BCITs.

An alternative mode of prompting nonconscious goals is through the use of subliminal priming, which avoids many downsides of conscious prompts including avoiding user irritation and reactance [12]. In line with nonconscious goal theory, a lab study by Ruijten et al. [34] found evidence of "the need for a behavior-relevant goal to make subliminal information effective". This implies that participants should receive pre-intervention training for a given goal, or interventions should be tailorable for participants to volunteer salient words.

HCI research beyond mobile BCITs has explored the use of subliminal communication in learning and driving [31]. However, the emphasis tends to be on the use of congruent subliminal communication to support conscious decision making during cognitively costly tasks, rather than on trying to prime nonconscious behaviour regardless of the current conscious task.

OPPORTUNITIES TO INTERVENE

Nonconscious priming has been shown to last over 24 hours in the lab [7], although other research shows a decay rate of 2 minutes [1]. We can perhaps bridge the gap by exploiting the ubiquity of mobile devices to deliver primes frequently. A study of 1960 smartphones found an average of 57 uses per day, comprised of 33 locked uses and 27 unlocked uses [13], which provides opportunities for continuous mobile interventions. The aim would not be to deliver 'just-in-time' primes, but instead make the idea of the desired behaviour more accessible at any given time and therefore more likely.

Retraining the nonconscious system

An alternative approach is to target the associative Stimulus-Response link itself through cognitive bias

modification (CBM), which tries to change learned reactions along cognitive paths by practicing alternative paths [47]. Psychology research has employed many CBM techniques, some of which are candidates for transfer to mobile BCITs. One potentially transferable CBM method is attention retraining using images, where participants repeatedly locate a target picture within a grid of distractors to promote attention for the target class of Stimulus (e.g. [8]). Another candidate CBM technique, employed where unwanted behaviour is associated with an approach bias, requires participants to 'push' unwanted items (represented as images) away and 'pull' wanted items towards them (e.g. [46]).

CBM techniques have been implemented to a limited extent in serious games (e.g. [35,44]), although few focus on mobile devices. However, we consider that instead of giving users an additional task in the form of a game, there is an opportunity to exploit existing user mobile interactions to insert CBM techniques. For example, we could remodel unlocking behaviour on mobiles [39] as a 'serious CBM incidental game' by adding-in images of wanted and unwanted cues to a pre-existing push/pull interaction. This technique is also a good fit for the limited interaction capabilities of wearables.

Despite this promising area of research, for any given unwanted behaviour, it remains a challenge for BCITs to definitively locate a relevant bias, related cue and correct technique to combat it.

Evaluating changes in the nonconscious system

The gold standard for determining the efficacy of any BCIT should be a measure of behavioural change, ideally including monitoring pre-, during and post-intervention behaviour in the long term. Short-term evaluations are a particular problem for habit change research since a habit may take 18-254 days to form, with automaticity plateauing around 66 days [21].

Yet gold-standard trials are difficult to achieve [20], so interim measures are crucial. We suggest using a validated measure of habit (e.g. the Self-Report Habit Index [41]) together with implicit techniques of evaluating the activity of the nonconscious system—see [47] for a review. The latter measure reaction times to stimuli as a proximate measure of nonconscious activation, although few tests have yet been implemented or validated on mobile devices.

Discussion

To conclude, we suggest two avenues of future research: firstly exploring the priming of behaviour, using ubiquitous mobile BCITs as personal contexts to outcue the external context such that the desired behaviour is performed; and secondly retrain the nonconscious system using CBM such that cues for unwanted behaviours become less salient and cues for desired behaviours become more so.

The major advantages of nonconscious strategies are that they are much less likely to provoke user irritation and reactance, and they do not require solutions to the difficult problems of behaviour and context sensing.

However, many interesting questions remain. Firstly, we do not fully understand what impact regular nonconscious prompts and/or CBM training strategies on mobile technology will have. Can reactance be triggered in the nonconscious system? To what extent should nonconscious prompts be supported by

conscious goal reminders? How should this balance change as users move through their behaviour changes? Crucially, how does habit apply to nonconscious interaction itself: will users habitually attend to nonconscious behaviour prompts or CBM training prompts, or can they learn to ignore them?

Finally, we need to consider the ethical issues. In line with Verbeek [40], we need to establish who exactly is responsible for the outcome of BCITs that target the nonconscious system, given that it will be complex product of the BCIT designer's intentions and the user's conscious and nonconscious systems.

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