

D1.5a Theoretical framework for behavioral change - initial

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Summary

The goal of SWELL is to develop a system that contributes to performing self-management to maintain a good health and/or mitigate health issues at home and work, through long-term, personalized and intelligent interaction.

Within WP1 'Requirements, architecture and impact', the aim of D1.5 is to develop a theoretical framework for behavioural change and empowerment through system supported self-control. D1.5 provides input for the architecture of the self-management system as well as for the evaluation of the effectiveness of self-management systems for behavioural change (D1.7). D1.5a gives a first overview of behavioural models. A detailed framework for behavioural change will be presented in D1.5b.

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1 Introduction

1.1 Background

Technological advances in human computer interaction have opened new possibilities to motivate and stimulate people to adopt healthy and productive lifestyles at home and at work. The challenge is to develop new approaches that are sensitive and responsive to people, that can monitor compliance and trigger persuasive interventions. Preferably, these approaches should be intuitive, with technology non-obtrusively integrated in everyday objects and environments. The emphasis is on user-friendliness, user empowerment and support for human interactions (Aarts and De Ruyter, 2009; Cook and Song, 2009). In this context, Aarts and De Ruyter (2009) identified the techniques of 'suggestion' (reminding people to perform certain behaviour at opportune moments) and 'self-monitoring' (allowing people to monitor themselves and informing them about how they could modify their behaviour).

In recent years, a growing number of technology based interventions (e.g. internet, mobile phones, smart phones) for behavioural change have become available. It is generally recommended that behavioural change interventions should be designed using theory, because basing interventions on theory seems to make them more effective (Abraham & Michie, 2004). This also applies to the development of self-support systems which aim to maintain a good health and/or mitigate health issues at home and work, through long-term, personalized and intelligent interaction.

A number of theoretical approaches for behavioural change is currently available in literature, however there is as yet no consensus as to which approach provides the best guidance for technology based intervention development and implementation, nor which approach has the greatest impact on behaviour, nor which approach should be applied to which kinds of behaviour, nor which approach(es) should be applied specifically for the development of personalized, smart systems. Which techniques or combinations of techniques are effective? Is goal setting alone effective or should it be combined with self-monitoring and feedback? Answers to these kind of questions are crucial for the design of personalized, smart systems.

1.2 Aim

D1.5 aims to develop a theoretical framework for behavioural change and empowerment through system supported self-control.

1.5a aims to give a first broad and general overview of behavioural models applied in the context of health. A detailed framework for behavioural change will be presented in D1.5b.

1.3 Overview

The current report provides an overview of behavioural models. Most contemporary approaches to behaviour change actually model what *determines* current behaviour; they are not explicitly concerned with *changing* behaviour, which is a different problem (Brug et al., 2007). Therefore, the overview is divided into two sections: models that explain why behaviour is performed and models that explain how behaviour can be changed. In addition, it provides an overview of behavioural change techniques, which are (partially) based on these models and can be implemented to realize behavioural change and contribute to maintaining a healthy lifestyle accordingly (Table 1).

Table 1: Overview of behavioural models and interventions.

Models to explain behaviour	Models to change behaviour	Behaviour change techniques
<ol style="list-style-type: none"> 1. Theory of Planned Behaviour 2. ASE Model 3. General Behaviour Model 4. Social Cognitive Theory 5. Protection Motivation Theory 6. Health Belief Model 7. Health Locus of Control and Social Learning Theory 8. Integrated Psychological Model of Health Behaviour Determinants 9. The Extended Parallel Process Model 10. Model of Link between Personality, Coping, Stressors & Outcomes 11. Self Determination Theory 12. Cognitive Adaptation Theory 13. Effort-Reward Imbalance 	<ol style="list-style-type: none"> 1. Trans theoretical Model (Stages of Change Model) 2. Precaution Adoption Process Model 3. Health Action Process Approach 4. I-Change Model 5. Elaboration Likelihood Model 	<ol style="list-style-type: none"> 1. Feedback 2. Reinforcement 3. Reward/ punishment 4. Goal Setting 5. Self-monitoring 6. Self-evaluation 7. Motivational Interviewing 8. Targeted, tailored communication 9. Reminders/Cues to action 10. Action planning/ implementation -intentions 11. Social processes of encouragement, pressure, support 12. Psycho-education 13. Active learning and participation 14. Framing 15. Numerical and contextual risk communication 16. Attitude change 17. Social comparison theory/ modelling 18. Cognitive dissonance 19. Contract 20. Social norms 21. Persuasive communication 22. Improve coping skills 23. Graded task, starting with easy tasks 24. Increasing skills 25. Rehearsal of relevant skills 26. Environmental changes 27. Use of imagery 28. Inoculation

2 Method

First, a group of 5 experts in the field of cognitive/ work& organizational psychology, human factors, health sciences, behavioural sciences, (cognitive) artificial intelligence and industrial design engineering was brought together to find an agreed set of key theoretical models to use for a framework for behavioural change for the development of personalized, self-control systems. The list of theoretical models was made in a brainstorming session. Secondly, for the selected models

from the brainstorm session, a non- systematic and limited literature search was performed in SCOPUS and in handbooks to gather additional information to provide the overview. Finally, the information was summarized and reported.

3 Models to explain behaviour

3.1 Theory of Planned Behaviour (Theory of Reasoned Action)

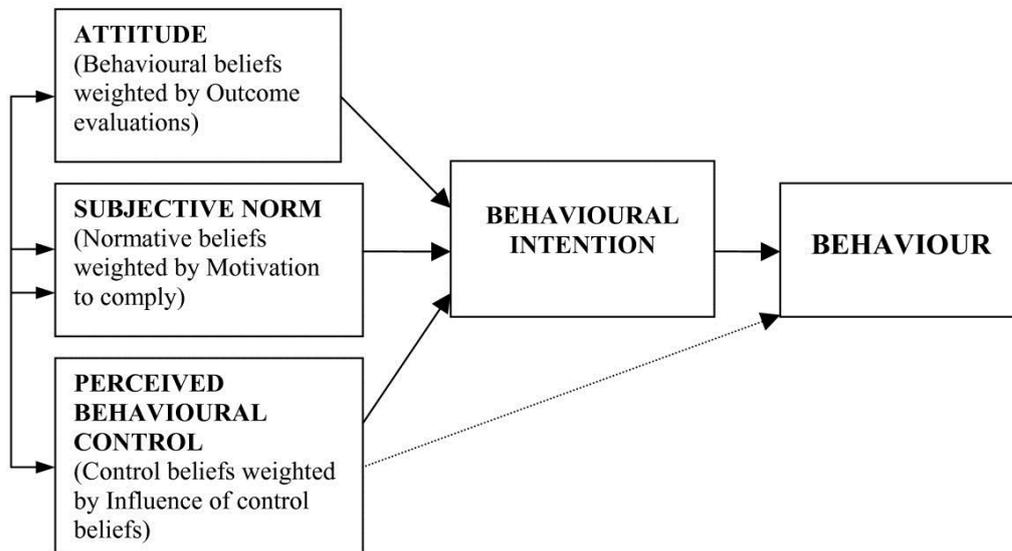
3.1.1 Short description

The Theory of Planned Behaviour (Ajzen, 1991) states that behaviour is best predicted by asking people whether they intend to exhibit specific behaviour: the behavioural intention. According to Ajzen the behavioural intention is determined by three determinants:

1. Attitude;
2. Subjective norm;
3. Perceived behavioural control.

According to this model, attitude, subjective norm and perceived behavioural control predict the behavioural intention, which then predicts behaviour. Background variables are supposed to only influence behaviour via those determinants of behavioural intention. The exhibited behaviour can lead to feedback which can lead to change of the three determinants (Brug, et al., 2007).

3.1.2 Model



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¹ (Francis, et al., 2008)

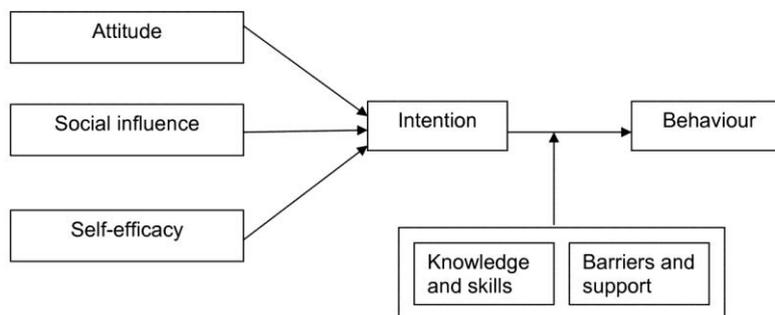
3.2 ASE Model

3.2.1 Short description

The ASE Model (Attitude - Social influence – self-Efficacy) (de Vries, 1988, 1995) was developed simultaneously with the Theory of Planned Behaviour and shows a lot of agreements with this theory. The two models however differ on two aspects (Brug, et al., 2007):

- The ASE Model identifies the determinant ‘social influence’ instead of the determinant ‘subjective norm’. Social influence embraces subjective norm, social support/pressure and modelling.
- The ASE Model does not use the term ‘perceived behavioural control’ but the term ‘self-efficacy’ instead. The difference between these terms however is minimal.

3.2.2 Model



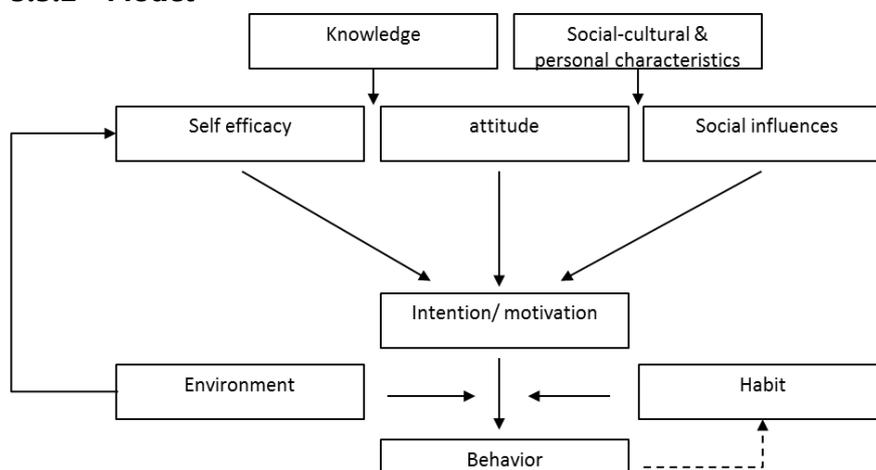
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3.3 General Behaviour Model

3.3.1 Short description

This model (Aarts, 1996) is an elaboration of the Theory of Planned Behaviour. In this model e.g. attitude, social norm and behavioural intention are the determinants of the final behaviour (Hendriksen, et al., 2010).

3.3.2 Model



² (Zwerver, et al., 2011)

3.4 Social Cognitive Theory

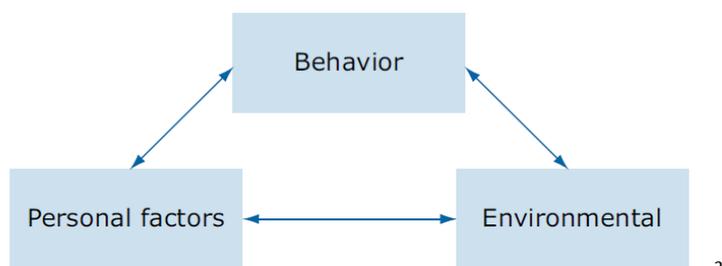
3.4.1 Short description

According to the Social Cognitive Theory (Bandura, 1986), human behaviour is to a large extent determined by the expectations one has about a certain behaviour. The following expectancies play a role in this (expectations are anticipatory outcomes of a behaviour, expectancies are the values that the person places on a given outcome (incentives)):

- Expectancies about the consequences in the social environment;
- Expectancies about the consequences from personal actions;
- Expectancies about whether one has the capabilities to perform certain behaviour (self-efficacy expectancy).

Behaviour is dynamic and a consequence of continuous interactions and influences between aspects of the environment, the person and the behaviour of the person. The different aspects are each other's determinants, "reciprocal determinism" (Brug, et al., 2007), which makes it possible to direct intervention strategies at improving emotional, cognitive, or motivational processes (personal factors), behavioural competencies or altering the social conditions under which people live and work environmental (environmental factors).

3.4.2 Model



3.5 Protection Motivation Theory

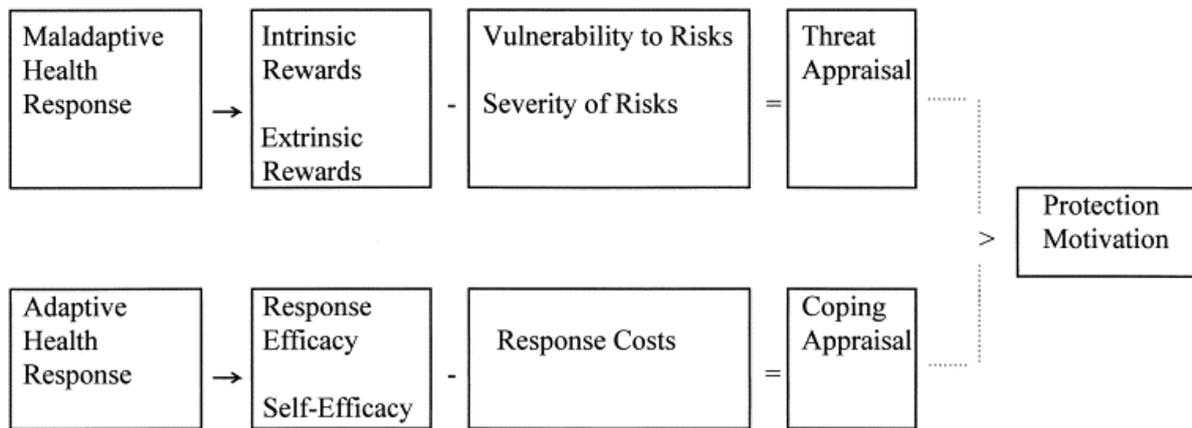
3.5.1 Short description

The Protection Motivation Theory (Rogers, 1975; 1983) was originally developed in research investigating the question at which anxiety level humans are most tended to perform preventive action. Behaviour that is focused on the protection of one's own health is denoted by the term 'adaptive response'. Behaviour that is not good for one's own health is denoted by 'maladaptive response'. Two processes, that can be the result from the experience of a health threat, are being distinguished (Brug, et al., 2007):

1. A process that is focused on estimating the threat;
2. A process that is focused on estimating the opportunities to deal with the threat (coping strategies).

³ (CommGAP, n.d.)

3.5.2 Model



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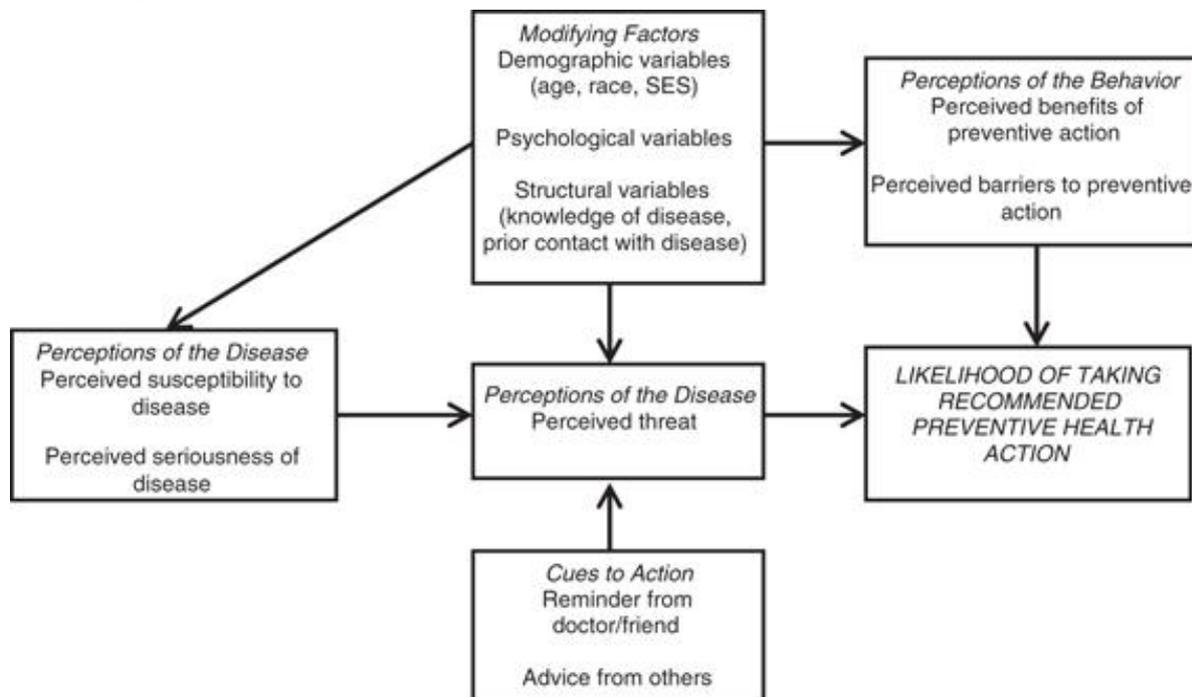
3.6 Health Belief Model

3.6.1 Short description

The central thought in the Health Belief Model (Hochbaum & Becker, '50s) is that people's intention to perform specific behaviour is determined by the perceived risk perception and the evaluation of the recommended behaviour. People will tend to show healthy behaviour when they think that (Brug, et al., 2007):

1. the threat of the health issue is substantial;
2. what they can do, genuinely is effective in order to reduce the chance of or the severity of the health issue.

3.6.2 Model



5

⁴ (Greening & Stoppelbein, 2000)

3.7 Health Locus of Control (HLC) and Social Learning Theory

3.7.1 Short description

The origins of the HLC construct can be traced back to Rotter's Social Learning Theory (Rotter, 1954). The main tenet of Social Learning Theory is that the likelihood of a behaviour occurring in a given situation is a function of:

1. The individual's expectancy that the behaviour will lead to a particular reinforcement
2. The extent to which the reinforcement is valued.

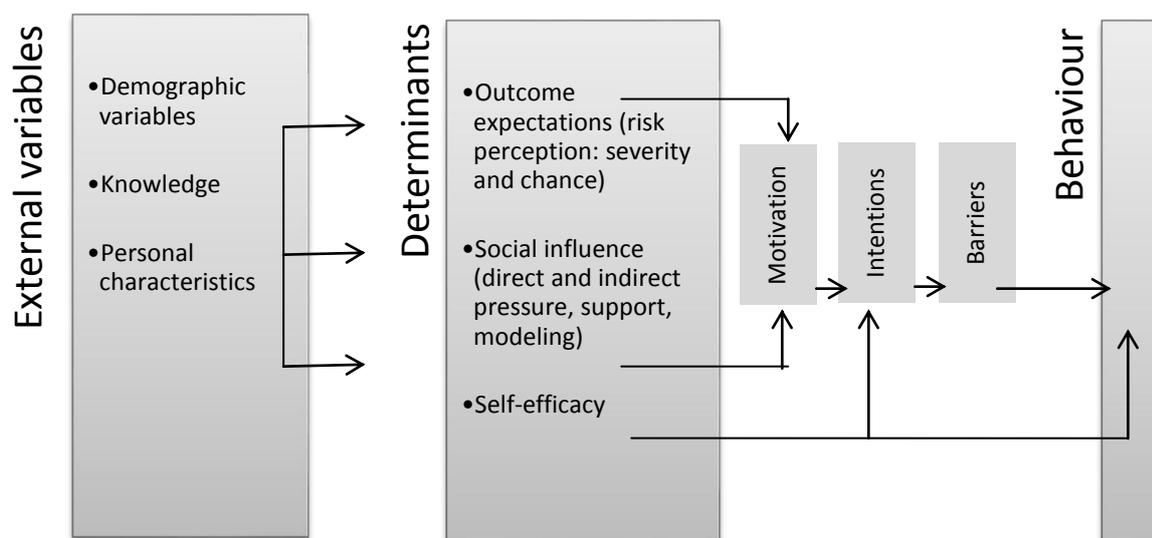
The locus of control construct has similarities with many other constructs which emphasize the importance of perceptions of control, including mastery, self-efficacy, personal causation, personal competence and perceived competence (Conner & Norman, 1996).

3.8 Integrated Psychological Model of Health Determinants

3.8.1 Short description

This model (Pieterse, et al., 1996) is an integrated model for health determinants. It uses elements from the ASE Model, as well as from the Theory of Reasoned Action, the Health Belief Model and the Protection Motivation Theory.

3.8.2 Model



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⁵ (Tanner-Smith & Brown, 2010)

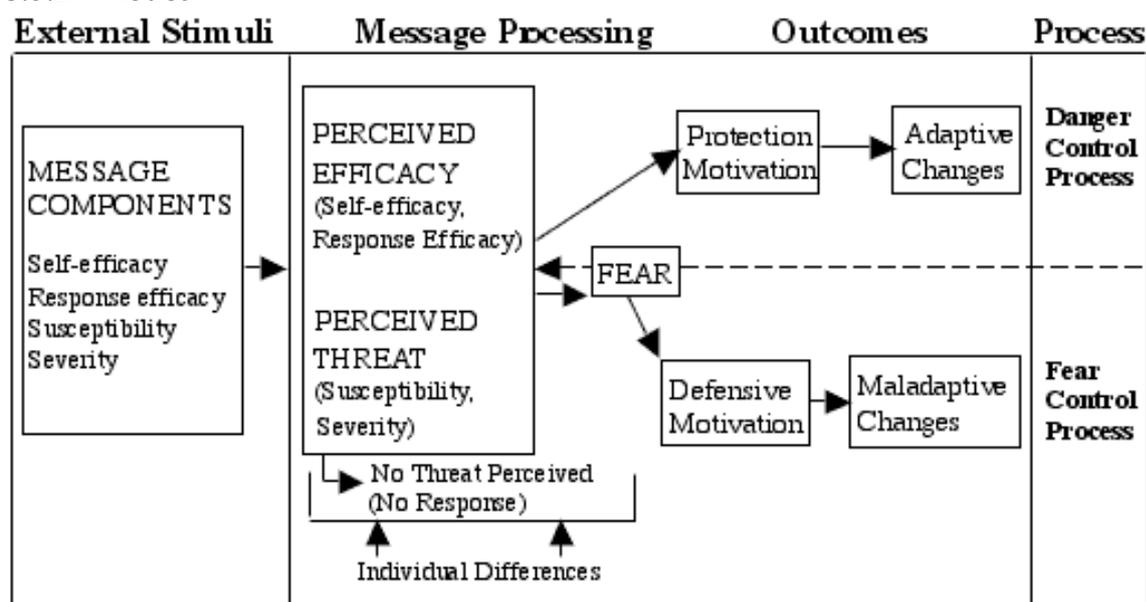
⁶ (Pieterse, et al., 1996)

3.9 The Extended Parallel Process Model

3.9.1 Short description

The Extended Parallel Process Model (Witte, 1992) predicts that high levels of perceived risk, especially in combination with low perceptions of self (self-efficacy) and/or low evaluations of the recommended response (response efficacy), often lead to rejection of recommendations and may result in negative, maladaptive responses. For example, people who have extreme anxiety about heart disease but doubt their ability to alter their eating habits (low self-efficacy) may justify eating high-fats foods by rationalizing that they may die tomorrow in a car accident. In another scenario, people who have extreme anxiety about heart disease but believe heredity, not diet, determines risks (low response efficacy) may continue eating a high-fat diet, rationalizing that poor health is predetermined genetically (Gordon, 2002).

3.9.2 Model

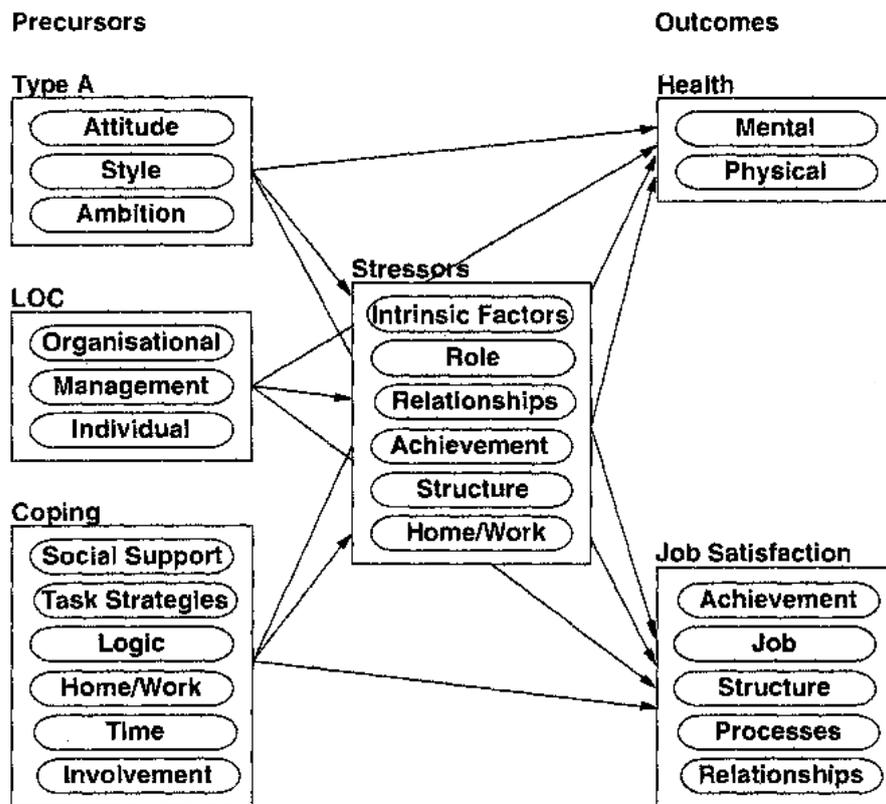


3.10 Model of Link between Personality, Coping, Stressors & Outcomes

3.10.1 Short description

The proposed model draws on the original model of occupational stress presented by Cooper and Baglioni (1988) and Robertson, Cooper & Williams, (1990). Cooper and Baglioni (1988) found empirical support for an indigenous model of stress, where personality and coping strategies preceded and determined the perception of job stressors which, in turn, had an impact on the mental wellbeing of the individual (Sadri & Marcoulides, 1994).

3.10.2 Model

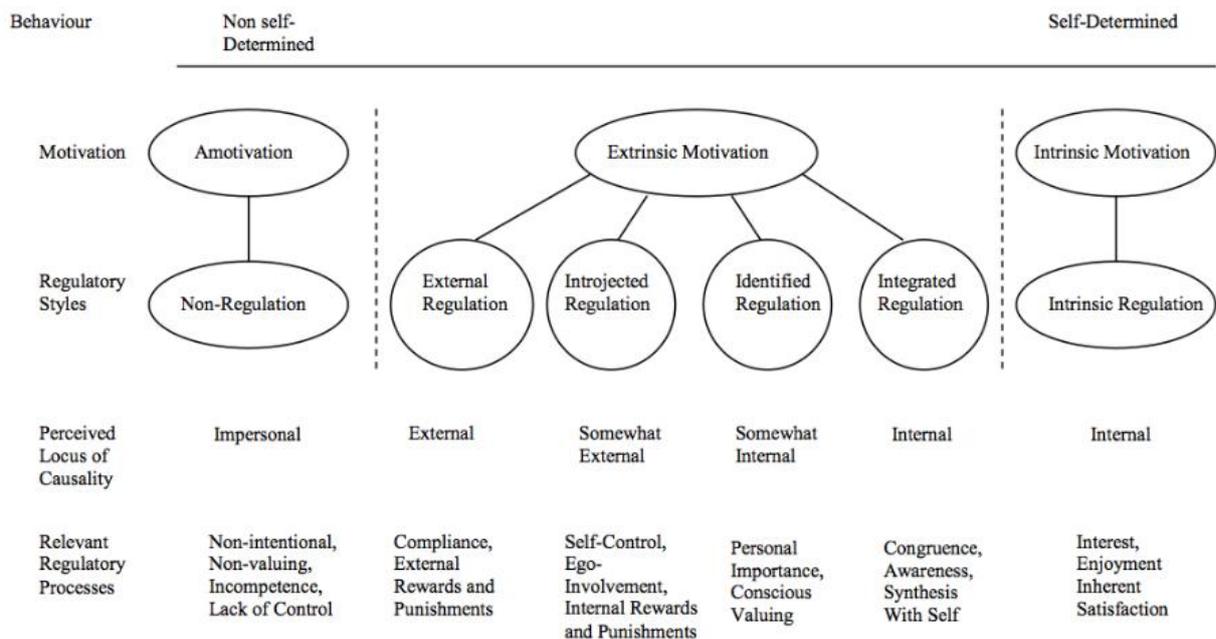


3.11 Self Determination Theory

3.11.1 Short description

Self-determination theory (SDT) (Deci and Ryan, 2000) is an empirically based theory of human motivation, development and wellness. The theory focuses on types, rather than just amount, of motivation, paying particular attention to autonomous motivation, controlled motivation, and motivation as predictor of performance, relational, and well-being outcomes. It also addresses the social conditions that enhance versus diminish these types of motivation, proposing and finding that the degrees to which basic psychological needs for autonomy, competence, and relatedness are supported versus thwarted affect both the type and strength of motivation. SDT also examines people's life goals or aspirations, showing differential relations of intrinsic versus extrinsic life goals to performance and psychological health (Deci & Ryan, 2008).

3.11.2 Model



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3.12 Cognitive Adaptation Theory

3.12.1 Short description

To increase cognitive adaptation (optimism, self-esteem, self-control) people possess unrealistically positive views of themselves that enhance their well-being, manifest as optimism, a sense of control, and self-esteem (Taylor, 1983). Cognitive adaptation was first proposed as a process occurring after a threatening event such as a chronic illness. According to cognitive adaptation theory (CAT; Taylor, 1983), successful adaptation to victimization is accomplished through engagement in a series of mildly positive self-relevant cognitive distortions. That is, the adjustment process in response to a threatening event involves:

1. a search for meaning where the individual tries to achieve or maintain an optimistic attitude towards the event or towards life in general;
2. an attempt to regain mastery over the event or over one's life in general;
3. a restoration of self-esteem.

Subsequently, Taylor and Brown (1991; 1988), reframed these cognitive distortions in terms of 'positive illusions' and further suggested that optimism, perceived control, and positive self-perceptions promote well-being (Ratelle, et al., 2004).

3.13 Effort-Reward Imbalance

3.13.1 Short description

The Effort-Reward Imbalance model includes both situational and personal information. It emphasizes that important social roles (the work role) are to offer a person recurrent options of

⁷ (Ryan & Deci, 2000)

contributing and performing (self-efficacy), of being rewarded or esteemed (self-esteem), and of belonging to some significant group. These potentially beneficial effects of the work role on self-regulatory needs are dependent on a basic requirement of social exchange: reciprocity and fairness. Effort at work is spent as part of a socially organized exchange process to which society at large contributes in terms of rewards (money, esteem, and career opportunities, including job security). An imbalance between the efforts put into work and the psychological rewards received induce stress. The coping pattern over commitment accounts for sustained strain reactions in exposed persons (Siegrist, et al., 1999).

3.13.2 Model



4 Models to change behaviour

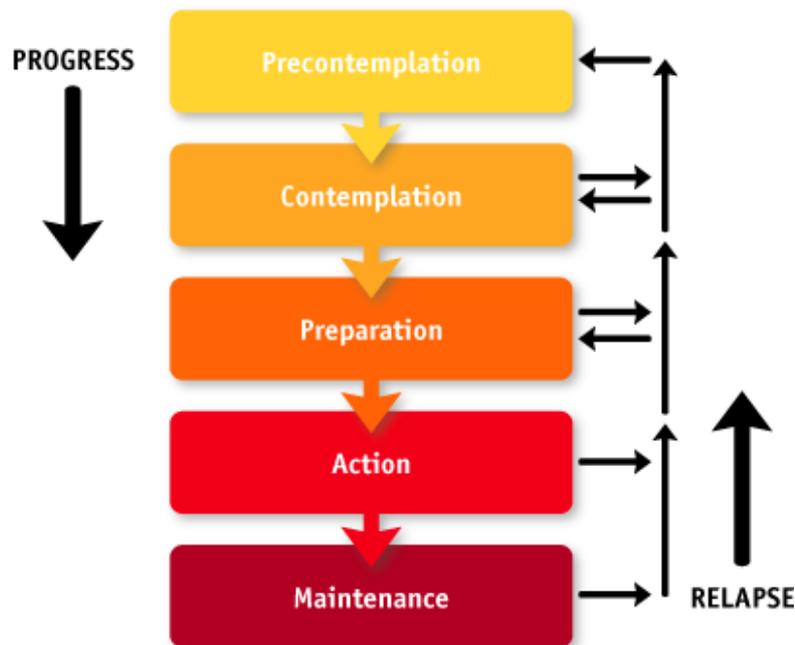
4.1 Trans-theoretical Model (Stages of Change Model)

4.1.1 Short description

The Trans-theoretical Model (Prochaska e.a., 1992) shows that health behaviour change is not an easy step from risk behaviour to healthy behaviour; there are at least five stages to be distinguished. Humans who are in the Pre-contemplation stage do not consider to change their behaviour. Humans in the Contemplation stage do consider to change their behaviour, but do not have concrete plans to do so. When such plans are being made, people get into the Preparation stage. Subsequently people get into the Action phase, in which an attempt to behaviour change occurs. The Maintenance phase starts when the behaviour change is maintained during a period of time (mostly six months) and has changed into a habit. In addition to the 5 stages, the concept of relapse is part of the model. It is not a stage in itself but describes a return from Action or Maintenance to an earlier stage (Brug, et al., 2007).

⁸ (Siegrist, et al., 1999)

4.1.2 Model



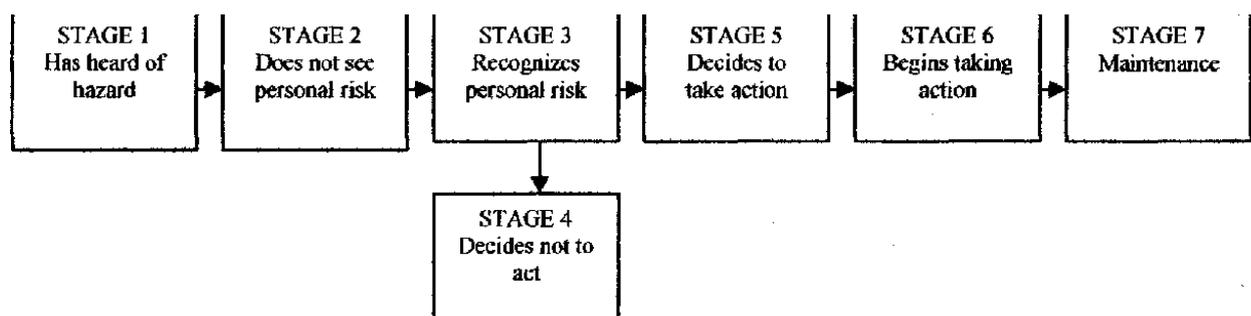
4.2 Precaution Adoption Process Model

4.2.1 Short description

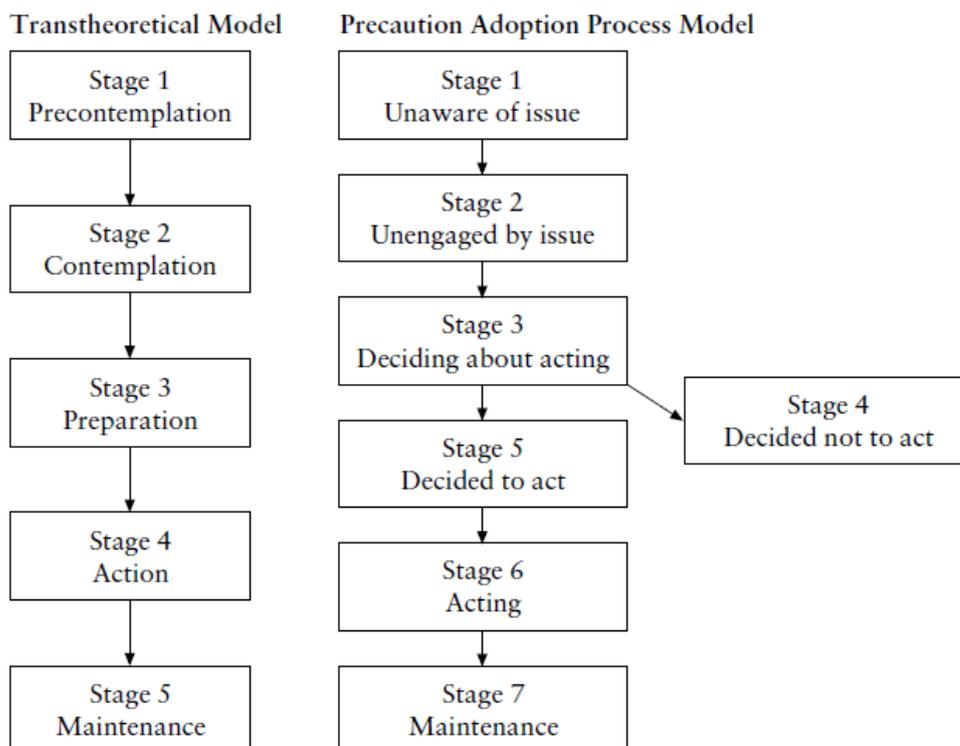
The Precaution Adoption Process Model (Weinstein & Sandman, 2002) is a model based on the Trans-theoretical Model. In this model, awareness of the risk behaviour is specified as a first essential step in the process of behaviour change from pre-contemplation towards contemplation. Hereby a distinction is being made between three stages of awareness (Brug, et al., 2007):

1. One is not aware of the health issue;
2. One is unengaged of the health issue;
3. One is aware of one's own risk behaviour. In this stage one decides to either change or not to change the behaviour.

4.2.2 Model



4.2.3 Precaution Adoption Process Model versus Stages of Change



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4.3 Health Action Process Approach (HAPA)

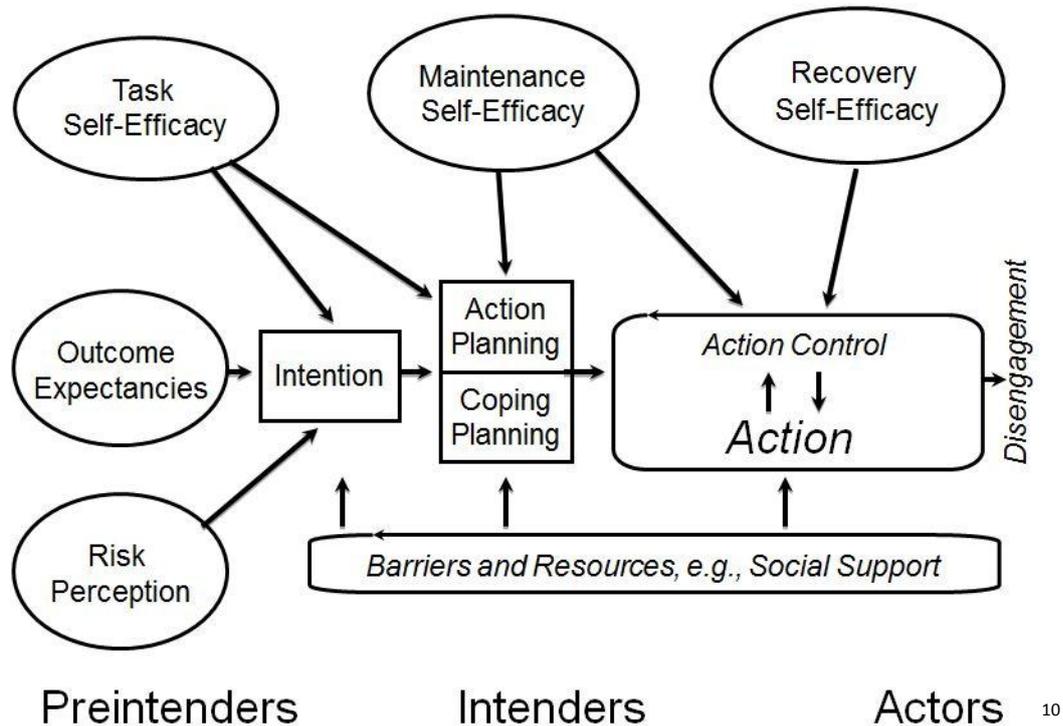
4.3.1 Short description

The HAPA (Schwarzer, 2004) is based on the Trans-theoretical Model. The HAPA however is not bound to the time phases as in the Trans-theoretical Model. The HAPA emphasizes the importance of the motivational and volition phase (Brug, et al., 2007). Its basic notion is that the adoption, initiation, and maintenance of health behaviours must be explicitly conceived as a process that consists of at least a motivation phase and a volition phase. The latter might be further subdivided into a planning phase, action phase and maintenance phase.

During the motivation phase the individual develops an intention, and this intention is predicted by self-efficacy and outcome expectancies ('I am confident that I can lose weight and I know that losing weight will improve my health'). The HAPA suggests that outcome expectancies precede self-efficacy because people make assumptions about outcomes before they ask themselves whether they can perform the action. They then carry out an appraisal of threat or risk—a little like the perceived severity element of the Health Belief Model. The HAPA suggests that this element may be minimal in many cases and specifically that fear appeals may have only limited value (Pitts & Phillips, 2003).

⁹ (Rutter & Quine, 2002)

4.3.2 Model



4.4 I-Change Model

4.4.1 Short description

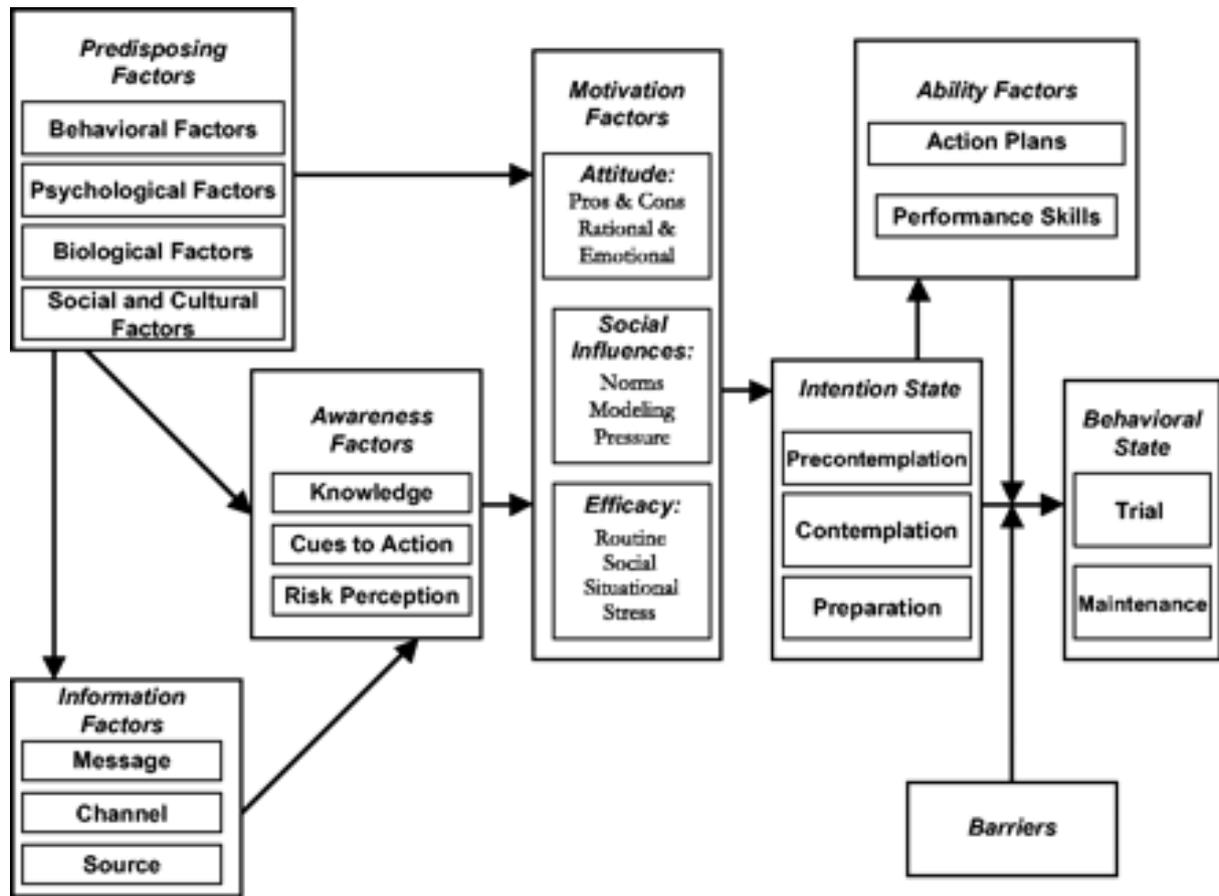
Just like the HAPA Model, the I-Change Model (de Vries, 2003) distinguishes from the Trans-theoretical Model by not being bound to the time phases. The I-Change Model focuses on the pre-motivational, motivational and post-motivational phases (Brug, et al., 2007).

The I-Change Model or the Integrated Model for explaining motivational and behavioural change is derived from the ASE Model, that can be considered as an integration of ideas of the Theory of Planned Behaviour, the Social Cognitive Theory, the Trans theoretical Model and the Health Belief Model. According to the I-Change Model, behaviour is the result of one's intention, one's capacities and perceived barriers. Intention is influenced by three motivational factors: attitude, social influence and self-efficacy. Besides these factors, motivation factors also influence the intention. Motivation factors are influenced by different predisposing factors, awareness factors and information factors. The three awareness factors knowledge, risk perception and cues to action are also addressed in the Health Belief Model.

In order to change behaviour it is important to connect to someone's stage of change. To do so, a customized approach is important. It is necessary to indicate someone's stage of change in order to conduct an effective intervention. Dependent on the stage of change, tailored information can be offered to the person (Schermers, et al., 2009).

¹⁰ (Schwarzer, 2011)

4.4.2 Model



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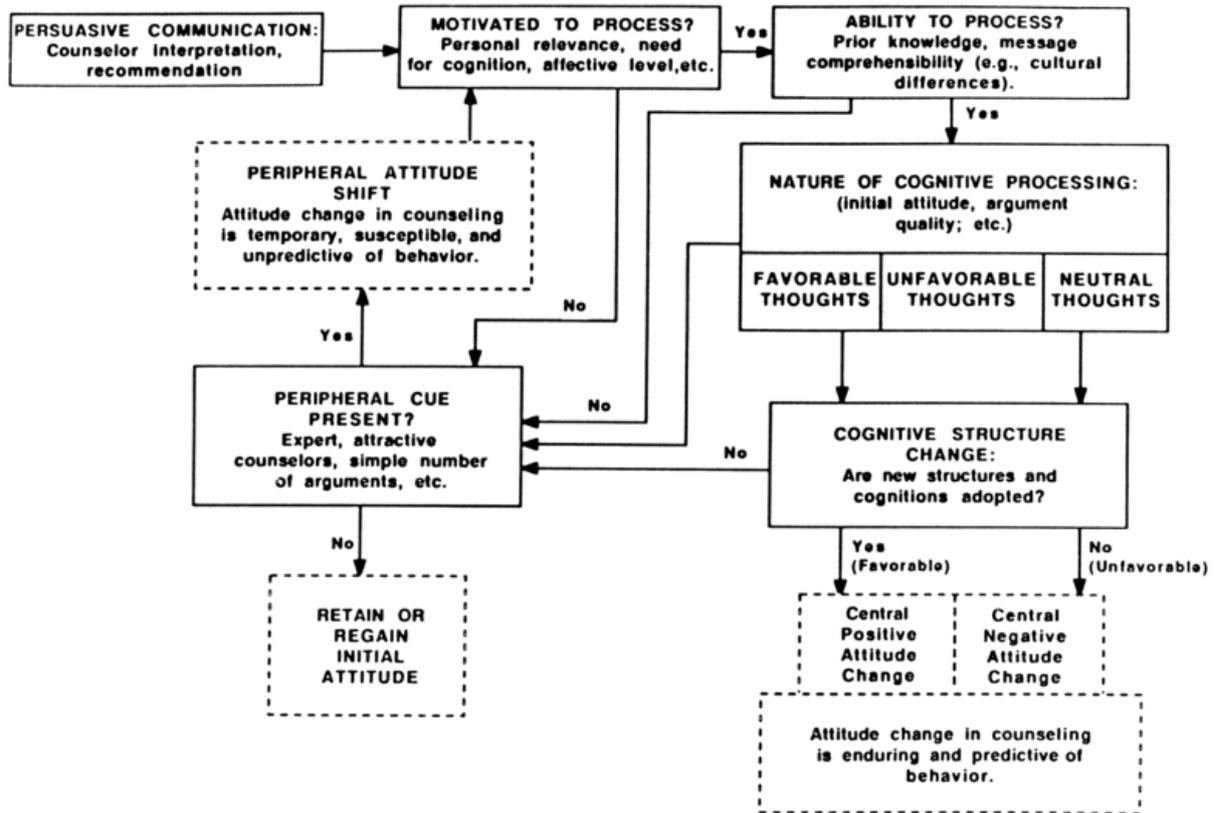
4.5 The Elaboration Likelihood Model

4.5.1 Short description

The Elaboration Likelihood Model (Petty et. al., 2002) is a theory about knowledge and information transfer. This theory states that some people tend to think about health publicity more than others. They have a large 'tendency to think'; they tend to process the offered information more 'central'. Others have a lower tendency to think and are being influenced by peripheral aspects, while absorbing health publicity. These peripheral aspects can be the messenger or configuration of the message. According to this model, attitude change as a consequence of central assimilation (e.g. focussing on arguments), is more stable and lasting than changes as a consequence of peripheral assimilation (e.g. focussing on the reputation of the source). Health publicity should therefore aim to promote a central assimilation of information. It should motivate people to think and offer them skills for central information assimilation. A popular method is active learning and participation via role playing. The peripheral route however can be used to bring a topic to attention and thereby increase the chance for further central assimilation (Brug, et al., 2007).

¹¹ (Huver, et al., 2006)

4.5.2 Model



12

¹² (McNeill & Stoltenberg, 1989)

5 Behaviour change techniques based on identified models/theories

Even with theories and models for behavioural change, there is little information about how to develop theory-based interventions. Evidence based behaviour change techniques should be directed at behavioural determinants. In order to develop a theory based self-support system, it is necessary to specify the range of techniques that are available for behavioural change and develop a method for selecting the relevant techniques for a specific self-support . This overview, which is probably not complete yet, is a first step.

Behaviour change technique	Goal/description	Judged to be effective in changing these determinants ¹³ (Italic determinants are based on expert opinions)
1 Feedback	Feedback makes people aware of the of the health improving or harming effects of their behaviour (Rollnick e.a. 1999)	Beliefs about capabilities Beliefs about consequences
2 Reinforcement	Method based on the theory of 'operant conditioning'. Positive reinforcement amplifies the positive consequences of the desired behaviour. Negative reinforcement reduces the negative consequences of the desired behaviour (in Brug et al., 2007; Carlson e.a. 2000; Skinner, 1938)	<i>Beliefs about capabilities Motivation and goals</i>
3 Reward/ punishment	Rewarding people for healthy behaviour of punishing people for unhealthy behaviour	Skills Motivation and goals
4 Goal Setting (behaviour or outcome)	To get people to set themselves specific, difficult goals leads to higher performance than vague, non-quantitative goals, Locke, 1968	Skills Motivation and goals Action planning <i>Self-regulation (personal regulation of goal directed behaviour or performance)</i>
5 Self-monitoring	Mapping the process of the actions and its consequences.	Skills Beliefs about capabilities Beliefs about consequences Memory, attention, decisions processes <i>Self-regulation</i>

13 (Michie, et al., 2008)

6	Self-evaluation	Evaluating the result of the actions and why they were successful or unsuccessful.	<i>Self-regulation</i>
7	Motivational Interviewing	A counselling technique that aims to let people research their own ambivalence to help them in the process of behaviour change. This method is widely used for health issues that are a result of a lack of self-regulation (Miller & Rollnick, 2002)	Beliefs about capabilities Motivation and goals <i>Self-regulation</i>
8	Targeted, tailored communication	Information that is tailored to the receiver's personal characteristics and preferences	<i>Beliefs about capabilities</i> <i>Motivation and goals</i> <i>Memory, attention, decision processes</i>
9	Reminders/Cues to action	A cue-to-Action interrupts the automaticity of one's habitual patterns, thus providing the opportunity for more conscious choice	Memory, attention, decision processes Action planning
10	Action planning/ implementation - intentions	Set concrete plans that specify when, where and how a certain action has to be performed (Gollwitzer & Sheeran, 2006)	Memory, attention, decision processes Action planning
11	Social processes of encouragement, pressure, support	Encouragement is a key concept in promoting and activating "social interest" (a tendency for people to unite themselves with other human beings, to accomplish their tasks in cooperation with others) and "psychological hardiness" (a personality structure comprising the three related general dispositions of commitment, control, and challenge that functions as a resistance resource in the encounter with stressful conditions)" in individuals (Griffith & Powers, 1984).	Social/professional role & identity Beliefs about capabilities Motivation and goals Social influences
12	Psycho-education (information regarding behaviour, outcome)	The goal of psycho-education is to understand and be better able to deal with a health issue. Personal strengths, resources and coping skills are reinforced, in order to understand that relapse is a part of recovery, and contribute to health and wellness on a long-term basis	Knowledge Beliefs about consequences Motivation and goals
13	Active learning and participation	Learning new skills in an environment where the actual skill	<i>Skills</i> <i>Memory, attention,</i>

		is practiced actively (e.g. role playing)	<i>decision processes</i>
14	Framing (or use of heuristics)	Framing is a cognitive bias, evident when presenting people the same option in different formats, it alters their decisions. People are specifically inconsistent if options concentrate on losses or gains: a loss is more devastating than the equivalent gain is gratifying. Thus, people tend to avoid risk when a positive frame is presented but seek risks when a negative frame is presented. Additionally, gains for smaller values are psychologically larger than equivalent increases for larger quantities	<i>Memory, attention, decision processes</i>
15	Numerical and contextual risk communication	Offering people information about the consequences of risk behaviour. This method is useful in the first two stages of the Precaution Adoption Process Model ¹⁴	<i>Knowledge Beliefs about consequences Memory, attention, decision processes</i>
16	Attitude change	Attitudes are subject to change by social influences, as well as an individual's motivation to maintain cognitive consistency when cognitive dissonance occurs (i.e., when two attitudes or when attitude and behaviour conflict)	<i>Knowledge Beliefs about capabilities Beliefs about consequences Motivation and goals</i>
17	Social comparison theory/ modelling	To get people to compare themselves to healthy models. Assumptions: people tend to form opinions of themselves based on reference to the traits to others in their reference group, Festinger 1954	<i>Skills Social influences</i>
18	Cognitive dissonance	To get individuals to experience greater dissonance and make them more likely to attempt to reduce it by changing behaviour. Assumptions: individuals who hold beliefs contrary to their own behaviour experience discomfort and anxiety, Festinger 1957	<i>Beliefs about consequences Memory, attention, decision processes</i>
19	Contract	Agreed performance of target behaviour with at least one other	<i>Motivation and goals</i>

¹⁴ (Brug, et al., 2007)

		person, written and signed	
20	Social norms	To use messages to correct misperceptions concerning the behaviour of others in the social group. People seek to conform to the example of peers when deciding how to behave; people attribute memorable bad behaviour to entire peer group. Perkins Berkowits, 1986	<i>Social influences</i>
21	Persuasive communication	Process of guiding people toward the adoption of an idea, attitude, or action by rational and symbolic	Beliefs about consequences Motivation and goals
22	Improve coping skills	Constantly changing cognitive and behavioral efforts to manage specific external and/or internal demands that are appraised as taxing	Beliefs about capabilities Emotion
23	Graded task, starting with easy tasks	set easy tasks to perform, making them increasingly difficult until target behaviour performed	Skills Beliefs about capabilities Motivation and goals
24	Increasing skills (problem solving, decision making, goal setting)		Skills Beliefs about capabilities Motivation and goals
25	Rehearsal of relevant skills		Skills Beliefs about capabilities
26	Environmental changes (e.g. objects to facilitate behaviour)		Environmental context and resources
27	Use of imagery	Imagery is used as a stand-in for anticipated situations and then for rehearsing desired responses	Action planning
28	Inoculation	Aim of inoculation is to strengthen existing attitudes and beliefs. There are two basic key components to successful inoculation. The first is threat, which provides motivation to protect a person's attitude or belief. Refutational preemption is the second component, the cognitive part of the process. It is the ability to activate a person's own argument for future defence and strengthen their existing attitudes through counter arguing	<i>Beliefs about consequences</i> <i>Emotion</i>

6 Conclusion and next steps

This overview provides a first step towards a theoretical framework for behavioural change. This exercise provides the following lessons:

- The overview is a broad and general overview of behavioral models and theories applied in the context of health, composed by a group of five experts, supplemented with limited literature search. Therefore, this is presumably not a complete list.
- Theories and models often overlap and are often combined or merged from other models. In order to make a translation from theory into practical design criteria for development of self-support systems, some form of consolidation is necessary. Firstly, criteria have to be determined on which (type of) models have to be included in the framework. Secondly, it is necessary to choose between different consolidation approaches to determine the components of the framework, for instance distillation (produce a single theory for general use, distilled from other theories), consensus-building (a group of experts find an agreed set of key constructs), combination (combining contents of several theories into a new one), etc. Thirdly, for each component of the framework, behavioral change techniques have to be determined and finally, these have to be translated into design principles (requirements) for development of self-support systems that aim to change behavior.
- A large number of theories are concerned with the determinants of behavior (why behavior is performed) and less theories are concerned with the determinants of behavior change (how behavior can be changed). It is mainly the stage approaches that have change as their primary objective. These approaches are few and not well supported in literature. Understanding what causes people to behave as they currently do will not necessarily provide a good foundation for pinpointing how best to get them to do something else.
- Noticeable is the limited attention that is paid to automatic behavior in the models and theories that were covered. It seems that theories of behavior tend to focus on rational and less on unconscious determinants of behavior. While habits or learned automatisms are also important types of behavior; theories on these determinants may provide interesting input for developing self-support systems.

In the next phase (D1.5b) the consolidated framework for behavioral change will be proposed with which designers, system developers, and practitioners can specify the content of behaviour change interventions across domains to specify 1) requirements for the self-support system and 2) claims about how these requirements can contribute to mitigating and/or preventing health issues at home and at work. A framework will be provided in which the key determinants of behaviour change are included. The framework prevents developers of self-support systems to pick just an existing behavioural approach of the shelf and thereby risk missing important components, which is currently common practise. It has to provide evidence based input for the architecture of the self-management system as well as for the evaluation of the effectiveness of self-management systems for behavioural change.

To this end, the following activities are needed for D1.5b “Consolidated framework for behavioural change and empowerment through system supported self-control”:

1. Determine focus criteria. Which model(s) will be used in the framework and why? Examples of criteria are suitability for self-support and properties of target group

2. Extended review of the literature to provide an evidence base for the framework
3. Determine components of the framework (e.g. stage of behavioural change, targeted behaviour (cure/ prevention/ amplification), theory/ constructs, environment, interventions, intervention design processes)
4. Expert session(s) for optimizing the framework together with developers of self-support systems (who are the intended end-users of the framework)
5. Translation of theory into design principles using the Situated Cognitive Engineering approach (Neerinx et al., 2008)

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