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ePartners supporting behavior change

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Summary

The present report focuses on developing a comprehensive framework that guides the design of ePartners that support behavior change to promote health. An ePartner is an interactive, virtual or embodied computer assistant to which one can communicate and that assists persons through tailored advice, coaching and support.

Chapter 2 describes the general framework regarding behavior change. It starts with specifying the desired health goal and the behavior change to reach that goal. Next determinants that affect this behavior (change), and techniques changing these determinants are defined. These steps reflect the first steps of Intervention Mapping (Bartholomew et al., 2011), which is combined with situated Cognitive Engineering (Neerinx & Lindenberg, 2008). In order to evaluate this approach, we used three scenarios to develop baseline requirements for ePartners-that-care. It proved to be an efficient way to develop requirements, given the around 175 requirements and 40 use cases that were developed within the three scenarios in the sCE-tool.

The resulting number of requirements, behavior change techniques, determinants, and theories raise the question of managing this vast amount of data. One factor contributing to this large number is the level of abstraction at which requirements and use cases are formulated. Future research should focus on how to make and maintain the amount of theories, determinants, BCTs, and requirements applicable and searchable when designing ePartners-that-care. In addition, content information regarding the specific health (care) problem is also required as input for the ePartner.

Chapter 3 addresses how an ePartner can be tailored by describing the various approaches and terminology regarding tailoring. Within the health education domain tailoring is a well-defined approach, incorporating an elaborated ontology that positions tailoring on a dimension from generic, targeted, personalized, tailored to interpersonal communication. Also a method how to design tailored communication is observed in the literature. Finally, Chapter 4 provides a short introduction to the field of persuasive technology, because an ePartner is a technology whose features in itself may encourage its use and impact.

The general behavior change framework could be enriched by incorporating elements from tailoring and persuasive technology in its content (behavior determinants and behavior change techniques) and method (situated Cognitive Engineering and Intervention Mapping). However, this also poses the question at which level of abstraction the framework should operate and the scope of the framework.

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1 Introduction

An ePartner is an interactive, virtual or embodied computer assistant to which one can communicate and that assists persons through tailored advice, coaching and support (Neerincx, 2004). One of the domains in which an ePartner may be especially useful is health and health care (Blanson Henkemans, 2009). Changing demographics (i.e., rise of the ageing population), disease prevalences (i.e., increase in chronic and lifestyle-related diseases), and health care values (i.e., from paternalistic, disease-oriented to more shared and patient-centered) promote that citizens take more responsibility for their health and healthcare. An ePartner may empower citizens to do so and enable them to self-manage their health and illness. In the “ePartners that care”-project a general framework is developed and evaluated that provides the building blocks to design ePartners for this purpose.

Managing your own health concerns *behaving* in such a way that this is accomplished. This implies setting health-related goals (e.g., having friends at school and getting good grades), and enacting behavior (e.g., taking ADHD medication on time), to reach those goals, as well as to manage behavior when obstacles occur (e.g., forgotten to take medication to school, discuss this with a teacher), and facilitate the enactment on opportunities (e.g., set timer of smartphone as reminder to take medication). Two building blocks to design ePartners that care are therefore: setting goals and reaching goals. Originally each building block was addressed by a separate work package (WP 1 and WP 2, respectively), but given that setting and reaching goals are both part of behavior change these two packages were partly integrated.

Three aspects affecting the success of ePartners in supporting behavior change are described in the following chapters. Chapter 2 focuses on behavior change and techniques to realize this. It also addresses two methods to design (technological) interventions that support behavior change: Intervention Mapping (Bartholomew et al., 2011) and situated Cognitive Engineering (Neerincx & Lindenberg, 2008). In order to illustrate how more abstract theoretical concepts translate into concrete ePartners, three different health scenarios were chosen. For these scenarios, requirements were specified and described in use cases illustrating how an ePartner in a specific situation supports a user. A general condition that promotes the successful application of behavior change techniques is the extent to which they are tailored. Chapter 3 addresses how an ePartner can be tailored by describing the various approaches and terminology regarding tailoring. Finally, an ePartner is a technology whose features in itself may encourage its use and impact. Therefore, Chapter 4 provides a short introduction to the field of persuasive technology. In the final chapter the results are discussed and future directions are described.

2 Behavior (Change) Theory and Techniques

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Based on the literature and expert opinion, we developed a general framework describing the psychological processes affecting behavior change. Figure 1 depicts this framework. First a goal (an end-state) is set that a person wants to reach from a certain point (a start-state). This goal is reached by behavior change, for instance, a lower weight by more physical activity and a low-calorie diet. Behavior (change) is influenced by two processes: (a) an implicit, automatic, unconscious, associative, effortless process, and (b) an explicit, controlled, conscious, deliberative, demanding process (e.g. Evans, 2008; Hoffman et al., 2008; Strack & Deutsch, 2004).

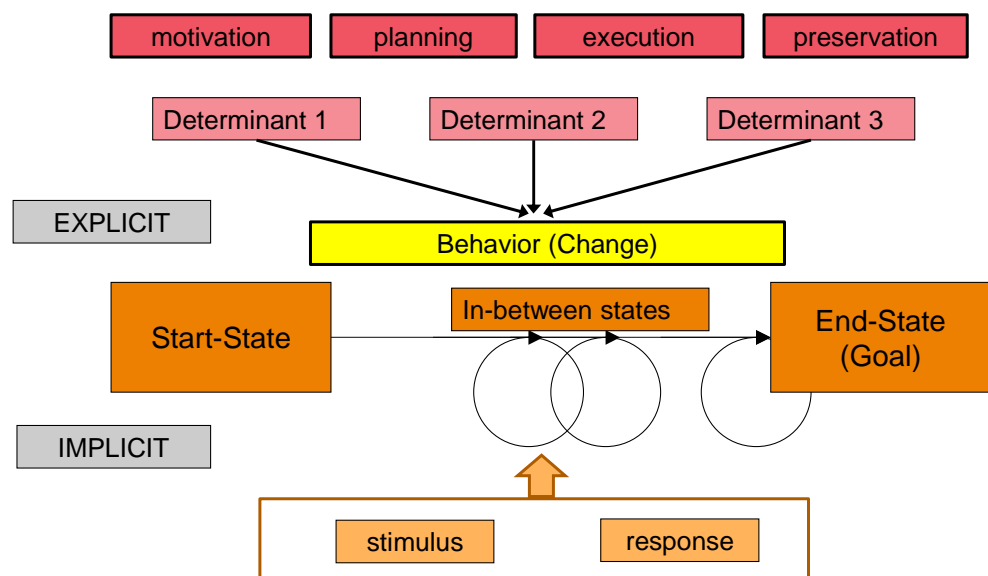


Figure 1: General framework describing the psychological processes affecting behavior change.

The explicit process mainly refers to social cognitive models of behavior change, like the Theory of Planned Behavior (Ajzen & Madden, 1986) and Social Cognitive Theory (Bandura, 1986), and self-regulation models (e.g., Vohs & Baumeister 2004). They specify determinants like attitude, response-efficacy or ego-depletion that affect behavior. The implicit process is a relative new field of research and refers to learned stimulus-response associations, like habits and implementation intentions (Sheeran et al. 2013); this is also referred to as cognitive bias modification. Bartholomew et al. (2011, chapters 2 and 3) provide an overview of several theories and determinants. For instance, the Theory of Planned Behavior states that behavior is influenced by the intention to perform that behavior (i.e., a goal), which is affected by the determinants: (1) the attitude towards that behavior, (2) the subjective norm regarding that behavior, and (3) the self-efficacy in performing that behavior.

Behavior change occurs in several phases (Gollwitzer, 1996; Prochaska & Diclemente, 1984; Rothman et al., 2011; Schwarzer & Luszczynska, 2008;

Weinstein et al. 1998). The following phases are discerned: (a) motivation phase, in which a person develops an intention (or goal) to act; (b) planning phase, in which the actions are planned; (c) execution phase, in which a person starts acting toward goal achievement; and (d) persistence or re-evaluation phase, in which the initiated behavior is maintained in order to achieve the end-state successfully. Depending on the specific phase of behavior change different determinants are effective.

2.1 Behavior Change Techniques

Most theories and determinants explain behavior, but do not describe how to change behavior. This distinction between explaining behavior and changing behavior is essential for methods that design interventions, like Intervention Mapping (Bartholomew et al. 2011). Also for designing ePartners it is a crucial distinction. Figure 2 displays the relation between behavior (change) theory and technique. Theories may explain behavior by describing determinants (e.g., self-efficacy from the Theory of Planned Behavior), or how to change behavior (e.g. modeling from Social Cognitive Theory), and provide limitations under which a determinant or technique is more or less effective (i.e., boundaries). For instance, modeling is more effective when the model is similar to the targeted person.

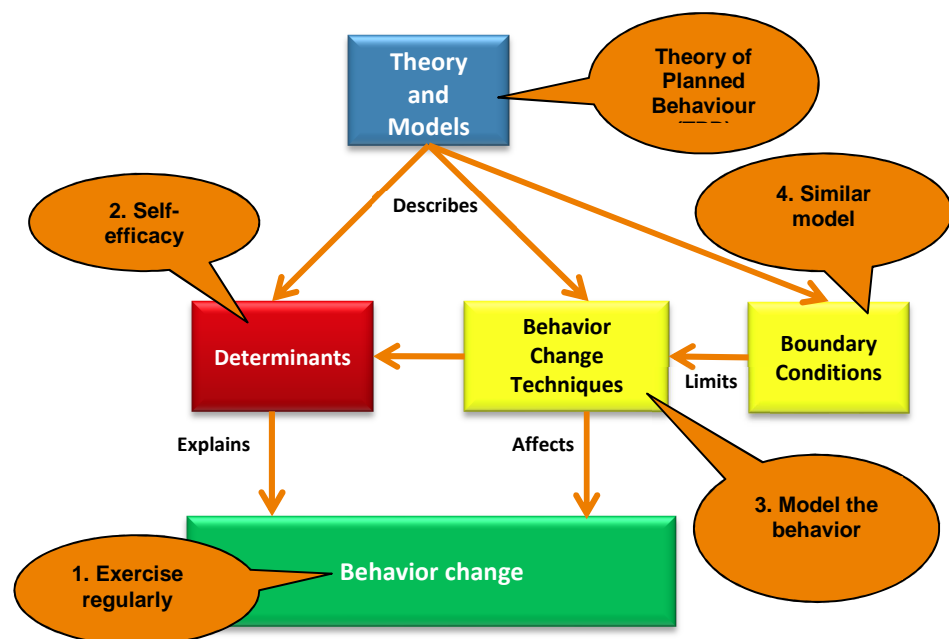


Figure 2: Relation between theory, technique and behavior, illustrated by promoting regular exercise.

Abraham and Michie (2008) defined 26 Behavior Change Techniques (BCTs) based on 195 descriptions of interventions to change a person's behavior (i.e., to increase physical activity and healthy eating). These 26 BCTs consisted of 22 single techniques, and 4 more encompassing techniques; relapse prevention, stress management, motivational interviewing, and time management. Dusseldorp et al. (2013) grouped these 26 BCTs into three phases of behavior change: Motivation phase, Planning phase, and Action/Continuation phase (see Table 1).

Several other classifications of BCTs exist. Abraham (2012) identifies 40 BCT's: the 26 from Abraham and Michie (2008) and 14 BCT's from Abraham et al. (2011). Roughly, these 40 techniques can be divided into "increase motivation", "enhance self-efficacy", "regulating feelings", "goals & plans", "social support", "environmental change", and "rewarding". These BCT's are linked to change processes, including antecedents and determinants of behavior (11 change mechanisms). Dixon and Johnston (2010) organized interventions into three competency domains: generic interventions, basic behavior change and specific behavior change techniques. The latter category comprised of 89 techniques. Three routes to behavior change are distinguished: motivation development, action on motivation, and prompted or cued behavior.

We used the 26 BCTs of Abraham and Michie (2008) (see Table 1) as a starting point for designing ePartners that care, because it is the most parsimonious categorization. In addition, it is used to categorize other interventions targeted at reduction of alcohol consumption and smoking (Webb et al., 2010) and promoting walking and cycling (Bird et al. 2013). These studies also provide empirical evidence that coding interventions in BCTs is useful, indicating that some BCTs are more effective than others for specific health activities.

Most of the 26 BCTs originate from an explicit process, although some are focused at establishing stimulus-response relations (e.g., habituation), like "prompt practice" (nr 17) and "Teach to use prompts or cues" (nr 15) and thus stimulate a more implicit process. Sheeran et al. (2013) describe possible BCTs based on implicit cognition, implicit affect, and implicit motivation. In a TNO Knowledge Investment Project 2012 several determinants and BCTs are discerned following from automatic processes, like attentional bias modification treatment, goal priming, implementation intentions, habit formation and approach/avoidance training (Blanson Henkemans, Keer & Otten 2012). These implicit-based BCTs are also considered in designing effective ePartners.

In a related TNO Enabling Technology Project a WIKI is developed in which Figure 2 provides the lay-out for the presented information (Open Innovation Smart Coach Project 2012). The WIKI is filled with theories, determinants, BCTs and boundaries, and their relations resulting from both implicit and explicit processes (see <http://wiki.scetool.nl/>).

Table 1. Overview of BCTs grouped into three phases: Motivation phase, Planning phase, and Action/Continuation phase. Techniques are numbered according to the taxonomy of Abraham and Michie (2008). One technique may be important for several phases. In this case, the technique is classified to the phase it was most important. (Adapted from Dusseldorp et al., 2013)

Motivation phase	
Technique	Definition
1. Provide information about behavior health link	General information about behavior risk, for example, susceptibility to poor health outcomes or mortality risk in relation to the behavior
2. Provide information on consequences	Information about the benefits and costs of action or inaction, focusing on what will happen if the person does or does not perform the behavior
3. Provide information about others' approval	Information about what others think about the person's behavior and whether others will approve or disapprove of any proposed behavior change
4. Prompt intention formation	Encouraging the person to decide to act or set a general goal, for example, to make a behavior resolution such as "I will take more exercise next week"
25. Motivational interviewing	Prompting the person to provide self-motivating statements and evaluations of their own behavior to minimize resistance to change
Planning phase	
5. Prompt barrier identification	Identify barriers to performing the behavior and plan ways of overcoming them
7. Set graded tasks	Set easy tasks, and increase difficulty until target behavior is performed.
8. Provide instruction	Telling the person how to perform a behavior and/or preparatory behaviors
9. Model or demonstrate the behavior	An expert shows the person how to correctly perform a behavior, for example, in class or on video
10. Prompt specific goal setting	Involves detailed planning of what the person will do, including a definition of the behavior specifying frequency, intensity, or duration and specification of at least one context, that is, where, when, how, or with whom
16. Agree on behavior contract	Agreement (e.g., signing) of a contract specifying behavior to be performed so that there is a written record of the person's resolution witnessed by another
19. Provide opportunities for social comparison	Facilitate observation of nonexpert others' performance for example, in a group class or using video or case study
20. Plan social support or social change	Prompting consideration of how others could change their behavior to offer the person help or (instrumental) social support, including "buddy" systems and/or providing social support
21. Prompt identification as a role model	Indicating how the person may be an example to others and influence their behavior or provide an opportunity for the person to set a good example
26. Time management	Helping the person make time for the behavior (e.g., to fit it into a daily schedule)

Action/Continuation phase	
6. Provide general encouragement	Praising or rewarding the person for effort or performance without this being contingent on specified behaviors or standards of performance
13. Provide feedback on performance	Providing data about recorded behavior or evaluating performance in relation to a set standard or others' performance, i.e., the person received feedback on their behavior.
15. Teach to use prompts or cues	Teach the person to identify environmental cues that can be used to remind them to perform a behavior, including times of day or elements of contexts.
17. Prompt practice	Prompt the person to rehearse and repeat the behavior or preparatory behaviors
11. Prompt review of behavior goals	Review and/or reconsideration of previously set goals or intentions
12. Prompt self-monitoring of behavior	The person is asked to keep a record of specified behavior(s) (e.g., in a diary)
14. Provide contingent rewards	Praise, encouragement, or material rewards that are explicitly linked to the achievement of specified behaviors
18. Use follow-up prompts	Contacting the person again after the main part of the intervention is complete
22. Prompt self-talk	Encourage use of self-instruction and self-encouragement (aloud or silently) to support action
23. Relapse prevention (relapse prevention therapy)	Following initial change, help identify situations likely to result in readopting risk behaviors or failure to maintain new behaviors and help the person plan to avoid or manage these situations
24. Stress management (stress theories)	May involve a variety of specific techniques (e.g., progressive relaxation) that do not target the behavior but seek to reduce anxiety and stress

2.2 Designing interventions like ePartners

Two methods to design (technological) interventions are recently used in combination by TNO (e.g., Blanson Henkemans et al., 2012): Intervention Mapping (IM, Bartholomew et al., 2011) and situated Cognitive Engineering (sCE, Neerincx & Lindenberg 2008). IM describes six steps to ensure that (health promotion) interventions are systematically developed and grounded in theory and evidence, and to maximize the likelihood for effects:

- 1 Conducting a needs assessment, in which the behavioral problem is examined as well as its determinants and environmental conditions constituting the behavior;
- 2 Creating matrices of change objectives based on the specified behavioral determinants and environmental conditions;
- 3 Selecting theory-based intervention methods and practical strategies;
- 4 Integrating these methods and strategies into an organized program;
- 5 Planning for the adoption, implementation and sustainability of the program; and
- 6 Generating an evaluation plan.

Steps 1 to 3 are also reflected in Figure 2, in that step 1 represents the behavior, step 2 the determinants, and step 3 the BCTs. These 3 steps will result in the

design of an application in step 4. In designing this specific application the sCE-method is especially useful.

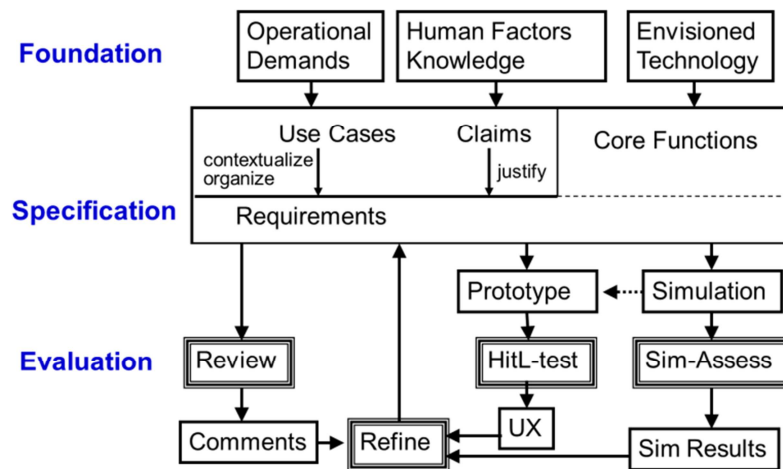


Figure 3. Description of the three phases of situated Cognitive Engineering.

The sCE method originates from the field of cognitive engineering: a science of user-centred design for systems comprising of both people and machines (Neerincx & Lindenberg, 2008). Figure 3 depicts the three phases in the development process of sCE. In the present ePartner project and a related TNO Enabling Technology Project (Open Innovation Smart Coach Project 2012) the specific interaction and combination of IM and sCE have evolved. Generally speaking the interaction and combination between IM and sCE is as follows. In sCE's foundation phase IM's steps 1-3 are incorporated as part of Human Factors Knowledge. IM's step 4 (designing the application) is represented in sCE's Specification phase. IM's steps 5 and 6 are located in sCE's Evaluation phase.

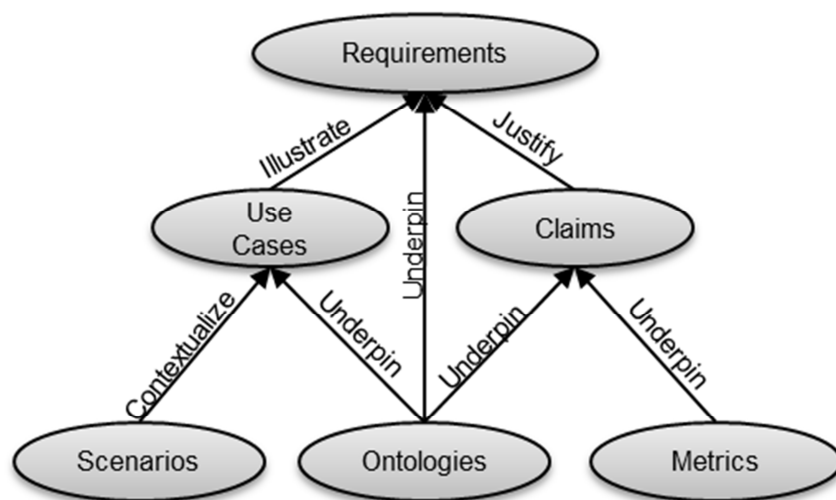


Figure 4. Description of specification phase of situated Cognitive Engineering.

The logic of the foundation and specification phase of sCE is also represented in Figure 4. Scenarios provide a general description of the behavioral problem (cf. IM's step 1). Use cases describe specific interactions between a user and the ePartner

illustrating how in a certain scenario BCTs are enacted in order to go from the starting state/situation to a desired state/situation. In doing so also the requirements for the ePartner are clarified, that is, WHAT the ePartner should do to produce the desired state/situation. Claims provide justifications for the requirement (WHY, e.g., expected effects on determinants and behavior).

Five steps of the IM-method are added to the sCE tool (sCET, see www.scetool.nl) as an optional module. The IM step “Planning for the adoption, implementation and sustainability” is not implemented. The IM-module provides an overlay that routes one through the IM-steps that are automatically linked to the relevant sCE routines, thus one does not need to pay attention to the specifics of the sCE-phases. Therefore, the sCETool is now suited for developers of ePartners who want to apply sCE or IM.

2.3 Scenario's, use cases and requirements for ePartners

In order to test the framework and building blocks described in sections 2.1 and 2.2 three scenarios were chosen to represent the variety in the health and health care domain.

- 1 Stephan a child with ADHD who needs to adhere to his medication and to structure his daily activities; and
- 2 Rashid an overweight adolescent who needs to improve his lifestyle, that is, exercise more and eat more healthy; and
- 3 Mr. King an elderly man with three conditions (osteoarthritis of his hips and knees, heart rhythm disorders, and the loss of his wife made him gloomy) living alone independently needs to maintain social contacts and to exercise regularly.

These scenarios differ regarding (a) age of the actor, (b) mental and/or physical health problems, and (c) prevention, cure or care.

Within these scenarios, behavior was chosen that needed to change to obtain a desired goal, determinants of that behavior were formulated, and BCTs to influence those determinants. Next, use cases were described that illustrated what the ePartner required in order to apply a BCT. This practical test of the framework is executed within the sCETool, in which the relevant data are described in the ePartners that care-project map. It proved to be an efficient way to develop requirements, given the around 175 requirements and 40 use cases that were designed for the 3 scenarios. Given this amount, the project group decided to choose three use cases per scenario as showcases. In this section we describe one showcase of each scenario as an example of requirements necessary to support behavior change by an ePartner following the framework described above. Other requirements in the sCET-project map also reflect the demands of the other Work Packages, namely “Interaction design patterns” and “privacy”.

Example Scenario Stephan child with ADHD

Behavior: taking medication on specific moments

Determinant: barriers

BCT: prompt review of behavior goals

Use case Action sequence:

- ePartner notifies the user at an appropriate moment (private, quiet) to reflect on progress on goals
- ePartner indicates that user does not perform activities that contribute to goal behavior (and shows several moments)
- ePartner indicates that this was a goal they both agreed upon

- User indicates that he did not notice the reminders
- ePartner shows the moments of these reminders
- User sees that he is not wearing the smartwatch during these times
- ePartner suggests to shift the reminders earlier on the daily schedule
- User agrees

Requirement: ePartner shall give performance feedback.

Example Scenario Rashid overweight adolescent

Behavior: buy healthy food

Determinant: attitude, knowledge

BCT: Provide information on consequences

Use case Action sequence:

- The ePartner invites the user to play a nutritional product game in supermarket
- The user accepts the invitation
- The ePartners asks the user which product he/she intended to buy
- The user answers to intend to buy unhealthy food and drinks (e.g. a bag of chips and a soda)
- The ePartner challenges the user to find three more and three less healthy products within the intended product range
- The user fulfills the challenge by looking at number of carbs of various products in range
- The ePartner challenges the user to find three more and three less healthy products outside the intended product range (e.g., vegetables, water)
- The user fulfills the challenge by looking at the number of carbs of various products outside the range
- The ePartner provides rewards for fulfilling the challenges
- The ePartner asks the user what he/she assesses from the challenges (i.e., comparison of products)
- The user reflects on the game outcomes (e.g., intended products are very unhealthy and there are healthy and enjoyable alternatives)
- The ePartner thanks the user for his/her time

Requirement: The ePartner shall initiate and accommodate playing known games, harmonized to the user goals and momentary context.

Example Scenario Mr King elderly person with comorbidity

Behavior: train as proposed by physiotherapist

Determinant: (implementation) intention

BCT: prompt Specific goal setting

Use case Action sequence:

- ePartner reminds the user of the training
- ePartner asks whether the user is motivated to perform the behavior
- User answers he is not
- ePartner suggests exercises that match the personal interests of the user
- ePartner suggest that the user sets a goal for training regarding these exercises
- User agrees
- ePartners suggest that the goal should be specific regarding time and context
- User sets a goal
- ePartner checks whether the goal is specific regarding time and context
- ePartner qualifies the goal on specificity, proximity and whether it matches with personal values

- ePartner provides feedback on whether the goal is specific, proximal and personal enough
- User adjusts the set goal according to the feedback of the ePartner
- ePartner saves the goal for later review
- ePartner thanks the user and ends

Requirement: ePartner shall adapt to user's characteristics.

2.4 Conclusion

The general framework regarding behavior change starts with specifying the desired health goal and the behavior change to reach that goal. Next determinants that affect this behavior (change), and techniques changing these determinants are defined. These steps reflect the first steps of Intervention Mapping (IM, Bartholomew et al. 2011). IM is combined with situated Cognitive Engineering (sCE, Neerinx & Lindenberg, 2008) to specify the requirements for an ePartner-that-cares in which behavior change techniques are applied. This framework was successfully employed using 3 health (care) scenarios, resulting in 40 use cases and around 175 requirements. Given the limited timeframe of the project, we illustrated the usefulness of the framework, but we did not exhaust the amount of requirements and use cases that could be described.

One of the reasons for the expanding number of requirements and use cases is that within the framework one goes from a very general, abstract level to a more specific, concrete level. For one general behavior change technique various concrete use cases can be described. Also use cases and requirements can be described at different levels of concreteness. However, even the 175 requirements were quite a lot to handle and search through when connecting use cases to specific requirements.

In the ePartners-that-care project map of sCET we made a categorization while developing the requirements. Examples of the seven main categories are "interact with persons and other systems", "monitor user and environment", and "privacy". However, a considerable overlap consisted between the categories. In future projects, a next step is to define a structure of the requirements beforehand, and adjust this categorization when defining new ePartners.

The expansion not only relates to the amount of requirements, but also applies to the number of BCTs, determinants, behaviors and goals. Although the behavioral framework provides a logic, that is, a BCT influences a determinant, which affects behavior, these are not one-to-one relations. One determinant (e.g., Attitude) can be influenced by several BCTs, but also one BCT (e.g., Provide opportunities for social comparison) may affect several determinants. One way to structure the number of determinants and BCTs is to use phases of behavior change and implicit versus explicit processes (see Figure 1 and Table 1). Another possibility is to categorize BCTs from more generic to specific behavior change techniques (cf., Dixon & Johnston, 2010). Future research should focus on how to make and maintain the amount of determinants, BCTs, and requirements applicable and searchable when designing ePartners-that-care.

A general technique that promotes the successful application of more specific behavior change techniques is the extent to which they are tailored. The next Chapter 3 addresses how an ePartner can be tailored by describing the various approaches and terminology regarding tailoring. Tailoring may also provide another approach how to structure the amount of determinants, BCTs and requirements.

3 Tailoring

H. van Keulen, W. Otten

An ePartner is considered a useful medium for tailoring because it can take into account many tailoring variables. In addition, it can interact with the user and adapt to the user's characteristics. Tailoring is thus seen as a special feature of an ePartner. However, what is meant by "tailoring"?

Within the health education domain, the term "tailoring" ("advies-op-maat") is frequently used. Tailored communication is defined as any combination of information or change techniques intended to reach one specific person, based on characteristics that are unique to that person, related to the outcome of interest, and have been derived from an individual assessment (p.1; Kreuter & Skinner, 2000). Besides tailoring other terms are used that seem to refer to similar or dissimilar communication forms, for example, personalized ("gepersonaliseerd"), targeted or segmented, adaptive, situated, and recommendation. Because research findings show that there can be significant differences in the effectiveness of these approaches (Broekhuizen et al., 2012; Noar et al., 2007), it is necessary to standardize the terminology. Such an ontology further facilitates collaboration and communication. Within ePartner, a clear description of the (dis)similarities between terms with regard to tailoring will therefore be made.

3.1 Methods

First, the definitions of tailoring and similar terms are described from the health education domain and MESH-terms in the research database PubMed. Next, people from a tailoring network (i.e., colleagues from TNO who work with tailoring from a variety of disciplines) are asked to complement the definitions with their expertise from other domains. Finally, other TNO-projects that focused on eHealth or ePartners are consulted for complementing the definitions of tailoring (PERISCOPE, ADMIRE, Smartcoach, ALIZ-E, SWELL).

3.2 Results

Tailoring has not been defined as a MESH-term within the PubMed research database. The tailoring ontology will therefore be mainly based upon literature from the health education domain. First, the health education domain will be explained, followed by a description of the tailoring ontology within this domain. Subsequently, the evidence for tailoring will be outlined, as well as the theoretical framework for tailoring. Next, when to use tailoring and frameworks for developing and implementing a tailored intervention will be described. Finally, terms denoting tailoring from other domains are described.

3.2.1 *The health education domain*

The health promotion domain is described as combinations of educational, political, regulatory, and organizational supports for behavior and environmental changes that are conducive to health (Green & Kreuter, 2005). Health education is a subset of health promotion and is primarily based on education. Health education is expected to change health behavior through behavioral determinants (e.g. knowledge, awareness, risk perception, attitudes, social influence). The health

education domain has much ground in common with the (health)psychology domain, because both recognize the importance of theoretical models to explain as well as to change behavior. Within the health education domain, tailoring is recognized as one of the basic behavior change methods, because it turned out to be useful for almost any determinant at the individual level (Bartholomew et al., 2011).

3.2.2 Tailoring ontology within the health education domain

Within the health education domain, the individualization of health communication involves two processes:

- *Segmentation* is the degree to which the audience is divided into increasingly more defined, homogenous groups (Hawkins et al., 2008). The higher degree of segmentation, the more information is needed from recipients to determine the segmentation variables. Therefore, Kreuter and colleagues (2000) describe this as the dimension *level of assessment*, which they define as the extent to which an individual's characteristics have been assessed in order to drive the communication.
- *Customization* is the degree to which the messages (layout, channel, content, source etc) reflect relevant individual characteristics (Hawkins et al., 2008). This is similar to the definition used by Kreuter et al. (2000) for the dimension *content of communication*, that is the degree of individualization in the communication itself.

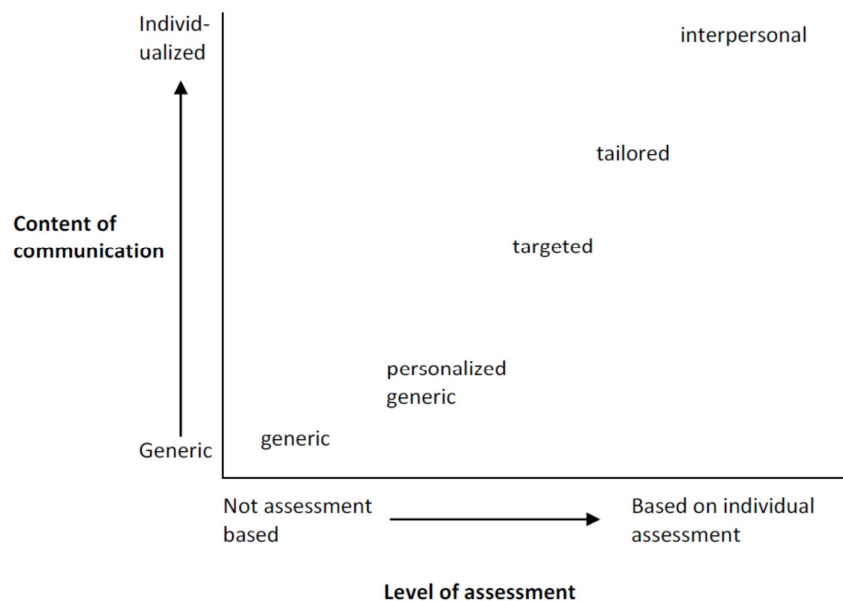


Figure 5. Classification of health communication approaches (Kreuter et al., 2000)

Both processes or dimensions are linked to each other; the degree of individualization will increase as the level of assessment increases and vice versa (Kreuter et al., 2000). On the continua of both processes or dimensions, communication strategies overlap (see Figure 5). In general, five health communication approaches have been identified (Kreuter et al., 2000), that is generic, targeted, personalized, tailored and interpersonal communication. The definitions of these communication methods are described below:

- 1 *Generic communication* is information intended to reach groups of individuals by using a medium other than personal contact without taking into account the characteristics of those to whom the communication will be offered, and offers a means to reach large numbers of people (Kreuter & Skinner, 2000). The information is not individualized or based on any kind of individual assessment (Noar et al., 2007). An example of generic communication is a general brochure on the risks of smoking that one might read in a doctor's office.
- 2 *Targeted communication* or *targeting* is an intervention approach for a defined population subgroup that takes into account characteristics shared by the subgroup's members. From a marketing perspective, targeting is also referred to as *market segmentation* (Kreuter & Skinner, 2000). An example of targeting is breast cancer screening material for older women.
- 3 *Personalized communication* or *personalization* is a form of generic feedback, with the distinction that in personalized generic feedback, a personal characteristic, such as the name of the receiver, is used to personalize the message (Kreuter et al., 2000; Noar et al., 2007). Personalization is generally used to draw attention to and enhance message processing of the generic message, but there is also some evidence that they affect behavior directly (Dijkstra, 2005). An example of personalization is a mass mailing for the lottery ('Peter Jansen, you may have already won 2.500.000 euro').

Hawkins and colleagues (2008) state that personalization is one of the strategies (besides feedback and content matching) through which tailoring goals can be achieved. The three most common personalization tactics are (Hawkins et al., 2008):

- *Identification*, this involves identifying the receiver in the message, for example by mentioning the name, including pictures of the recipient or recognizing recipient's birthday.
 - *Raising expectation of customization*, this involves overt claims of customization, for example 'the following health information has been created especially for you'.
 - *Contextualization*, this involves framing the message in a context that is meaningful to the recipient, for example using demographic characteristics of patients to select age- and sex-matched images to include in mammography letters, or a message from which the source matches the receiver's demography or preferences. Other used contextualization variables were family structure (e.g., framing dietary messages differently for parents of children in different age categories), residential status (e.g., framing messages on home injury prevention differently for renters versus owners), ethnicity/culture and personal interests.
- 4 *Tailored communication* or *tailoring* is any combination of information or change strategies intended to reach one specific person, based on characteristics that are unique to that person, related to the outcome of interest, and have been derived from an individual assessment (Kreuter & Skinner, 2000). Because the computer is often used to generate tailored feedback, tailoring is also referred to as *computer tailoring*. Tailoring can be applied once or multiple times. When tailoring is applied multiple times, it can be either *static* (providing one baseline

assessment on which to base all successive feedback) or *dynamic* (assessing communication variables prior to each feedback) (Krebs et al., 2010).

For each of the following types of tailoring examples are provided:

- *Action tailored communication* is information on how to change behaviors and what to do in difficult situations (Kroeze et al., 2008). Action tailored information is used to improve skills and self-efficacy expectations. An example of action tailored communication is feedback about how a receiver could change his diet based on an analysis of the contributing products to saturated fat intake of this participant, and suggestions for dealing with situations in which a receiver thought it would be difficult to reduce saturated fat intake.
- *Descriptive tailored communication* is defined by Hawkins et al. (2008) as information about what is known about the recipient (i.e., attitudes, beliefs, behaviors, etc.) based upon an assessment. This definition is similar to the first part (a) of *personalized tailored communication* (Kroeze et al., 2008), that is (a) information about the receiver's behavior, (b) a comparison of (a) with the recommended behavior, and (c) a comparison of (a+b) with the receiver's perception of his/her own behavior (e.g., perceived as low fat intake compared to actual high fat intake). Because part (b) and (c) are also referred to as evaluative tailored communication and to facilitate future communication about these types of tailored communication, we will refer to personalized or descriptive tailored communication as defined by Hawkins et al. (2008; thus excluding part (b) and (c) from Kroeze et al., 2008). Hawkins and colleagues (2008) argue that this type of feedback influences behavioral determinants by stimulating self-referential thoughts about beliefs, behaviors or environmental constraints related to the outcome of interest. In addition, it could build rapport or lower resistance to persuasion through effects as 'feeling acknowledged' or 'feeling understood'. Personalized or descriptive tailored communication differs from personalized communication or personalization, in that the first is used to increase awareness, whereas the second is used to draw attention and enhance message processing. An example of personalized or descriptive tailored communication is feedback about the receiver's fat intake (e.g., 'Based on your answers on the questionnaire, we determined that you eat 24 grams of fat per day').
- *Normative tailored communication* is defined as messages based on a comparison of the receiver's responses to an assessment of the responses of their peers (Kroeze et al., 2008; Noar et al., 2007). This is also referred to as *comparative tailored communication* by Hawkins et al. (2008). Normative or comparative tailored communication may stimulate changes in perceived norms, attitudes or beliefs through effortful processing on self-evaluation and normative comparison (Hawkins et al., 2008). An example of normative tailored communication is feedback about the receiver's fruit and vegetable consumption compared to that of others of the same institution, age or sex (e.g., 'Compared to other women from this health center, you eat fewer servings of fruits and vegetables per day').
- *Ipsative tailored communication* are messages based on a comparison of the receiver's current responses to an assessment with their responses at a previous time point (Noar et al., 2007). This is also known as *iterative tailored communication* (De Vries & Brug, 1999). Ipsative or iterative tailored communication are a form of dynamic tailoring. Both are used to enhance self-monitoring, which may increase central information processing (Dijkstra & De

Vries, 1999). An example of ipsative or iterative tailored communication is feedback about the receiver's current energy-saving behavior compared to the previous year, for example whether the receiver has become more energy-saving, less energy-saving or shows stable energy-saving behavior.

- *Evaluative tailored communication* involves feedback that makes interpretations, judgments or inferences based on what is known about the receiver's attitudes, beliefs or behaviors (Hawkins et al., 2008). This type of communication is used to change behavioral beliefs through providing new insights to a person's behavioral or psychological state, because the tailoring agent may be perceived credible (Hawkins et al., 2008). An example of evaluative tailored information is 'your physical activity level is well below the recommended level of 30 minutes of moderately intense activity on at least 5 days of the week' or 'you said you intend to start exercising regularly. That could be a good way to lower your blood pressure'. Evaluative tailored communication overlaps with the before mentioned types of tailoring, because all of them may contain evaluative information.
- 5 *Interpersonal communication* is the most individualized form of communication, the communication is delivered by a real life person (Noar et al., 2007). An example of interpersonal communication is a counseling session of a nurse practitioner with a diabetic patient about the patient's lifestyle behaviors. Although interpersonal communication can be generic in nature, for example when the provider delivers general health information without taking into account the characteristics of the receiver, it has the greatest potential to be the most highly individualized due to its real life nature (Noar, Harrington & Aldrich, 2009). The level of individualization depends on the knowledge, skill and motivation of the provider (Spitzberg & Cupach, 1984).

3.2.3 *Evidence for tailoring within health education*

This paragraph describes what is known so far from the health education domain about the general evidence for effects of tailoring, the evidence for specific types of tailored feedback as well as the evidence for the type of determinants used in tailoring.

General evidence for tailoring. In general, tailored communication has been found to be more effective than targeted or generic communication in promoting health behavior change (Broekhuizen et al., 2012; Enwald & Huotari, 2010; Eyles & Mhurchu, 2009; Neville et al. 2009; Noar et al., 2007; 2009), because it improves exposure and information processing, is better appreciated, and more likely to be read and experienced as personally relevant (Brug et. al., 2003; Hawkins et al., 2008; Ruiters et al., 2006). Because tailored information is often not delivered by a real life person, the strategy is suitable for reaching large groups of people (Neville et al., 2009). Due to their possibilities for a wide reach at relatively low costs, tailored interventions have substantial impact at a population level (Neville et al., 2009a; Noar et al., 2007). Evidence for the cost-effectiveness of tailored interventions is scarce, however, a study showed that tailoring appeared more cost-effective than a person-delivered intervention (Van Keulen et al., 2010).

Evidence for specific types of tailored feedback. More research is needed into the evidence for the effectiveness of certain types of tailored feedback. Up until now, some evidence exists supporting certain feedback types. Dynamic tailoring has

shown to produce larger effects than static tailoring (Krebs et al., 2010). Studies using more intervention contact points produced more change than those that did not (Noar et al., 2007). Noar and colleagues (2007) therefore suggested that adding iterative or ipsative feedback to a tailored intervention may thus increase its behavioral effects. In addition, a combination of personal, normative and action tailored feedback was most effective in changing awareness, intention and behavior compared to personal feedback only or personal normative feedback only (Kroeze et al., 2008).

Evidence for tailoring on specific determinants. There is little known about the effects of tailoring on specific determinants. Evidence so far showed that tailoring on a combination of demographics, theoretical constructs as well as on behavior itself seemed to produce larger effects than tailoring on demographics only, theoretical characteristics only, behavior only, or theoretical concepts plus demographics or plus behavior (Noar et al., 2007). As for theoretical constructs, it was shown that tailoring on attitude, self-efficacy, stage of change, processes of change and social support produced larger effects than studies that did not include these constructs (Noar et al., 2007).

3.2.4 *Theoretical framework for tailoring within health education*

Table 2 gives an overview of theories that are often used to develop tailored interventions depending on the purpose and outcome of tailoring. Theories used to explain the rationale for the evidence of tailoring will be described hereafter, followed by theories that are often used for the development of tailored interventions.

Theories explaining the evidence of tailoring. The rationale for the evidence of tailoring has been attributed to the Elaboration Likelihood Model (Petty and Cacioppo, 1981). The ELM recognizes two routes of information processing. While the peripheral route relies on a more superficial processing of information by heuristics or cues, the central route requires more cognitive processing and careful examination of the arguments contained within a message. The central route is more likely to result in stable attitudes and future behavior than peripheral processing. Because the processing route depends on the individual's involvement with information, tailored information is more likely to give rise to central route processing than generic information. However, feedback has to be convincing in order to minimize adverse reactions, because the central route also involves counter-argument and evaluation of the credibility of arguments (Hawkins et al., 2008). The extent to which people engage in central information processing is influenced by personal involvement with and understanding of the message (Petty & Cacioppo, 1981). Because tailored communication is perceived as personally relevant more often than generic communication (Brug et al., 2003; Hawkins et al., 2008; Ruiter et al., 2006), it is more likely that central information processing occurs, and as a result, attitude and behavior change. Ipsative or iterative tailored communication is used to increase central information processing through promoting self-monitoring (Dijkstra & De Vries, 1999).

Table 2. Outcomes which can be achieved by tailoring (adapted from Noar, Harrington & Aldrich, 2009)

Purpose	Theories	Variables types	Specific variables	Outcomes
Match content to individual's information needs & interest	TTM, Stages of change, HBM, SCT, TRA, Extended Parallel Process Model	Psychosocial variables, past behavior	Attitudes, beliefs, self-efficacy, social norms, perceived susceptibility, perceived severity, behavioral intentions, stage of change, previous behavior	Persuasion (intervention convinced me)
Use design, production, and channel elements to capture and keep individual's attention	Activation Model Sensation-seeking Targeting limited Capacity Model	Message design variables ('look and feel')	Message sensation value	Attention (intervention kept my attention)
Place information in a meaningful context	Audience segmentation Personalization Culturally-oriented theories	Demographic, cultural variables	Gender, age, race, gender norms, cultural norms, ethnic identity, racial pride, religiosity, collectivism	Perceived relevance (intervention was designed for me and reflects my beliefs and values)
Present information in type and structure preferred by individual	Exemplification Theory Narratives Entertainment Education Message Framing Emotional appeals	Message structure variables (type of appeal)	Narrative versus statistical Gain versus loss framing Fear, guilt, warmth, and other appeals	Message processing (intervention made me think, I am able to recall information, later on)

Another theory which has been used to explain the effects of tailoring is the Precaution Adoption Process Model (PAPM; Weinstein, 1988). The PAPM recognizes five stages to behavior change: unaware of the issue, aware of the issue but not personally engaged, engaged and deciding what to do, planning to act but not yet having acted, and acting. Personalized or descriptive tailored feedback and normative or comparative tailored information are an important strategies to improve awareness and motivation to change (Weinstein & Sandman, 2002). The PAPM also states that action tailored information is needed to improve skills and self-efficacy expectations in order to translate motivation into actual behavior change (Weinstein & Sandman, 2002).

Theories used in tailored interventions. To develop tailored interventions, behavior explanation theories (e.g. The Theory of Planned Behavior; TPB; Ajzen & Madden, 1986) are used to explain which determinants influence behavior, whereas behavior change theories (e.g., Social Cognitive Theory; SCT; Bandura, 1986) are used to change these behavioral determinants. The following behavior explanation theories or behavior change theories have been widely used in tailored interventions (Broekhuizen et al., 2012; Noar et al., 2007): the Transtheoretical model (TTM;

Prochaska et al., 1992), the Health Belief Model (HBM; Janz & Becker, 1984), the Theory of Reasoned Action (TRA; Fishbein & Ajzen, 1975), the TBP (Ajzen & Madden, 1986), and SCT (Bandura, 1986). These theories incorporate a number of social-psychological determinants that may influence behavior change. Similar constructs across the theories include attitudes and beliefs, self-efficacy, social norms, perceived threat, behavioral intentions, and stages of change. In tailored communication, the message content is based upon theoretical constructs that are known to influence the behavioral outcome of interest. The right messages are tailored to the right person; constructs that do not need to change for that specific person can be de-emphasized or ignored, while those that need to change can be emphasized in the message (Noar et al., 2009). For example, a person who plans to be physically active according to the recommendations in the next month and has formed the action plan 'inform others about this plan' may receive the following message: "You have indicated that you want to inform others about your plans to increase your level of physical activity. This is important, because others can then support and stimulate you in carrying out your plans. It may also help you to stick to your plans." whereas a person who has no plans to be physically active will not receive tailored messages on action plans.

Up till now, tailoring has mostly focused on these before mentioned theoretical determinants. This type of classic tailoring was called content tailoring (i.e., matching content to information needs and interests) by Rimer and Kreuter (2006). To further increase intervention efficacy, they have argued for three additional tailoring approaches (Noar et al., 2009): 1) using design, production and channel elements to capture attention and enhance message processing (e.g., tailoring on need for cognition or sensation seeking); 2) placing information in a meaningful context (e.g., tailoring on demographic factors) to increase perceived relevance of the tailored intervention; and 3) presenting the type and structure of information preferred by participants (e.g., tailoring on delivery mode or message frame) to enhance message processing. This approach also fits with for instance the Persuasion-Communication Matrix of McGuire (1985), in which key elements (source, target, channel and content) are matched with determinants (attention, understanding, attitude change etc.). These approaches, including possible theories and theoretical constructs, are listed in Table 2.

3.2.5 *Development of tailoring in health education programs*

This paragraph describes when to use tailoring, followed by two frameworks that are often used to develop tailored interventions: the Intervention Mapping framework and the tailoring framework.

When to use tailoring. A tailored approach is needed when there is a large variation between individuals in behavior and behavioral determinants (Brug et al., 2003; Kreuter, Strecher & Glassman, 1999). For example, with regard to physical activity and nutrition behavior, Kreuter and colleagues (1999; 2000) showed that there was considerable individual variation in the important predictors of behavior change. By surveying a range of behaviors and behavioral predictors (e.g., stages of change, barriers and outcome expectations) they were able to identify 78% (physical activity) and 98% (nutrition) of study participants who would have received a unique set of messages (i.e., not received by any other participant), had this individual variation been taken into account (Kreuter et al., 1999). This individual variation indicates the need for interventions that address personal differences in perceptions and performance with regard to these behaviors.

Intervention Mapping. The Intervention Mapping framework is described in section 2.2.

Tailoring framework. Specifically for the development and implementation of tailored interventions, Kreuter et al. (2000) have developed an organizing framework of nine steps:

- 1 Analyzing the health problem: the objective is to learn as much as possible about the health outcome of interest, the behaviors influencing the health outcome, behavioral determinants. Only when these factors are clearly identified and well understood can they be accurately measured and then adequately addressed by tailored messages. For example: when creating tailored communication to promote breast-feeding, one needs to know about the factors that influence a woman's decision whether to breast-feed (e.g. beliefs, values, motivation, social support).
- 2 Developing a program framework: an outline is created to describe all the parts of the tailored health communication program. In order to tailor the framework to the target group, it is necessary to gather information about the topic from members of the target group. For example, the first part of the communication addresses misconceptions about health benefits of breastfeeding for the mother and baby, followed by suggested solutions for situations when mothers find it difficult or embarrassing to breast-feed, and finally, information to help mothers talk with friends about breast-feeding.
- 3 Developing tailoring assessments: creating the assessment tools used to collect information. For example, developing an online questionnaire with questions about beliefs, attitudes, social influences with regard to breast-feeding.
- 4 Designing the tailored feedback: deciding about the design and presentation of the tailored program to participants. The design has to be based on understanding of the needs and preferences of the target group and the nature of the health problem addressed. For example, developing an online virtual assistant for delivering the tailored message because mothers prefer interactive, online information about breast-feeding.
- 5 Writing tailored messages: the actual content of the communication is created by developing a large library of different messages to all possible responses or combinations of responses to questions in the tailoring assessment. For example, mothers with low self-efficacy expectations towards breast-feeding will receive another message than mothers with a high self-efficacy expectations.
- 6 Creating tailoring algorithms: linking the messages in the library to the questions in the tailoring assessment by using if-then algorithms (i.e. logic statements or decision rules that specify which messages should be given to which participants under which circumstances). For example: creating a rule that IF mothers had a low score on subjective norms (i.e., who perceived negative attitude from persons from the close environment) THEN they will receive a message about how to deal with this negative subjective norm.
- 7 Automating the tailoring process: translating the algorithms into a computer program that automatically performs the final tailoring tasks. The computer program matches participants' answers with specific tailored messages and places messages into a final feedback format. For example, tailoring software (e.g., tailorbuilder) is used to generate tailored feedback through an online, virtual avatar.

- 8 Implementing the program: the tailored program is actually put into use. For example, mothers will receive an e-mail invitation with a link to a website with an online questionnaire and tailored feedback about breast-feeding.
- 9 Evaluating the program: systematically evaluating the effectiveness of the program. For example, it will be examined whether mothers received the tailored feedback, whether they liked it, and whether the information made them positively change their breast-feeding behavior.

To increase the effectiveness of tailored interventions, the steps in both Intervention Mapping and tailoring frameworks have to be performed in close collaboration with the target group. For example, for step 1 in both frameworks (needs assessment / analyzing the health problem), members of the target group can be involved through focus group interviews or surveys, whereas in step 4 of the tailoring framework (designing tailored feedback) members of the target group can be involved by means of pretest of designed materials.

In order to develop and implement a tailored ePartner, both the Intervention Mapping and tailoring frameworks are recommended and need to be integrated. The situated Cognitive Engineering tool (sCET) has proven useful for the development of virtual assistants such as the ePartner (Neerincx & Lindenberg, 2008; Blanson Henkemans et al., 2009). The Intervention Mapping framework and sCE have recently been integrated as a method and in the sCE-tool to design ePartners (see Chapter 2). However, to use tailoring in ePartner, it is also recommended to integrate the tailoring framework within the Intervention Mapping framework and SCET in the future.

3.2.6 *Tailoring within other domains*

This section gives a first impression of the tailoring ontology from outside the health education domain, specifically from the artificial intelligence domain:

Adaptive communication: Adapting the communication to the receivers' needs and preferences perceived through the interaction between the receiver and the program. For example, a person receives a wake-up call from a virtual travel ePartner 30 minutes before his or her next appointment, because the receiver estimated that he or she needs 25 minutes to get to this appointment and was five minutes late for the last similar appointment, whereas after five times being on time, the wake-up call will be provided 25 minutes before his or her next appointment (Paul van den Haak, personal communication, 29 november 2012).

Situated communication: Adapting the communication to the situation in which the receiver behaves. For example, the virtual travel ePartner does not disturb the receiver while driving in his or her care to guarantee safety (Paul van den Haak, personal communication, 29 november 2012).

Persuasive technology: using interactive computer systems to change people's attitudes and behaviors (Fogg, 2003). For example, the virtual travel ePartner convinces the receiver to change gear in time in order to save fuel and to save money. Persuasive technology features in Chapter 4.

Recommendation: Providing behavioral advice. For example, a virtual travel ePartner advises the receiver to travel to the next meeting by public transport to avoid traffic-jam (Paul van den Haak, personal communication, 29 november 2012).

3.3 Conclusion

Tailoring is within the health education domain a well-defined approach, incorporating an elaborated ontology that positions tailoring on a dimension from generic, targeted, personalized, tailored to interpersonal communication. This dimension is defined by (a) segmentation (i.e., specifying the audience), and (b) customization (i.e., specifying the message). The term tailoring in itself encompasses five different ways of tailoring, like ipsative tailoring wherein current responses are compared to past responses of the receiver. Compared to this rich ontology, we did not observe a similar level of precision in describing tailoring in other domains. However, we did perform a limited search. Future research into the ontology of tailoring should elaborate the search in the other domains. Moreover, it should compare and combine the ontology from other domains with the present results from the health education domain.

Another topic for future study is the relation between tailoring and specific Behavioral Change Techniques (see Table 1). Certain forms of tailoring require specific interpretations of a BCT, like “provide feedback on performance” could be descriptive, normative or evaluative. Or tailoring could be a comprehensive technique like Motivational Interviewing (cf. Bartholomew et al., 2011). Noar et al. (2009, see table 2) characterize tailoring in a more encompassing way, so that also interaction and design elements can be tailored, and cultural differences are included.

A recommendation is to examine how insights from the tailoring framework (Kreuter et al., 2000) could be incorporated into the method combining situated Cognitive Engineering (sCE) and intervention Mapping (IM). For instance, tailoring focuses more at assessing characteristics from the user in order to tailor. Therefore, close collaboration with the target group is recommended.

The next chapter describes a quick scan of the field of persuasive technology. Technological features of the ePartner in itself could seduce a person to use it, and by using the person's behavior may change.

4 Persuasive technology – quick scan

J.B. Janssen, W. Otten

The term “Persuasive technology” is frequently used when ICT is designed to influence people’s behavior. The term “Persuasive technology” was introduced about 10 years ago and refers to a research area that uses computer technology to change behavior. We wondered how this research area could contribute to the *ePartners that Care*-project, above and beyond the contribution of theories of behavior change stemming from social and health psychology. Therefore the central research questions are:

- What is the scope of the research area persuasive technology: which academic disciplines contribute to the field, what is the relation to other scientific disciplines, which theories are used, developed and applied, which kind of research is performed and published, and which application areas are addressed or problems are solved?
- How can persuasive technology uniquely contribute to ePartner development, relative to contributions of other scientific fields, like human-computer interaction or (social) psychology?

4.1 Method

This quick scan is based on expert interviews, a literature review, a search on related conferences, and an additional web search. The research area recently emerged and it is possible that research in related areas is missed due to the use of other terminology.

The quick scan started by conducting interviews with a convenient sample of experts in the field of human-computer interaction. The following experts contributed to the overview: Prof. Dr. Mark Neerincx, senior research scientist man-machine interaction at Delft University of Technology and TNO, Dr. Jurriaan van Diggelen, research scientist at TNO, Dr. Jan van Erp, senior research scientist haptic computing at TNO.

Based on these interviews we investigated when the concept of persuasive technologies started. As recommended by the experts, we used Fogg’s overview book (2003) as a starting point. Furthermore, we looked at the introduction of the term in literature. The search was continued using google scholar (scholar.google.com). In the searches the following search terms were used: Persuasive technology, mental models, agent technology, captology, health captology, nudging, choice architectures.

Using the results from the literature study a brief list of conferences was collected. The main topics on conferences of persuasive technology were listed.

4.2 Results

This section describes the findings of the research. First common definitions of persuasive technologies are listed, followed by the various disciplines that contribute to this research area.

4.2.1 *Definition and terminology*

Fogg, one of the founders of the persuasive technology field, defines persuasive technology as:

“A persuasive computing technology is a computing system, device, or application intentionally designed to change a person’s attitude or behavior in a predetermined way.” (Persuasive Technologies, 2007)

Fogg stresses that “Persuasion is noncoercive”. He mentions that “the use of force—is not persuasion; neither is manipulation or deceit”.

Some researchers extend the scope of persuasive technology to (implicit) design aspects. Redström (2006) argues that there are “strong relations to foundational issues in persuasive design in a variety of areas of design discourse, including areas that at first could be seen as being at its fringes”. Furthermore that “design can be seen as inherently persuasive and that objects can be understood as a kind of arguments in material form.”. In this overview, we use the definition of Fogg to investigate the field.

Fogg introduced the term *Captology* (derived from *C*omputers *A*s *P*ersuasive *T*echnologies) as the study of *computers* as persuasive technology. At its essence, *captology* focuses on the planned persuasive effects of computer technologies.

4.2.2 *Disciplines and Scientific podia*

Persuasive technology is a multidisciplinary research area. It combines the work of (social) psychology, communication studies (both including learning), computer science; especially human-computer interaction, mobile and communication technologies and ethics. As a result scientific output is partly published at conferences or in journals of one of these disciplines. Besides these existing podia, there are a few specialized conferences and workshops (see Table 3).

Table 3. Overview of conferences and workshops on persuasive technology.

Name of podium	Type/ Publisher	Scientific scope	Details
Persuasive Technology (PT)	International conference	Persuasive Technology is an interdisciplinary research field, focusing on the design and development of interactive technologies that may create, maintain, or change human thought and behavior.	8 th edition in 2013
Mobile Health	Stanford persuasive tech lab	Focus on mobile healthcare applications within persuasive technology	2010-2012
CHI	International conference	Human Computer interaction in general. (Some tracks/workshops on persuasion/persuasive technology)	Workshops within the conference included: 2009 - Creative Thought and Self-Improvement 2011 - Persuasion, Influence, Nudge, and Coercion with mobile devices – helping people to help themselves

The main conference on persuasive technology is named equally. The main topics at this conference are:

- Theory and design of persuasion
- Persuasion and social media
- Persuasive interfaces and visualization
- Tailored and personalised persuasion
- Evaluation of persuasive applications
- Mass and organizational persuasion
- Persuasion through entertainment
- Persuasion in commercial applications
- Ethical/privacy aspects of persuasion
- Persuasion for healthy living
- Persuasion for sustainable environment
- Mobile and ubiquitous persuasion
- Persuasion in smart environments
- Learning through persuasion

4.2.3 *Classifying Persuasive technology*

Five classifications of persuasive technologies were encountered: (A) Fogg's Functional triad, (B) Computers as social actors/teammates, (C) Ubiquitous computing, (D) Fogg's Behavior Model, and (E) Persuasive Systems Design.

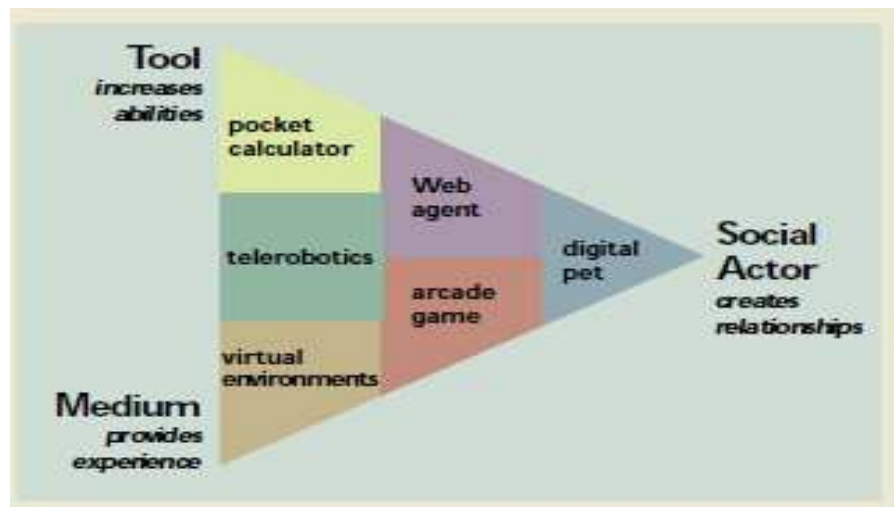


Figure 6. Functional triad of persuasive technology (Fogg, 1998)

A. The Functional Triad. Fogg (1998) proposes the Functional Triad as a classification of three "basic ways that people view or respond to computing technologies" (see Figure 6). These ways are computing technologies as tools, as media, and as social actors – or as more than one at once. The functional triad helps analyzing persuasive technologies. For the ePartner project, persuasive technology also fulfills the three functions: tool, medium and social actor (see Table 4).

Table 4. Essence and affordances of persuasive technology functions (Fogg, 2003)

Function	Essence	Persuasive Affordances
Computer as tool or instrument	Increases capabilities	<ul style="list-style-type: none"> • Reduces barriers (time, effort, cost) • Increases self-efficacy • Provides information for better decision making • Changes mental models
Computer as medium	Provides experiences	<ul style="list-style-type: none"> • Provides first-hand learning, insight, visualization, resolve • Promotes understanding of cause-and-effect relationships • Motivates through experience, sensation
Computer as social actor	Creates relationship	<ul style="list-style-type: none"> • Establishes social norms • Invokes social rules and dynamics • Provides social support or sanction

B. Computers as social actors/teammates. Phillips (2011) describes the transition in computing technology from tools to teammates. She states that humans construct internal representations (mental models, see related work) of “objects in the environment, such as other people, animals, and machines”. In these representations people tend to attribute human-characteristics to non-living objects (anthropomorphism). She distinguishes two models how humans perceive robots: Equipment vs. Teammate Mental Models. The equipment model is traditional and considers the technology to be a tool, while teammate models incorporate concepts as collaboration and pro-activeness. The current trend is to focus on applying teammate models. Since we are in a transition, we will see mixed forms emerge. This increases the need for careful design, having trust in the technology is essential for acceptance and successful implementation (and usually people overestimate the technological capabilities).

C. Ubiquitous computing. Ubiquitous computing is the field in which information processing is fully and thoroughly integrated in everyday objects and activities. Intille (2004) mentions ubiquitous computing and context aware algorithms as a new opportunity for healthcare applications. He describes two trends that emerge:

- Rapid adoption of powerful mobile computing devices, and
- Context aware computing: the computer can automatically infer what a person is doing from sensor data.

Combined this enables “a class of just-in-time persuasive interfaces to be created that motivate behavior change by providing well-timed information to users at points of decision, behavior, or consequence.” His review suggests that there are four components to an effective strategy to motivate behavior change using just-in-time information:

- 1 present a simple, tailored message that is easy to understand,
- 2 at an appropriate time,
- 3 at an appropriate place, and
- 4 using a nonirritating strategy (even after possibly hundreds of presentations).

The two trends described by Intille (2004) cover points 2 and 3. The fourth bullet is considered the greatest challenge. In the remaining of the paper, he describes the following challenges for just-in-time persuasive interfaces to motivate behavior change:

- *Achieving subtlety.*
Balance between messages that motivate and messages that irritate.
- *Detecting the right time.*
Some activities are difficult to detect by a computer and require other monitoring strategies (e.g. taking food).
- *Sporadically interacting in time.*
- *Avoiding over-reliance on external justification.*
How to achieve long-term sustainable behavior if the technology is discontinued?
- *Leveraging consumer technologies*
How can we use broadly available hardware for this technological solution?
- *Motivating the “healthy.”*
How to motivate people that do not consider themselves to be sick?
- *Proving efficacy.*
How to evaluate if the technology is doing its job?

D. Fogg's Behavior Model (FBM). The functional triad describes different subcategories of persuasive technology, which allows classification of applications in three main categories. It does not provide a strategy for designing and developing persuasive technologies. The Fogg Behavior Model (FBM) helps academics understand behavior change better. On the behavior model website (2012) Fogg claims that "What was once a fuzzy mass of psychological theories now becomes organized and specific when viewed through my Behavior Model". The FBM highlights three principal elements, each of which has subcomponents. Specifically, the FBM outlines *three Core Motivators* (Motivation), *six Simplicity Factors* (Ability), and **three type of Triggers**. The subcomponents define the larger elements. For example, in the FBM the word Ability refers to how the six Simplicity Factors work together in the context of a Trigger (see Figure 7).

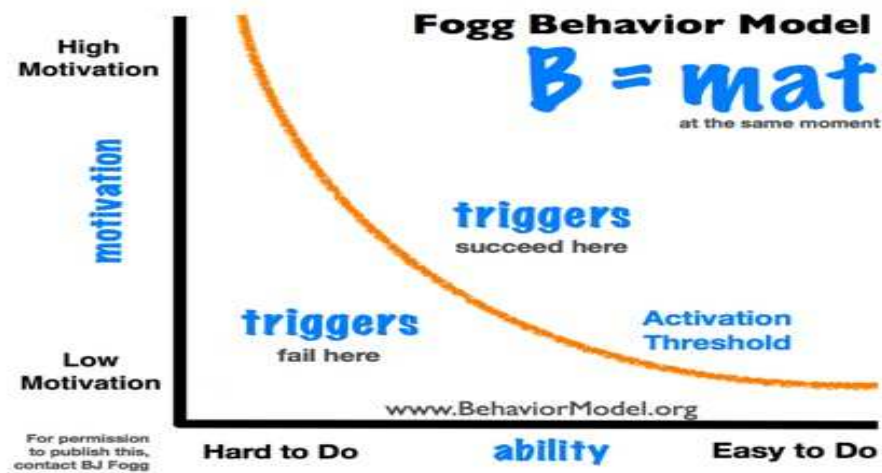


Figure 7. The Fogg Behavior Model builds upon Triggers, Abilities and Motivation (Behavior model website, 2012)

Element 1: triggers

First, people have to notice the trigger. If a trigger is not perceived by the audience, a new behavior is not started. Second, we associate the trigger with a target behavior. The third aspect is the moment the trigger is presented. The trigger should be presented when we are both motivated and able to perform the behavior.

Element 2: Abilities/Simplicity

The following six abilities should be available.

- Time
- Money
- Physical Effort
- Brain Cycles
- Social Deviance
- Non-Routine

Element 3: Motivation

- Pleasure – pain
- Hope – fear
- Acceptance – rejectance

Starting or increasing behavior means improving or adding to these three elements. Stopping or decreasing behavior means taking away or reducing aspects of these three elements.

(E) Persuasive Systems Design (PSD). Oinas-Kukkonen and Harjumaa (2008) state that the strategies of Fogg cannot directly be used for software implementations. They propose a systematic method for the development of persuasive systems based on the strategies described by Fogg. Their Persuasive Systems Design (PSD) model contains three steps:

- 1 designers should understand the key issues behind persuasive systems,
- 2 designers should analyze the persuasion context, and
- 3 designers should consider the system qualities.

The system qualities (step 3) are described comprehensively; the underlying principles of the system qualities are described, and the belonging software requirements and examples of implementation are given. The system qualities are divided into four categories:

- a. task support,
- b. dialogue-support,
- c. credibility support, and
- d. social support.

The strategies within the first two categories (task- and dialogue support) are based on the strategies of Fogg (2003). There are no fundamental differences; the descriptions deviate in the level of details. The underlying idea of credibility, the third category, is that a system that is more credible is more persuasive. Fogg (2003) discusses credibility extensively in his overview book, however not as part of his functional triad. The last category is social support, which describes how to use social influence strategies to persuade the user. These social strategies could be used in an ePartner by connecting the users with their peers. Horsch et al. (2012) describe the development of a specific ePartner as a virtual sleep coach. Table 5 shows how the connection with peers mediated by this virtual sleep coach might be beneficial per social persuasion strategy (adapted from Horsch et al. 2012).

Table 5. Persuasive strategies defined by Fogg (2003) applied to an envisioned virtual sleep coach (adapted from Horsch et al., 2012).

technology as a tool	
Persuasive strategy	Potential application in the sleep domain
Reduction (Simplifying)	By giving a format for a sleeping diary it is simpler to fill it out, the benefit/cost ratio for coachees increases
Tunnelling (Guidance through a process)	The coach can guide the coachee through calming down at the end of the day step-by-step, e.g. turn off the TV, read some pages in a book, put on your pyjamas, brush your teeth, lie in your bed
Tailoring (Personalisation)	The treatments, like wake up time, or a specific relaxation exercise are tailored to the coachee
Suggestion (Intervene at right time)	An alarm to indicate bedtime and wake up time is given at the right time
Self-monitoring (Track coachee)	From the sleep diary averages are calculated
Surveillance (Be observed by others)	Sleep measures (e.g. bed time, sleep efficiency, wake up time) are shared with a therapist
Conditioning (Reinforcing behaviour)	The virtual coach rewards the coachee when the sleep diary is filled out e.g. with a compliment

technology as social actor	
Persuasive strategy	Potential application in the sleep domain
Physical cues (Looks of coach)	The virtual coach should suit the coachee. So the coachee might choose between different characters. Two options could be: a female or a male coach
Psychological cues (Personality of coach)	The coach can for example 'have' a dominant or submissive personality style
Language cues (How something is communicated)	The coach could give feedback on sleep efficiency by saying: you almost reached the sleep efficiency goal of 85%, good job! About the same event the coach could also say: you only accomplished a sleep efficiency of 75%, this is not enough.
Social dynamics (Unwritten rules of interacting with others)	The coach can use reciprocity to persuade the coachee to adhere to a treatment. For example, [bed partner] has helped you to stick to your bedtimes by going to bed at the same time as you, do your relaxation exercise to increase the chance of sleep, so you both can go to bed earlier next week.
Social roles (Impersonalisation)	The coach can have multiple roles and characters, for example one motivator for motivational support and a sleep therapist as authority to teach the coachee about sleep and sleep hygiene

4.2.4 *Related work and concepts*

The following section provides a brief introduction to three ePartner related concepts originated outside the persuasive technology area.

(a) Agents (Computer Science field). In the agent community no single definition of an agent is agreed upon. Wooldridge and Jennings (1995) describe an agent (in a weak notion) as a hardware or software based computer system that enjoys these properties:

- Autonomy, it can operate without intervention of others;
- Social ability, it can communicate with other agents (or humans);
- Reactivity, it can perceive its environment and act upon changes timely; and
- Pro-activeness, it can take initiative by showing behavior directed towards a goal.

Stronger notions of agents state that agents are computer systems that are implemented using concepts applied to humans. One example is the use of mentalistic notions, such as believes, desires, and intentions. One step further is the concept of emotional agents. Agents may each monitor a part of a complex task, and to successfully execute this task they have to collaborate (see Figure 7).

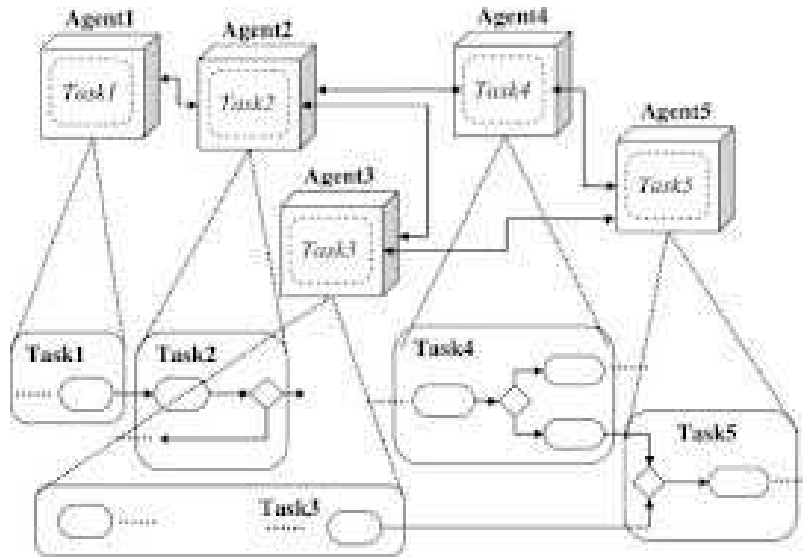


Figure 8: Agents collaborate to execute tasks.

(b) BDI agents. One way of implementing an agent is using the belief, desire and intention paradigm (Bratman, 1999). Agents internally store beliefs (perceptual facts it holds true), desires (motivational states; what does it want to achieve) and intentions (deliberated states; what does it plan to do). Using such a paradigm agents can reason upon the actions they take and the possible/probable consequences of these actions in the world.

(c) Mental models (Psychology & Computer Science). Norman (1983) states that mental models contain predictive and explanatory power. “In the consideration of mental models we need really consider four different things: the *target system*, the *conceptual model* of that target system, the user’s *mental model* of the target system, and the *scientist’s conceptualization* of that mental model, The system that the person is learning or using is, by definition, *the target system*. A *conceptual model* is invented to provide an appropriate representation of the target system, appropriate in the sense of being accurate, consistent, and complete. Conceptual models are invented by teachers, designers, scientists, and engineers.” (see also Figure 9)

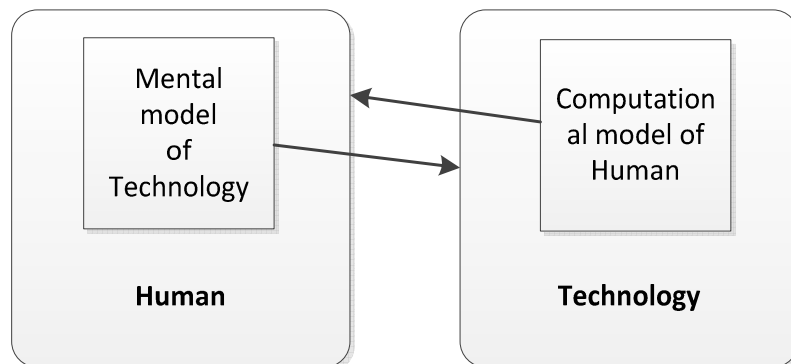


Figure 9: Derived from Norman (1983).

4.3 Conclusion

Persuasive technology is an emerging research area that combines psychology and computer science. Based on the quick scan it seems a promising field that deserves a more thorough review in the future. The present quick scan describes the scope of the field. However, on the basis of the quick scan we cannot decide whether persuasive technology uniquely contributes to ePartner development, relative to contributions of other scientific fields, like human-computer interaction or (social) psychology.

Persuasive strategies allow designers to maximize the effects of persuasion in the technology they design. It seems that persuasive technology offers guidelines for ePartner development that prevents basic mistakes. These strategies should be applied in the design process of ePartners, since these technological partners can be classified as persuasive technology.

5 Discussion

The focus in the present report was on developing a comprehensive framework that guides the design of ePartners that support behavior change to promote health. Chapter 2 focuses on behavior change and techniques to realize this. Chapter 3 addresses how an ePartner can be tailored by describing the various approaches and terminology regarding tailoring. Finally, Chapter 4 provided a short introduction to the field of persuasive technology, because an ePartner is a technology whose features in itself may encourage its use and impact.

Chapter 2 described the general framework regarding behavior change. It starts with specifying the desired health goal and the behavior change to reach that goal. Next determinants that affect this behavior (change), and techniques changing these determinants are defined. These steps reflect the first steps of Intervention Mapping (IM, Bartholomew et al. 2011), a method to systematically develop health education interventions. In the present project and related projects, IM is combined with situated Cognitive Engineering (sCE, Neerincx & Lindenberg, 2008), a method to systematically develop the requirements for interactive, human-centered automation (see also www.scetool.nl). In order to evaluate this approach, we used three scenarios to develop baseline requirements for ePartners-that-care. It proved to be an efficient way to develop requirements, given the around 175 requirements and 40 use cases that were developed within the three scenarios in the sCE-tool.

One of the challenges in the present project was to handle and act on the right level of abstraction. In order to keep the general framework applicable to a wide range of health and healthcare domains a relative high level of abstraction was needed.

Thus many discussions and formulations were at quite a conceptual level. A contributing factor was that the members of the ePartner-that-cares project came from various theoretical fields, that is, health, social and cognitive psychology, man-machine interaction, ergonomics and informatics. A way to handle this was using the three more concrete scenarios:

- 1 Stephan a child with ADHD who needs to adhere to his medication and to structure his daily activities;
- 2 Rashid an overweight adolescent who needs to improve his lifestyle, that is, exercise more and eat more healthy; and
- 3 Mr. King an elderly man with three conditions living alone independently at home needs to maintain social contacts and to exercise regularly.

The methodology of sCE also enforces a more concrete level by requiring the formulation of use cases, that is, describing the various steps how an actor gets from the starting situation to the desired situation while interacting with the epartner. As such the necessary requirements of the ePartner to take those steps become clear. The resulting baseline consisted of 175 requirements, most at an intermediate abstract, conceptual level. The question is whether this level of abstraction suits the next step in the design process of ePartners that care or that it is still not concrete enough. A related question is which expertise is necessary at which level of abstraction to contribute to the development of an ePartner in a specific health(care) domain.

The more concrete, the larger the amount of requirements. However, even the 175 requirements were quite a lot to handle and search through when connecting use cases to specific requirements. In the ePartners-that-care project map of sCET we developed a categorization while producing the requirements. However, a considerable overlap consisted between the categories. In future projects, a next

step is to define a structure of the requirements beforehand, and adjust this categorization when defining new ePartners.

The question of extensiveness also relates to the number of BCTs, determinants, and theories. For instance, in a TNO Knowledge Investment Project (EC Life Style Self-management) several determinants and BCTs are discerned following from (a) automatic processes, (b) affective processes, and (c) moral norms and values. Adding the BCTs, determinants and theories from the literature, it accumulates to a vast amount. A way to manage this extent information is a WIKI developed in a related TNO Enabling Technology Project (Open Innovation Smart Coach Project). The WIKI describes theories, determinants, BCTs and boundaries, and their relations resulting from both implicit and explicit processes (see <http://wiki.scetool.nl/>).

Future research should focus on how to make and maintain the amount of theories, determinants, BCTs, and requirements applicable and searchable when designing ePartners-that-care. In addition, content information regarding the specific health (care) problem is also required as input for the ePartner.

Chapter 3 describes a general technique that promotes the successful application of more specific behavior change techniques, namely the extent to which these BCTs are tailored. Within the health education domain tailoring is a well-defined approach, incorporating an elaborated ontology that positions tailoring on a dimension from generic, targeted, personalized, tailored to interpersonal communication. The term tailoring in itself encompasses five different ways of tailoring. Future research into the ontology of tailoring should elaborate the search in other domains than health education. Moreover, the present and future results regarding tailoring should be implemented in the behavior(change)-framework that was developed in Chapter 2.

A recommendation is to examine how insights from the tailoring framework (Kreuter et al., 2000) could be incorporated into the method combining situated Cognitive Engineering (sCE) and intervention Mapping (IM). For instance, tailoring focuses more at assessing characteristics from the user in order to tailor. Therefore, close collaboration with the target group is recommended.

Chapter 4 describes persuasive technology, an emerging research area that combines psychology and computer science. Based on a quick scan it seems a promising field that deserves a more thorough review in the future. The present quick scan describes the scope of the field. However, on the basis of the quick scan we cannot decide whether persuasive technology uniquely contributes to ePartner development, relative to contributions of other scientific fields, like human-computer interaction or (social) psychology. It seems that persuasive technology offers strategies that should be applied in the design process of ePartners.

This report examined how an ePartner-that-cares could successfully support setting goals and reaching goals in order to promote health. A general framework based on behavior change was employed to design a requirements baseline for ePartners in three health(care) scenarios. The framework could be enriched by incorporating elements from tailoring and persuasive technology in its content (behavior determinants and behavior change techniques) and method (situated Cognitive Engineering and Intervention Mapping). However, this also poses the question at which level of abstraction the framework should operate and the scope of the framework.

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<http://www.slideshare.net/captology/stanford-6401325> (Top 10 mistakes in behavior change)