Int. J. Human-Computer Studies 77 (2015) 38–51

Contents lists available at ScienceDirect

Int. J. Human-Computer Studies

journal homepage: www.elsevier.com/locate/ijhcs

Personalizing persuasive technologies: Explicit and implicit personalization using persuasion profiles ☆

Maurits Kaptein [a,*], Panos Markopoulos [b], Boris de Ruyter [c], Emile Aarts [b]

[a] Radboud University, Nijmegen Archipelstraat 13, 6524 Nijmegen, The Netherlands
[b] Eindhoven University of Technology, The Netherlands
[c] Philips Research, The Netherlands

ARTICLE INFO

Article history:
Received 8 May 2014
Received in revised form
2 December 2014
Accepted 16 January 2015
Communicated by E. Motta
Available online 24 January 2015

Keywords:
Persuasive technology
Persuasion profiling
Adaptive persuasive systems

ABSTRACT

This paper discusses how persuasive technologies can be made adaptive to users. We present persuasion profiling as a method to personalize the persuasive messages used by a system to influence its users. This type of personalization can be based on *explicit* measures of users' tendencies to comply to distinct persuasive strategies: measures based on standardized questionnaire scores of users. However, persuasion profiling can also be implemented using *implicit*, behavioral measures of user traits. We present three case studies involving the design, implementation, and field deployment of personalized persuasive technologies, and we detail four design requirements. In each case study we show how these design requirements are implemented. In the discussion we highlight avenues for future research in the field of adaptive persuasive technologies.

1. Introduction

We have entered an era of persuasive technology of interactive computing systems intentionally designed to change people's attitude or behavior (cf. Fogg, 2002). A substantial body of research has demonstrated the feasibility of these technologies in a variety of contexts and for different ends, e.g., advertising (Kaptein and Eckles, 2012), promoting healthy or pro-social behaviors (Lambert, 2001; Morris and Guilak, 2009; Consolvo et al., 2008, 2009), and reducing energy consumption (see, e.g., Svane, 2007; Midden et al., 2008; Bang et al., 2006; Dillahunt et al., 2008). Still, *reliably* affecting an individual's attitude or behavior remains an elusive goal (Oinas-Kukkonen and Harjumaa, 2008). This is true despite the argument made by Fogg and Eckles (2007), in their book Mobile Persuasion, that persuasive systems *could* be more persuasive than their human counterparts. Their arguments are based on a number of empirical investigations showing that humans respond similar to computers as they do to humans (e.g., Nass et al., 1996; Fogg and Nass, 1997a,b) and that, compared to humans, computers could be more persistent and "always on" (Fogg, 2009; Preece, 2010).

To be effective persuasive systems should deliver the right message, at the right time, in the right way. This very general maxim (and truism) emphasizes three key elements for successful attitude and behavior change: First, the target of the persuasive attempt needs to be receptive to the end goal of the attempt. Here, with the term "end goal" we refer to the target attitude or behavior that the technology was intentionally designed to promote (see Fogg, 1998, for a discussion on the intentionality of persuasive systems). Second, the message needs to be delivered at a time that enables the recipient to attend to it, and, if immediate action is required, one that provides the opportunity for the action (Faber et al., 2011). Finally, large variation can exist in the way in which a persuasive request is framed: a message aiming to persuade users to work out more could read "80% of users runs at least once a week" or "Fitness experts recommend that you run at least once a week". In both cases the end goal is the same, but the argument differs substantially.

Unfortunately, the *right* time, the *right* message, and the *right* way for a persuasive request are hard to determine at design time, without knowing the specific situation and person concerned. A solution to this is to create *adaptive* persuasive systems; systems that adapt the message, the timing, and the persuasive approach to the situation at hand. The notion of *ambient* persuasion has been proposed as a (partial) answer to this challenge (cf. Aarts et al., 2007; Kaptein et al., 2009). Ambient persuasion combines the notion of *ambient intelligent systems*—systems that build on the large scale integration of electronic devices and the ubiquitous availability of digital information—and persuasive technologies; systems aimed at changing users' attitudes or behaviors (Kaptein et al., 2009). In an ambient intelligent world, massively distributed devices operate collectively while embedded in the environment using information and intelligence that is hidden in the interconnection network. Context sensing in this setting could help determine appropriate

☆This paper has been recommended for acceptance by E. Motta.

* Corresponding author. Tel.: +31 621262211.
E-mail addresses: maurits@mauritskaptein.com (M. Kaptein), p.markopoulos@tue.nl (P. Markopoulos), boris.de.ruyter@philips.com (B. de Ruyter), e.aarts@tue.nl (E. Aarts).

http://dx.doi.org/10.1016/j.ijhcs.2015.01.004
1071-5819/

persuasive ends, fitting the user context and activities. Embedded and ubiquitous computing devices can help present the message at a location that will be noticed by users, fitting their activity and context. Till now however less is published about how to effectively personalize the persuasive approach. Our research addresses this challenge by using *persuasion profiles* to enable the personalization of the framing of persuasive attempts.

Adapting the persuasive approach to the persuadee has long been advocated throughout many fields that study persuasion. For example, marketeers advocate adapting sales tactics to consumers (McFarland et al., 2006), and health-care professionals promote tailoring of the persuasive principles used to gain medication compliance (e.g., Strecher et al., 1994; Kreuter and Strecher, 1996; Dijkstra, 2005). In a similar vein, and borrowing from the marketing literature, Churchill (2013) has recently advocated the need to distinguish between *process* and *outcome* personalization; readers are referred to Churchill (2013) for an extensive explanation of these concepts which concludes with a call to think more, and more imaginatively, about them. Notably, many of these discussions focus on the "way" rather than the end-goal of a persuasive request and argue that the method itself should be personalized (Kaptein et al., 2011).

Recently, health-care professionals and researchers, most noticeably in the domain of nutrition education, are examining computer-tailored interventions. Here, tailored interventions are often created to mimic to a certain extend person-to-person counseling (de Vries and Brug, 1999; Brug et al., 2003). Both target group segmentation—which also initially emerged within marketing (Tynan and Drayton, 1987; Plummer, 1974)—and personalization based on psychological characteristics such as people's stage-of-change (Brug et al., 1997; Prochaska and Velicer, 1997) are starting to be used. Initial evaluations show an increased effectiveness of these types of computer-tailored interventions over more traditional, "one size fits all" health education efforts (Brug et al., 1998; Brugg, 1990a,b). Noar et al. (2007) conducted a meta-analysis of the effects of tailoring on the success of health interventions based on over 50 published comparisons and derived the same conclusion: tailored interventions are more successful than generic ones.

Currently, however, most persuasive technologies described in the research literature or implemented commercially are not personalizing their "ways". This is striking since personalization of the end-goal is common place in commercial applications. Examples of the latter can be found in the rich literature on recommender systems (Kantor et al., 2011; Gretzel and Fesenmaier, 2006), or in the attempts to serving personalized ads through behavioral targeting (Stallworth, 2010). Notable exceptions do exist: Hauser et al. (2009) discuss how persuasive attempts in e-commerce can be made more successful by tailoring to customers cognitive style. Some of these approaches have likely made their way into commercial applications but the outcomes of these attempts are hardly shared with the research community. It remains that in most current persuasive technologies outside the marketing domain, the way in which the end goal is presented, alias the approach taken to influence users, is not adapted to the individual.

In this paper we detail how persuasive technologies can adapt the ways in which their users are persuaded—irrespective of the end goal—with the aim to increase the effectiveness of the technological interventions. In the current paper we focus specifically on the content of these interventions (see Davidson et al., 2003, for a taxonomy of intervention types). Possible taxonomies of *content* are provided in several fields, most noticeably by Michie et al. (2013) in behavioral medicine: our focus here is on persuasive user feedback (see also DiClemente et al., 2001). First, we discuss briefly some of the social psychology findings which motivate that designers of persuasive technologies should use the so-called *influence principles* to persuade their users. The effectiveness of these different means to influence the behavior of users has been shown convincingly by those studying persuasion and social influence. Next, we introduce explicit and implicit methods of personalization, and we propose four practical design requirements for the design of personalized persuasive systems. Finally, we describe three instances of adaptive persuasive systems to illustrate the challenges facing designers of such systems.

2. Persuasion and persuasive technology

In looking for a scientific foundation for designing persuasive technologies, designers and researchers often turn to social sciences that study persuasion, most notably psychology (e.g., Bless et al., 1990; Crano and Prislin, 2006). Within this large field several theories of attitude and behavior change, such as the transtheoretical model of behavior change (e.g., Prochaska and Velicer, 1997; Long and Stevens, 2004), and the theories of reasoned action and its follow up, the theory of planned behavior (see, e.g., Madden et al., 1992; Fishbein and Ajzen, 2011), have gained large support and are used actively by designers (see for example Consolvo et al., 2009). Also, classical psychological work on operant conditioning (Skinner, 1976) has made a mark on the design of persuasive technologies, most notably in efforts of gamification (Deterding, 2012). Fogg on his website on the Fogg behavioral model[1] describes a large list of influential models and theories for the design of persuasive systems such as social cognitive theory (Bandura, 1991), the heuristic-systematic model (Chaiken, 1980; Chaiken et al., 1989), the elaboration likelihood model (Petty and Cacioppo, 1986), work on resistance and persuasion (Knowles and Linn, 2004), cognitive dissonance theory (Festinger, 1957), and a number of others (e.g., Maslow and Herzeberg, 1954; Heider, 1944; Deci and Ryan, 2010). Finally, work in which (heuristic) decision making of individuals is studied, under the heading of behavioral economics (Kahneman and Tversky, 1979; Kukar-Kinney and Close, 2009), has been incorporated in attempts to design effective persuasive technologies.

Psychologists often describe different influence principles that can be used to change attitudes or behaviors. Similar descriptions of fixed principles (or strategies) to change attitudes or behaviors can be found in the marketing literature under the heading of sales influence tactics (McFarland et al., 2006). In our attempt to describe adaptive persuasive systems we focus on the literature regarding influence principles as pioneered by Cialdini and Trost (1998) and later followed up on by Cialdini (2001) and Guadagno and Cialdini (2005). These principles describe distinct psychological means that designers of persuasive technologies can use to increase the effectiveness of their persuasive applications.

2.1. Influence principles

The array of influence principles that can be used to change the attitudes and behaviors of users can be overwhelming. Both researchers and practitioners have made extensive use of the categorization of persuasive messages as implementing more general influence principles. Theorists have varied in how they individuate persuasive strategies: Cialdini (2001, 2004) develops six principles at length, Fogg (2002) describes 40 "strategies" under a more general definition of persuasion, Kellermann and Cole (1994) gather 64 groups from several existing taxonomies, and others have listed over 100 distinct tactics (Rhoads, 2007). These different counts result from differing levels of exhaustiveness, exclusivity, emphasis, and granularity (Kellermann and Cole, 1994). Influence principles are however a useful *level of analysis* that helps us to group and distinguish specific influence tactics or implementations of these principles (Kellermann and Cole, 1994; O'Keefe, 1994). In this paper we focus on the six influence principles as discussed extensively by Cialdini (2001). The effectiveness of each of

[1] See http://www.behaviormodel.org