Subliminal Priming of Nonconscious Goals on Smartphones

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Abstract
We present a theoretical justification for and design of an experiment to explore the use of subliminal priming of nonconscious goals on smartphones to achieve behaviour change.

Author Keywords
Behaviour change; mobile; priming; subliminal; goals; nonconscious; dual process theory.

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

Introduction
The requirement for behaviour change interventions is clear: humans persist in behaviours they know to be harmful. The World Health Organisation (WHO) estimates that 61% of cardiovascular deaths world-wide are due to behaviours around poor diet, alcohol & tobacco use and physical inactivity [27]. Meanwhile, smartphone ownership is on the increase, reaching 69% in the UK in 2015 [11], providing a clear opportunity for mobile behaviour change interventions using technology (BCITs).

We present a novel approach exploring the presentation of subliminal stimuli on smartphones,

aiming to activate nonconscious goals to make a desired behaviour more likely to be performed. We explore the underling theory and outline the justification for our experimental design. Finally, we outline our future plans to widen the research into real-life situations.

Theory

Dual process & habit theory

Dual process theories (DPT, see [8] for a review) suggest that human behaviour results from two distinct sets of processes: Type 1, a set of fast, heuristic, associative, contextual, automatic, parallel processes; and Type 2, a slow, rational, rule-based, abstract serial process.

A habit is a learnt behaviour that is frequently repeated, has a high degree of automaticity (carried out with minimal conscious awareness or intent) and is performed in response to stable contextual cues [12,18], where the cues may include cognitive constructs such as mood. The source of habitual behaviour is Type 1 processes, where cue-behaviour links are stored in the associative memory.

Habits can therefore be impervious to conscious attempts to change behaviour: habits are a Type 1 process that can be triggered and operate without conscious awareness [29], and intention-behaviour gaps [26] persist in the face of strong habits.

Goal theory

Goals are "mental representations of desired states pertaining to behaviors or outcomes" [2]. Conscious goals can drive the creation of habits by motivating the repetition of behaviour until it has been repeated sufficiently to form strong cue-behaviour links, at which point the behaviour becomes relatively impervious to outcomes.

Goal Setting Theory (GST, [15]) gives pointers on appropriate goal design, suggesting that: hard, specific goals are more effective than easy, vague ones; goals need to be accepted by the user; and feedback is important. Crucially, some goal research indicates that like habits, goals can be not only activated nonconsciously [1] but may even operate nonconsciously - see Sheeran et al. [24] for a review. Further, empirical evidence from fMRI scans [19] show that similar areas of the brain become active when the same goal is primed either consciously or nonconsciously.

This presents a clear opportunity to intervene: if we can prime goals nonconsciously, then we can leverage the human ability to infer context and to flexibly determine when best to perform a given behaviour, rather than relying on BCITs to perform the task imperfectly and risk annoying the user.

Experiment design

Intervention domain & technology

Our chosen domain is sedentary behaviour because it is an established problem [21] and is relatively easy to track the behaviour with smartphones. We can therefore avoid self-report, which has been found to be unreliable in the domain [6]. We targeted Android phones and used the EmotionSense framework [20].

Prime design

Research in psychology frequently uses supraliminal priming paradigms with concealed intentions, for

example scrambled sentence tasks where the answers are intended to prime a goal of "performing well" [4]. However, we decided this approach was not suitable for a mobile BCIT for two reasons: firstly, the usability of tasks such as word searches or unscrambling sentences on smaller screens may hamper priming efficacy; and secondly, on a theoretical level, GST suggests that such vague goals are less effective than more specific, concrete ones. Instead, we decided to use subliminal priming, where prompts are shown for a very short duration of time and subsequently masked such that the prompt is perceived but does not attract conscious attention.

Although there is controversy around the impact of subliminal persuasion (see [3] for a summary of some of the arguments), the existence of subliminal perception is broadly accepted. As predicted by nonconscious goal theory, Ruijten et al. [23] determined a requirement for a behaviour-relevant goal to be present to make subliminal information effective.

Other HCI research into subliminal priming has focused on the use of primes to provide congruent support for current tasks, e.g. in learning and driving [22] . By contrast, our research focuses on priming nonconscious goals, which may or may not be relevant to the current conscious task.

Selecting a prime

We decided to use a simple word as a subliminal prime rather than an image. Where the intended behavioural change is the formation of a new habit, behavioural prime word(s) should be salient to the participant in line with their intended goal. This either implies ensuring that participants receive pre-intervention training to accept a given goal (as in our experiment), or that the intervention should be tailorable such that participants can volunteer salient words. Such tailoring should also be employed where participants are trying to break an existing unwanted habit, keeping in mind evidence of ironic effects in priming: Earp et al. [7] showed that exposure to no-smoking signs increased cigarette approach behaviour in smoking participants.

We also added a simple smiley ":)" to the end of each prime word in order to test whether some positive valence can be attached to primed words via this method in addition to the mere exposure effect [17].

It is an open research question the extent to which the efficacy of nonconscious goal priming is also affected by goal outcomes, and therefore whether these systems also need to be supported by goal feedback. It's also possible that nonconscious priming could dispense with goal intermediaries entirely (given that we intend to bypass the conscious system) and directly prime any existing behaviour constructs.

Opportunities to intervene

Evidence on the persistence of the effects of nonconscious priming varies between more than 24 hours [5] and 2 minutes [1]. Given that a study of 1960 smartphones found an average of 57 uses per day, comprised of 33 locked uses and 27 unlocked uses [10], we suggest that unlock behaviour is an appropriate opportunity to prime users on multiple occasions a day. Our prompt therefore appears as an activity word, shown on participants' phone screens on unlock. We assumed that on unlock a user's attention is focused on their phone: we asked them to enable a

pattern - or pin - based screen lock, so they would need to concentrate to unlock.

Our initial intention was to use an exposure time of 50ms in line with other research [19], but we encountered several problems. In initial tests (n=22), a software bug meant we did not correctly log how long words were shown for. We subsequently determined that a word shown for 50ms with or without masking is visible. We therefore altered our code to request that the Android device shows the prime for 10ms after an interval of 50ms after unlock, with a mask shown immediately afterwards, also for 10ms.

Evaluation

Implementing mobile BCITs presents the opportunity to intervene and monitor over a longer term compared to lab-based studies. Short-term evaluations are a particular problem for habit change research: a habit may take from 18 to 254 days to form, automaticity plateauing around 66 days [14] , but with considerable individual variations and lack of clarity around the time taken to break habits. Nevertheless, gold-standard trials are difficult to achieve [13], so we have taken a two-stage approach to answer the research question of whether a frequent subliminal goal prompt on participants' smartphones makes a difference to their behaviour.

Phase 1 deploys the subliminal prime intervention for a week, testing whether our intervention has any impact on cognitive variables that indicate levels of prime activation and the valence attached to them, where the implicit assumption is that higher levels of activation and positive valence are likely to have an impact on behaviour. Phase 2 will be a longer 8-week in-the-wild study to test the impact of the intervention on actual behaviour. Several techniques exist to evaluate the activity of the cognitive variables — see [28] for a review. These tests provide an indirect measure of the availability and/or valence of certain concepts within Type 1 processes by measuring reaction times to related stimuli. We selected a Dot Probe Test (DPT, [16]) , to test the availability of our primes , and an Implicit Association Test (IAT, [9]) to test the valence attached to them.

Experiment method

- Two groups: intervention and control. Both groups visit a lab for two half-hour sessions, a week apart.
- On the first visit, all participants undertake goal training to identify concrete goals to meet the target goal word of "active".
- All subjects complete a demographics questionnaire, two tests to measure reaction times to a set of activity-salient words (DPT and IAT), a goal activation test and an explicit attitude test towards activity.
- The control group install an app which displays 2 nonsense words for 10ms each; the intervention group install an app that displays the chosen prime word "active :)" on unlock for 10ms, then masked with a nonsense word for 10ms.
- Subjects return to the lab after 1 week and complete the same DPT, IAT, goal activation and explicit attitude tests. They are debriefed and remove the app.

Future work

Our first step is to complete our short lab-based experiments and analyse the results. If we find a statistically significant effect of our intervention on our cognitive variables, we will repeat the experiment over a longer period of time and directly measure participant activity levels. If not, we will amend the lab experiment to determine whether an alternative experiment design can yield stronger results. We are also actively researching alternative interventions that target Type 1 processes including Cognitive Bias Modification (CBM) techniques [28] as seen in serious games [25], but modified to suit casual interactions on smartphones.

References

[1] Aarts, H., Custers, R., and Holland, R.W. The nonconscious cessation of goal pursuit: when goals and negative affect are coactivated. *Journal of Personality & Social Psychology 92*, 2 (2007), 165.

[2] Aarts, H., Custers, R., and Veltkamp, M. Goal Priming and the Affective-Motivational Route to Nonconscious Goal Pursuit. *Social Cognition 26*, 5 (2008), 555–577.

[3] Bargh, J.A. Does subliminality matter to social psychology? Awareness of the stimulus versus awareness of its influence. (1992). In R.F. Bornstein and T.S. Pittman, eds., Perception without awareness. Guilford Press, New York, NY, USA, 1992, 236–255.

[4] Bargh, J.A., Lee-Chai, A., Barndollar, K., Gollwitzer, P., and Trötschel, R. The Automated Will: Nonconscious Activation and Pursuit of Behavioral Goals. *Journal of personality and social psychology 81*, 6 (2001), 1014–1027.

[5] Chartrand, T.L. and Bargh, J. A. Automatic activation of impression formation and memorization goals: Nonconscious goal priming reproduces effects of explicit task instructions. *Journal of Personality and Social Psychology 71*, 3 (1996), 464–478.

[6] Clark, B.K., Sugiyama, T., Healy, G.N., Salmon, J., Dunstan, D.W., and Owen, N. Validity and reliability of measures of television viewing time and other non-occupational sedentary behaviour of adults: a review. *Obesity reviews 10*, 1 (2009), 7–16.

[7] Earp, B.D., Dill, B., Harris, J.L., Ackerman, J.M., and Bargh, J.A. No sign of quitting: Incidental exposure to no-smoking signs ironically boosts cigarette-approach tendencies in smokers. *Journal of Applied Social Psychology 43*, 10 (2013), 2158–2162.

[8] Evans, J.S.B.T. Dual-processing accounts of reasoning, judgment, and social cognition. *Annu. Rev. Psychol. 59*, (2008), 255–278.

[9] Greenwald, A.G., McGhee, D.E., and Schwartz, J.L. Measuring individual differences in implicit cognition: the implicit association test. *Journal of personality and social psychology 74*, 6 (1998), 1464.

[10] Hintze, D., Scholz, S., Findling, R.D., Mayrhofer, R., and Muaaz, M. Diversity in locked and unlocked mobile device usage. ACM Press (2014), 379–384.

[11] Ipsos. *Ipsos MediaCT Tech Tracker Q1 2015.* 2015. Available at: https://www.ipsos-mori.com/researchpublications/publications/1733/Ipsos-MediaCT-Tech-Tracker-Q1-2015.aspx

[12] Judah, G., Gardner, B., and Aunger, R. Forming a flossing habit: An exploratory study of the psychological determinants of habit formation. *British journal of health psychology*, (2012).

[13] Klasnja, P., Consolvo, S., and Pratt, W. How to Evaluate Technologies for Health Behavior Change in HCI Research. In *Proc. CHI'11*, ACM (2011), 3063—3072.

[14] Lally, P., van Jaarsveld, C.H.M., Potts, H.W.W., and Wardle, J. How are habits formed: Modelling habit formation in the real world. *European Journal of Social Psychology 40*, 6 (2010), 998–1009.

[15] Locke, E. a. and Latham, G.P. New Directions in Goal-Setting Theory. *Current Directions in Psychological Science 15*, 5 (2006), 265–268.

[16] MacLeod, C., Mathews, A, and Tata, P. Attentional bias in emotional disorders. *Journal of abnormal psychology 95*, 1 (1986), 15–20.

[17] Monahan, J.L., Murphy, S.T., and Zajonc, R.B. Subliminal mere exposure: Specific, general, and diffuse effects. *Psychological Science 11*, 6 (2000), 462–466.

[18] Orbell, S. and Verplanken, B. The automatic component of habit in health behavior: habit as cue-contingent automaticity. *Health psychology 29*, 4 (2010), 374–83.

[19] Pessiglione, M., Schmidt, L., Draganski, B., et al. How the brain translates money into force: a neuroimaging study of subliminal motivation. *Science 316*, 5826 (2007), 904–906.

[20] Rachuri, K.K., Musolesi, M., Mascolo, C., Rentfrow, P.J., Longworth, C., and Aucinas, A. EmotionSense: a mobile phones based adaptive platform for experimental social psychology research. In *Proc. UbiComp'10*, ACM (2010), 281–290.

[21] Rhodes, R.E., Mark, R.S., and Temmel, C.P. Adult sedentary behavior: a systematic review. *American journal of preventive medicine 42*, 3 (2012), e3–28.

[22] Riener, A., Kempter, G., Saari, T., and Revett, K. Subliminal Communication in Human-Computer Interaction. *Advances in Human-Computer Interaction 2011*, (2011), 1–3.

[23] Ruijten, P., Midden, C., and Ham, J. Unconscious persuasion needs goal-striving: the effect of goal activation on the persuasive power of subliminal feedback. In *Proc. PERSUASIVE'11*, ACM (2011).

[24] Sheeran, P., Gollwitzer, P.M., and Bargh, J.A. Nonconscious processes and health. *Health Psychology 32*, 5 (2013), 460.

[25] Wartena, B.O. and Dijk, H.W. van. Bias Blaster – Aiding Cognitive Bias Modification- Interpretation through a bubble shooter induced gameflow. In B. Schouten, S. Fedtke, T. Bekker, M. Schijven and A. Gekker, eds., *Games for Health*. Springer Fachmedien Wiesbaden, 2013, 47–60.

[26] Webb, T.L. and Sheeran, P. Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence. *Psychological bulletin 132*, 2 (2006), 249–68.

[27] WHO. *Global health risks: mortality and burden of disease attributable to selected major risks.* World Health Organization, 2009.

[28] Wiers, R.W., Gladwin, T.E., Hofmann, W., Salemink, E., and Ridderinkhof, K.R. Cognitive Bias Modification and Cognitive Control Training in Addiction and Related Psychopathology: Mechanisms, Clinical Perspectives, and Ways Forward. *Clinical Psychological Science 1*, 2 (2013), 192–212.

[29] Wood, W. and Neal, D.T. A new look at habits and the habit-goal interface. *Psychological review 114*, 4 (2007), 843–63.