

# **A review: How user characteristics affect the effectiveness of persuasive strategies in the health promotion domain of online interventions**



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## Abstract

**Background:** Disease and health problems due to unhealthy life-style or poor health behaviour are serious challenges of our present society, resulting in high costs for the health care system. Over the last decade the development of web-based interventions and applications increased. Usually, they contain Persuasive Technology (PT) elements to promote behaviour change. However, PT strategies do not seem to be equally effective for all users. That is why tailoring PT strategies to the needs of the users becomes increasingly important in the development of online interventions. Still, it remains to be identified how the PT strategies should be tailored to the user to achieve most positive outcome. Hence, the aim of this study is to review differences in user characteristics and their influence on the effectiveness of PT principles.

**Method:** In this review a literature search in different online databases was conducted to find studies in which PT strategies were applied with the aim of changing health related behaviour. Selection criteria were used to include studies, which investigate the influence of different user characteristics on PT strategies. The PT elements described in the interventions were coded according to the principles of the Persuasive System Design model (PSD-model). The following characteristics were coded: study design, characteristics of the studies, condition and purpose of the study, PT in the intervention, examined user differences, influence of user differences on the effectiveness of PT strategies (outcome).

**Results:** Following the search and selection procedure 10 studies were included. All reviewed articles contained an intervention or experiment that promoted healthy lifestyle. Dialogue support was most commonly employed, followed by primary task support. The most frequently applied PT principles were “reward” and “suggestion”. User differences that influenced the effectiveness of PT could be distinguished into 4 main topics: psychological factors, age, gender and education. Psychological factors occurred in 7 studies and were thereby most often examined in the reviewed articles.

**Conclusion:** The literature review shows that user characteristics influence the effectiveness of PT strategies in the health promotion domain of online interventions. Thus, tailoring interventions to individuals can lead to a better outcome of adopting healthy behaviour. The review gives a brief insight into preferred PT principles depending on the individual user characteristics. Due to the fact that there is most evidence about psychological factors to affect the effectiveness of PT strategies, tailoring PT strategies to this topic might be most promising.

## Samenvatting

**Achtergrond:** Ziekten en gezondheidsproblemen die veroorzaakt worden door een ongezonde leefstijl leiden tot hoge gezondheidskosten en moeten serieus worden genomen. Het laatste decennium heeft een toenemende ontwikkeling van online interventies en applicaties laten zien. Deze bevatten elementen vanuit Persuasieve Technologie (PT), die gedragsverandering bevorderen. Echter, blijken deze elementen niet voor iedereen even effectief te zijn. Om de efficiëntie van PT in het gezondheidsdomain te verhogen worden de PT strategieën soms getailored naar de behoeften van de gebruikers. Echter is niet bekend hoe deze strategieën het best getailored moeten worden om de effectiviteit van interventies te verhogen. Daarom is het doel van deze literatuuronderzoek om na te gaan in hoeverre gebruiker karakteristieken de effectiviteit van PT elementen beïnvloeden.

**Methode:** Het literatuuronderzoek werd gedaan door in verschillende online databases te zoeken naar studies die gebruik maken van PT strategieën om tot gedragsverandering te leiden. De PT elementen die beschreven worden in de interventies, zijn gecodeerd volgens de classificatie van het “Persuasieve System Design model” (PSD-model). Karakteristieken die gedurende de selectieprocedure gecodeerd werden, zijn: studie ontwerp, karakteristieken van de studie, conditie en nut van de studie, PT in de interventie, gebruiker karakteristieken, invloed van verschillen in gebruikers en het effect van de PT strategieën (uitkomst).

**Resultaten:** 10 studies werden geïncludeerd. De geselecteerde artikelen gaan over interventies of experimenten, die een gezonde leefstijl tot doel hebben. “Dialogue Support” werd meest gebruikt, gevolgd door “Primary Task Support”. De meest toegepaste principes waren “beloning” en “suggestie”. Gebruiker karakteristieken die de effectiviteit van PT beïnvloeden, werden in 4 hoofd topics ingedeeld: psychologische factoren, leeftijd, geslacht en opleiding. Psychologische factoren kwamen in 7 studies aan bod en makten dus het grootste gedeelte van de gebruiker karakteristieken in deze review uit.

**Discussie:** Het literatuuronderzoek laat zien dat gebruiker karakteristieken de effectiviteit van PT strategieën in online interventies beïnvloeden. Het tailoren van interventies op de behoeften van een individu, kan tot een betere adoptie van het gewenste gedrag leiden. De literatuurreview geeft een inzicht over PT principes die geprefereerd worden door individuele gebruiker karakteristieken. Omdat er het meeste bewijs voor is dat psychologische factoren de effectiviteit van PT strategieën beïnvloeden, wordt geadviseerd om PT strategieën op psychologische factoren toe te spitsen.

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## 1. Introduction

Disease and health problems due to unhealthy life-style or poor health behaviours are serious challenges of our present society. Recent literature shows that the risk of many diseases such as heart disease, obesity and diabetes type 2 can be reduced or prevented by the adoption of healthy behaviour (Lichtenstein et al., 2006; Artinian et al., 2010; Rejeski, et al., 2012). Thus, changing behaviour into more healthy behaviour has become the main topic of various interventions to solve health related problems. However, the capacity of these interventions is limited to a number of patients. As a result not everyone who needs support has the chance to participate. Increasing the participation number would require a higher amount of specialized personnel and supervisors leading to higher costs of the health care system. Due to the fact that according to the World Health Organization (WHO) (2009) people holding an unhealthy behaviour have an increased risk of developing a serious health problem in the future, a prevention from severe consequences becomes indispensable in order to keep the health costs as low as possible. Consequently, other opportunities are needed to help and support a high number of people, who show unhealthy behaviour resulting in health problems. The last decade a growing trend towards new innovations and technology as a key instrument of interventions emerged. The implementation of technology in interventions could be a solution through enabling a high capacity of participants, offering direct access without long waiting lists (Cuijpers, van Straten, & Andersson, 2008) and reducing health care costs by saving health services or preventing people from severe diseases (Griffiths, Lindenmeyer, Powell, Lowe, & Thorogood, 2006). Meanwhile, a variety of web-based interventions and applications related to problems concerning health and lifestyle do exist, for instance interventions to enhance physical activity after cardiac rehabilitation, sleep behaviour or eating habits (Antypas & Wangberg, 2014; Choe, 2011; Chomutare, Tatara, Årsand, & Hartvigsen, 2013; Fico, Fioravanti, Arredondo, Ardigo, & Guillen, 2010). Besides, the advantage of saving health care costs and reaching a greater number of people, online interventions support the self-management, self-determination and privacy of users, by being flexible in time and location (Drozd, Lehto, & Oinas-Kukkonen, 2012). Therefore, the use of online interventions is a promising method to solve the problem of unhealthy behaviour. However, not all participants show the desired results by following an online intervention (Kelders, Van Gemert-Pijnen, Werkman, Nijland, & Seydel, 2011). Some participants seem to profit more by an intervention than others. What remains to be identified is, where these differences between participants come from. Thus, the current review aims to take a closer

look towards this knowledge gap.

As reported by Barak, Klein, and Proudfoot (2009) a web-based or online intervention is defined as “...*a primarily self-guided intervention program that is executed by means of a prescriptive online program operated through a website and used by consumers seeking health- and mental-health related assistance. The intervention program itself attempts to create positive change and or improve/enhance knowledge, awareness, and understanding via the provision of sound health-related material and use of interactive web-based components*”.

In regard to the health- and lifestyle setting there is evidence that web-based interventions are effective in reaching the target behaviour related to diabetes (Ramadas, Quek, Chan, & Oldenburg, 2011), depression (Richards, & Richardson, 2012), obesity (Xu, Chomutare, & Iyengar, 2014), physical activity, dietary behaviour and alcohol consumption (Webb, Joseph, Yardley, & Michie, 2010). In general web-based interventions seem to be equally as effective as non web-based interventions (Wantland, Portillo, Holzemer, Slaughter, & McGhee, 2004; Gollings & Paxton, 2006). However, as also seen in face-to-face interventions the effect size of online interventions varies from small to large (Webb et al., 2010). In contrast, there are also studies that found no positive or just limited effects of online interventions (Lyons, Lewis, Mayrhoen, & Rowland, 2014; Norman, Zabinski, Adams, Rosenberg, Yaroch, & Atienza, 2007; Neve, Morgan, Jones, & Collins, 2010; Black et al., 2011; Kelders et al., 2011; van Gemert-Pijnen et al., 2011). The reasons for these differences in effectiveness remain unclear. Interventions do exist of complex frameworks with different theoretical backgrounds and techniques, which might have an influence on the effectiveness of an intervention. Compared to face-to-face interventions, online interventions focus on the application of convincing techniques to change behaviour with the support of technology. Besides the theoretical basis and the mode of delivery, behaviour change techniques seem to be an important factor to influence the behaviour in online interventions (Webb et al., 2010). Furthermore Webb et al. (2010) point out that the higher the number of applied behaviour change techniques the larger the effects.

A variety of techniques applied in online interventions deal with Persuasive Technology (PT), which represents an important component of online interventions (Fogg, 1999; Oinas-Kukkonen, 2010). According to Fogg (2003) PT is defined as an interactive computing system to change the users attitude or behaviour. It plays an important role in Human Computer Interaction (HCI). In the last years the interest in PT has grown among

researchers and practitioners, since it seems to be effective in motivating users to reach the target behaviour by changing their attitude or behaviour (Atkin & Salmon, 2013; Beun, 2013; Lin & Mann, 2012). Over the last years several different PT strategies were used in online interventions (Fogg, 2003; Oinas-Kukkonen & Harjumaa, 2008). The PT elements described in this study only refer to the principles of the Persuasive System Design model (PSD-model) by Oinas-Kukkonen and Harjumaa (2008), because these principles are broadly applied in online interventions and seem to be effective. The PSD-model is a design framework that consists of 28 PSD principles, which are classified into four groups: *Primary Task Support*, *Dialogue Support*, *Credibility Support* and *Social Support* (Oinas-Kukkonen & Harjumaa, 2008; Oinas-Kukkonen & Harjumaa, 2009). The principles of this classification are listed in Table 1. Based on this framework it is possible to investigate PT in applications related to healthcare and other domains.

Table 1.

*The Persuasive Systems Design Model (Oinas-Kukkonen & Harjumaa, 2009)*

Primary task support	Dialogue support	System credibility support	Social support
Reduction	Praise	Trustworthiness	Social learning
Tunneling	Rewards	Expertise	Social comparison
Tailoring	Reminders	Surface credibility	Normative influence
Personalization	Suggestion	Real-world feel	Social facilitation
Self-monitoring	Similarity	Authority	Cooperation
Simulation	Liking	Third-party	Competition
Rehearsal	Social role	Verifiability	Recognition

*Primary Task Support* is meant to support the user in what he/she is doing while making his/her task as simple as possible (Oinas-Kukkonen & Harjumaa, 2009). *Dialogue Support* facilitates computer-human dialogue through actions that tend to bring users closer towards their target behaviour. By this manner users get feedback of the used system (Oinas-Kukkonen & Harjumaa, 2009). *System Credibility* gives suggestions about how a system can be created to convince users of its effectiveness by maximizing the credibility. *Social support* as a design principle motivates users to be involved in social exchange with peers for their own purpose. The PT strategies that are listed in Table 1 are mostly used in the context of health interventions and are applied in different forms and combinations (Hamari, Koivisto, & Pakkanen, 2014).

Also often implemented in persuasive systems to promote health behaviour change, are game design elements. The application of these game elements in a non-game context is called “gamification” (Deterding, Dixon, Khaled, & Nacke, 2011). There is evidence that gamification works in a way that it facilitates to keep following an intervention by motivating its users with fun elements (Cugelman, 2013).

Most of the PT strategies reveal a “one-size-fits-all” approach based on the assumption that PT strategies are equally persuasive for any user. This indicates that the provided PT strategies do not distinguish between individual differences (He, Greenberg, & Huang, 2010). Thus, the “one-size-fits-all” approach assumes that PT yields to positive outcome for any user. However, this assumption is questionable in practice. The review of Hamari et al. (2014) of the persuasiveness of PT, demonstrates that PT does not always lead to positive results but can have negative outcomes such as cognitive overload, anxiety and peer pressure. This indicates that PT strategies might not be as effective for everyone as assumed. Accordingly, there is a great need to gain more knowledge about PT principles and their effects on users.

Meanwhile researchers and experts agree that people differ in their needs, expectations and motivation towards behaviour change and health technologies (Berkovsky, Freyne, & Oinas-Kukkonen, 2012; Halko & Kientz, 2010; Kaptein, De Ruyter, Markopoulos, & Aarts, 2012). Therefore, PT in online interventions should be matched to its individual users to reach better effects. In the field of PT there is one strategy called “tailoring” which is specially targeted on providing information in online interventions in a way that it fits to individual differences and preferences (Oinas-Kukkonen & Harjumaa, 2008). In this regard, information provision occurs in a way that it matches the interests, needs, personality or context of users. In the last years, there is growing evidence for the use of tailoring in online interventions to change health behaviour. A variety of tailored online interventions have led to positive outcomes according to health and lifestyle problems such as alcohol consumption (Chiauzzi, Green, Lord, Thum, & Goldstein, 2005), dietary (Neville, O'Hara, & Milat, 2009), smoking (Strecher, Shiffman, & West, 2005) and physical activity (Kroeze, Werkman, & Brug, 2006). Tailoring PT to its users has been found to increase the impact of persuasive applications (Berkovsky et al., 2012). To stress the effectiveness of tailoring the comparative study of Kaptein et al. (2012) applied tailored text messages implementing social influence strategies and contra-tailored text messages. In this context they demonstrate that contra-tailored strategies can even have the opposed effect by increasing the adoption of unhealthy behaviour instead of decreasing it. That indicates that the assumption of one-size-fits-all is indeed a



problematic approach and that a system should provide tailored information. Whether this also applies for tailoring PT strategies remains unclear. Despite the promising results of tailoring, the way of tailoring PT strategies to user characteristics and especially how these tailored strategies should be applied in interventions to gain most positive outcomes still remains to be identified.

Concerning PT, the question arises if tailoring PT elements to user characteristics might be an advantage in promoting health behaviour. Little is known about tailoring PT elements to different users and the existing studies failed to draw a general conclusion about which PT strategies should be implemented for the respective individual user to maximize the effects of an online intervention. Thus, there is need to better explore diversity among user characteristics related to the effectiveness of specific PT strategies with the aim to increase the efficacy of technology in the health domain, by tailoring PT strategies to its users. Therefore, this study aims to systematically review different user characteristics and their influence on the effectiveness of PT strategies. The research questions that should be answered are:

- (1) Which differences of user characteristics are analysed in health related online interventions?
- (2) Which PT strategies are used in the online interventions?
- (3) How do user characteristics influence the effectiveness of PT strategies in the health promotion domain of online interventions?

## **2. Method**

### *Search Strategy and study selection*

The study selection took place in two independent steps. First a dataset was composed by dr. S. M. Kelders. Second, this dataset served as starting point for the further selection of articles in regard to the research questions.

### *Existing dataset*

In this study an existing dataset was used. Thereby, an extensive literature research was conducted using the following databases: Web of Science, PsycInfo, Scopus and ScienceDirect. A combination of the constructs “persuasive technology” and “health” and synonyms was used to filter studies that only included PT in the health care setting. In order to ensure a broad extent of studies in the review, special keywords were used for the constructs (see Appendix, Table 1). Exclusion criteria for the title and abstract screening were (1) not an individual paper (2) not targeted at a health related behaviour, (3) no link with persuasive technology and (4) not written in English. The search strategy and exclusion based on title and abstract yielded 270 articles.

### *Recent review*

This review focuses on articles that examine different user characteristics and their reaction to PT strategies. Therefore the 270 remaining articles from the existing dataset mentioned above were put into Endnote. The title and abstract of the articles were searched for the keywords “individual difference”, “user differences”, “personal characteristics”, “user characteristic”, “personality” and “demographic”.

The remaining articles were screened on the basis of title and abstract. Inclusion criteria were that the article deals with the following five conditions: (1) the health care domain as a main topic, (2) an online intervention or experiment, that could be followed web-based or via a mobile application, (3) an application of PT-strategies to facilitate the achievement of healthy behaviour, (4) user characteristics and their influence on the effectiveness of PT, (5) an intervention or experiment that had been tested. Exclusion criterion was that (1) the intervention was not intended to promote healthy behaviour. As a last step the residual articles were read completely and checked for inclusion and exclusion. After finishing the selection

process, all 270 articles were screened globally to secure that no important article has been overseen. This yielded in the inclusion of one more article.

The keyword searching in the titles and abstracts of the existing dataset yielded 42 articles. After removing the duplicates 24 articles remained. Screening the title and abstract on eligibility another 12 articles were excluded. After reading the full-articles 10 articles were included (Figure 1). In total 15 articles were excluded based on title, abstract and full-text. Main reasons that led to exclusion of an article were that the study (1) did not include a tested intervention or experiment ( $n = 8$ ), (2) did not differentiate between user characteristics and their impact on PT elements ( $n = 5$ ) and (3) did not mean to change behaviour in the health care domain ( $n = 1$ ).

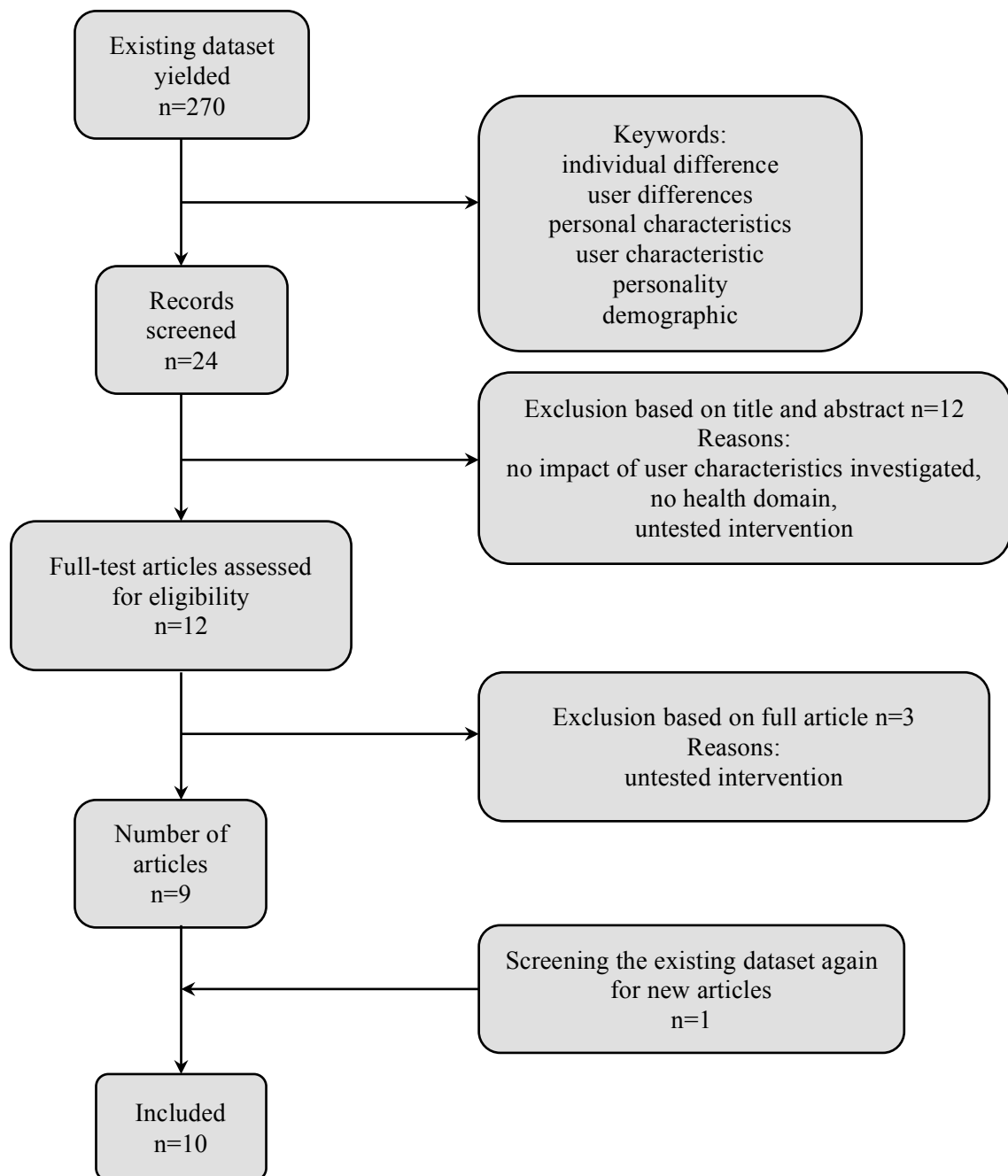


Figure 1. Flowchart of study search and selection

#### Data items

The remaining articles were coded by the following characteristics:

#### *Study design*

The names of the first author of all selected studies were recorded. Furthermore, the used study design was noted.

### *Characteristics of the selected studies*

The number of the participants that followed the intervention was listed.

Besides, a short description was given for each study to summarize general information about the intervention.

### *Condition and purpose of the study*

The intended condition of each intervention was recorded by enumerating the targeted health care areas of the interventions (lifestyle, chronic condition or mental health). Additionally, the purpose of each study was documented.

### *Persuasive Technology in the intervention*

The information about the applied PT strategies in the intervention was noted. Due to the fact that a variety of overlapping PT strategies from different models exist, in this study the PT-principles were linked to the PSD-model of Oinas-Kukkonen and Harjumaa (2009) to achieve a consistent overview about all used PT-principles. Since the PSD-model is a commonly used model in online interventions it is used as a foundation in this study. The PSD strategies are shown in Table 1. If the used PT principles based on another theory than the PSD-model and were mentioned by its original names in the articles, they can still be found in Table 2 (see Appendix). Since gamification plays an important role in PT, gamification features were considered both in the terms of the PSD-model and as a self-contained framework. If the applied PT could not be interrelated to one of the principles listed in the PSD-model, the PT elements were allocated to one of the PSD principle of the PSD-model that matched best. Furthermore, the total number of the PSD principles was recorded. Additionally, it was recorded whether the PT was presented via a web-based intervention, a mobile application or other.

### *Examined differences among users*

Any reported information on differences in user characteristics mentioned in the intervention was documented. User differences could be of demographical manner such as age, personality, education, race, gender or others.

### *Influence of different user characteristics on the effectiveness of PT strategies (Outcome)*

The main findings of all studies were extracted related to user differences in PT and the effectiveness of the intervention.

### 3. Results

#### *Characteristics of the selected studies*

An overview of the coded characteristics of the 10 studies is presented in Table 2 (see Appendix). The included articles tested either interventions (S1, S2, S3, S6, S10), features containing PT like storyboards (S4, S8, S9) or health related messages (S5, S7) that could be implemented in future interventions. Three out of 10 studies used a randomized control trial (RCT) (S1, S5, S7). The remaining 7 articles used exploratory study designs. These studies focused on gaining insight into the reaction to PT and background information to direct the implementation of these PT techniques in future interventions. The interventions were used via mobile applications (n = 3), web-based (n = 6) or both (n = 1). Promoting healthy lifestyle behaviour was the global target of all 10 studies. In this regard, the focus of the interventions was put on weight management (n = 2), promoting physical activity (n = 4), healthy eating (n = 2), both physical activity and healthy eating (n = 1) or on awareness of hypertension (n = 1).

#### *Persuasive Technology in the interventions*

Different PT principles were applied, based on a variety of theories and models for instance the Transtheoretical model of behaviour change (TTM), the Self-Determination Theory (SDT) the Behaviour Change Support System (BCSS), the Value Sensitive Design (VSD), the Persuasive System Design Model (PSD), the Fogg Behaviour Grid etc. An allocation of the PSD principles, which were used in the interventions, is presented in Table 2. Overall, PSD principles were used 56 times. Each study used 1-10 PSD elements. Dialogue Support elements were most often presented in the studies (n = 21), and occurred in almost all studies with the exception of one (S7). Primary Task Support elements were often applied as well (n = 19), followed by Social Support (n = 14) and Credibility Support (n = 2). The most commonly used principles in the interventions were: “suggestion” (n = 6), “reward” (n = 6), “self-monitoring” (n = 5) and “tailoring” (n = 5). Two articles (S3, S6) dealt with gamification, which can be considered as PT consisting of a variety of PT elements such as “liking” and “reward”.

Table 2.

*Persuasive elements from each study linked to the PSD-principles*

PSD - principles		Number of the study										Total
		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	
Primary Task Support	Reduction			x			x				x	3
	Tunneling		x									1
	Tailoring	x		x				x	x	x		5
	Personalization	x							x	x		3
	Self-monitoring	x		x					x	x	x	5
	Simulation								x	x		2
	Rehearsal											0
Dialogue Support	Praise	x			x				x	x		4
	Reward			x	x		x		x	x	x	6
	Reminder										x	1
	Suggestion		x	x		x	x		x	x		6
	Similarity											0
	Liking			x	x	x	x					4
	Social role											0
Credibility Support	Trustworthiness											0
	Expertise											0
	Surface											0
	Real world feel											0
	Authority				x	x						2
	Third-party											0
	Verifiability											0
Social Support	Social learning											0
	Social								x	x		2
	Normative			x			x					2
	Social facilitation					x	x					2
	Cooperation	x			x				x	x		4
	Competition				x				x	x		3
	Recognition						x					1
Gamification				x			x					2
Total number of PT elements		5	2	8	6	4	8	1	10	10	4	58

*Investigated user differences in health related online interventions*

Reported differences between users that were explored in the selected studies can be classified into 4 main topics: psychological factors (n = 7), age (n = 2), gender (n = 3) and education (n = 1). This is shown in Table 3 (see Appendix). Related to psychological factors, this topic is composed of all factors that are connected with the psyche of the users. Psychological factors that emerged in the articles were, locus of control (internal vs. external) (S1), motivation and belief (low vs. high; believer vs. nonbeliever) (S3), the Big Five personality traits (Openness

to experience, Conscientiousness, Extraversion, Agreeableness and Neuroticism) (S4), persuadability (low vs. high) (S5), the consideration of future consequences (CFC) (low vs. high) (S7), 7 different gamer type personalities (Achiever, Conqueror, Daredevil, Mastermind, Seeker, Socializer and Survivor) classified according to the BrainHex study (Bateman & Nacke, 2010) (S9) and the readiness for action (active vs. passive) (S10). Two out of ten articles focused on age (young vs. old) (S1, S6). Gender was distinguished in three studies (male vs. female) (S2, S6, S8). In relation to the topic education, three characteristics could be subordinated. One article dealt with educational status (low vs. high), computer experience (low vs. high) and vocabulary knowledge (low vs. high) (S1).

### *Influence of user characteristics on the effectiveness of PT strategies*

In this section the findings of the review study, which focuses on the 4 user characteristics described above and their impact on PT will be presented. An overview about the user characteristics and applied PSD principles is shown in Table 4 (see Appendix). All studies found significant differences between the perceived persuasiveness of the PT strategies and their users, no matter which user characteristics were presented. As shown in Table 3 there were positive as well as negative relations between the user characteristics and the reported effectiveness of the PT strategies to change behaviour.

Table 3.

*Representation of the different user characteristics related to the effectiveness (positive vs. negative) of the used PT principles*

User Characteristics	Study	Topic	Differentiation	Pos. (+) PSD-principle	Neg. (-) PSD-principle
Psychological factors	S1	Locus of control	Low		
			High (internal)	Tailoring Self-monitoring Personalization Praise Cooperation	
	S3	Motivation	Low	Gamification	
			High	Normative influence Reduction	
	S3	Belief	Believer		
			Nonbeliever	Reward	
	S4	Big Five	Openness to experience	Authority Competition	Reward (extrinsic motivation and neg.



				Reinforcement)
		Conscientiousness	Cooperation Competition	-
		Extraversion	-	Reward Praise (pos. and neg. Reinforcement)
		Agreeableness	Competition	Reward Praise (pos. and neg. Reinforcement)
		Neuroticism	Reward (neg. Reinforcement)	Cooperation
S5	Persuadability	Low		Authority Social facilitation Liking Suggestion
		High	Authority Social facilitation Liking Suggestion	
S7	CFC	Low	Tailoring Reward (gain frame messages)	
		High	Tailoring	
S9	Gamer type personalities	Achiever	Cooperation Self-monitoring Suggestion Reward	-
		Conqueror	Competition Social comparison Personalization Self-monitoring Suggestion Simulation	-
		Daredevil	Simulation	Competition Social comparison Self-monitoring Suggestion
		Mastermind	Competition Social comparison Tailoring Personalization Self-monitoring Suggestion Simulation	-
		Seeker	Competition Social comparison	

				Tailoring Personalization Praise	-
			Socializer	Competition Social comparison Cooperation	Tailoring Praise Self-monitoring Suggestion
			Survivor	Competition Social comparison Self-monitoring Suggestion	Cooperation Tailoring Reward
	S10	Readiness for action	Active	Self-monitoring	
			Passive	Reward	
Age	S1 S6		Young	Tailoring Self-monitoring Personalization Praise Cooperation	
			Old		Gamification
Gender	S2 S6 S8		Male	Personalization Simulation Cooperation Praise Competition Social comparison Self-monitoring Suggestion	Reward Tailoring
			Female	Personalization Simulation Cooperation Praise Competition Social comparison Self-monitoring Suggestion Tailoring Social facilitation Normative influence Recognition Liking Gamification	Reward Tailoring
Education	S1		Low		
			High	Tailoring Self-monitoring Personalization Praise Cooperation	

- no correlation between PT strategies and user characteristics were found

empty space: no results concerning PT strategies and user characteristics mentioned in the article

### *Psychological factors*

As already mentioned many sub-categories of psychological factors were described in the reviewed articles. In S1 “tailoring”, “self-monitoring”, “personalization”, “praise” and “cooperation” had a positive effect for participants with a high internal locus of control.

S3 concluded that motivated users might benefit from peer pressure techniques such as “normative influence”. In contrast, less motivated individuals might have more advantage by “gamification”, which provides an environment related to funny exercises. If the person joining the intervention believes in behavioural change, the importance of the cognitive dissonance should be increased for instance by using the PSD-principle “reduction”. However, if the user is a nonbeliever, making him aware of the benefits via educational strategies or “reward” can change his attitude towards the exercises.

S4 provided evidence that some personality types of the Big Five favour more with special PT strategies than others and some even dislike a few of the strategies. *Consciousness* strongly correlated with the PT strategies “cooperation” and “competition”. Furthermore, no negative correlations with this personality trait were found, indicating that people with this personality are in general most positive towards PT. All other personality traits showed at least one negative correlation with one of the PT strategies. Negative and positive reinforcement (in this study coded as “reward” or “praise”) most often occurred as being negative for many personality traits in changing behaviour except for *Neuroticism*. “Competition” seemed to be an effective strategy for the personality traits *Openness to experience*, *Conscientiousness* and *Agreeableness*. *Extraversion* had no positive correlations at all and therefore PT strategies do not seem to be suitable for this personality trait.

With regard to the personality types of gamers, all gamer types showed positive reactions with at least one of the PSD principles (S9). Most of the gamer types were receptive to following strategies: “competition”, “social comparison”, “self-monitoring” and “suggestion”. The gamer type *Mastermind* was most accessible to PT with 7 positive correlations, followed by *Conqueror* and *Seeker*. Less accessible to the PT principles was *Daredevil*, because this trait only showed a positive reaction to “simulation”. “Simulation” was not perceived as negative by any of the gamer personalities. The three gamer types *Daredevil*, *Socializer* and *Survivor* had in contrast to the other gamer types not only positive but also negative correlations with the PSD principles. “Self-monitoring” and “tailoring” occurred most in this context.

S5 examined that the degree of persuadability can influence the reaction to PT. Persuasive messages containing the PT principles: “authority”, “liking”, “suggestion” and “social facilitation”, are more effective to people who are easily to convince (high persuadable). Related to low persuadability the applied PT strategies had either no or negative effect.

The influence of CFC on the effectiveness of an intervention by “tailoring” health communication messages was examined in S7. People who are low in CFC are more responsive to gain frame message and people who are high in CFC are more responsive to the loss frame message. Based on the different outcomes for people with high and low CFC, the authors of S7 concluded that health communication messages should be tailored to individual characteristics, like the participants’ appraisal of long- and short-term consequences of their behaviour.

Related to activity, active elderly prefer to get information that enables reflection on possible intrinsic benefits and to see their exercise goals developing (S10). Thus, “self-monitoring” seems to be an important PT element for active elderly. Less active elderly prefer information that makes them aware of the extrinsic benefits of exercises such as extending their social network. Thus, “reward” in the context of social activities seems to be an important PT element for less active elderly.

### *Age*

Age mostly does not have a direct effect on the benefits of “gamification” but nevertheless the elderly do not use “gamification” that often, due to reduced ease of use (S6). S1 demonstrated that participants of young age were more motivated to maintain healthy lifestyle by using the PT elements “tailoring”, “self-monitoring”, “personalization”, “praise” and “cooperation.”

### *Gender*

Three studies examined the effect of gender and reported that female and male differ in their response to PT strategies. In general women show more positive relations with PT strategies than men. Even though, most of the effective PT strategies were effective for both, men and women, women are more receptive to the PT strategies: “tailoring”, “cooperation”, “personalization”, “praise” and “simulation” (S8). For both genders “reward” and “tailoring” are perceived as negative PT strategies. Furthermore “liking”, “social facilitation” and “normative influence” seemed to play a greater role among women than men, since in the

gamification study (S6) women felt to have social profit by assessing the social community of the game more positive than men and perceiving greater benefit from social interchange. Moreover, women noticed more positive perception of recognition and perceived the exercises as more playful hence had higher motivation to keep exercising. S2 stated that perceived persuasiveness is more important for men to intent behaviour change than for women. Conversely, unobtrusiveness seemed to be more important for women to intent behaviour change.

### *Education*

S1 analysed the influence of education level, computer experience and vocabulary on the effectiveness of a lifestyle diary, in which the PT elements “tailoring”, “self-monitoring”, “personalization”, “praise’ and “cooperation” were applied. Participants with a high computer experience, a great vocabulary and a high education level were more motivated to maintain the healthy lifestyle.

## 4. Discussion

The aim of this review was to collect and analyse studies in which user characteristics seemed to have influence on the effectiveness of PT strategies in online interventions, that target a health related problem. All in all the findings from the literature show that there is an overall agreement on the fact that the one-size fits all approach is not tenable with regard to the different reactions of users in the perceived persuasiveness of technology principles. Therefore a guideline is provided for tailoring PT strategies to different user characteristics in order to fulfil the needs of the users and assure optimal outcomes in adopting healthy behaviour.

### *Principle results*

This review includes 10 articles, that all describe online interventions or experiments to promote healthy lifestyle. To answer the first research question, differences in user characteristics that were analysed in the reviewed articles could be divided into 4 general topics: psychological factors, age, gender and education. This means that previous studies already determined several user factors that affect the outcome of online interventions. And there might be even more user characteristics that have not been investigated, yet. Psychological factors were discussed most frequently in the reviewed articles and were subdivided into 7 categories, which are related to the psyche. The second most frequent user characteristic that was analysed in the articles is gender, followed by age and education. Various PT strategies were used in the reviewed articles. The study has found that elements of Dialogue Support were investigated most consistently, closely followed by Primary Task Support. This differs with the findings of Kelders, Kok, Ossebaard and Van Gemert-Pijnen, (2012), who claim that Primary Task Support is most commonly employed in interventions that target chronic conditions and lifestyle. The small difference might be related to the fact that in the recent review only lifestyle interventions were included that determined differences between users. In context with the category Credibility Support only one principle was found. Elements of Credibility Support seem to be difficult to find in interventions, which is also shown in previous work. For this reason previous studies even eliminated this category of the PSD-model (Kelders et al., 2012; Kelders, Kok, & Van Gemert-Pijnen, 2011).

With regard to the second research question, the most commonly used PSD principles in the interventions were “reward” and “suggestion”. This is in limited agreement with former

studies, which found “suggestion” to be the second most frequently used element and “reward” a seldom used element (Kelders et al., 2012). The current review included 2 gamification studies, which might have led to a more frequent use of the strategy “reward”. “Reward” is a promising strategy in health interventions and therefore often used in gamification (Wang & Sun, 2011).

In almost all studies significant correlations were found between user differences and the effectiveness of PT principles. Thus, in regard to the third research question, the results of this study indicate that user characteristics influence the effectiveness of PT strategies in the health promotion domain of online interventions. These findings stress the importance of individual tailored interventions to fulfil the needs of the users and assure optimal outcomes in adopting healthy behaviour. The results of this review are in agreement with former studies indicating that the one-size-fits all approach is not applicable (Hamari et al., 2014; Kaptein et al., 2012; Berkovsky et al., 2012). However, these studies fail to give general guidelines about how to tailor PT strategies to different user characteristics. Hence, the current review aims to fill this gap by giving an insight into effective PT strategies that match the needs and preferences of different user characteristics.

With regard to the psychological factors the results show that, “competition” is a promising PT strategy for many personality types to change behaviour (Halko & Kientz, 2010; Orji, Vassileva, & Mandryk, 2014). This reveals that “competition” is a strategy that can be applied with less caution. Possible reasons why a variety of personalities perceive “competition” as an effective strategy can be that people gain satisfaction from performing well, preference for difficult tasks (seeking the challenge), desire to win, motivation to put forth effort in competitive situation, satisfaction from outplaying someone’s performance or feeling motivated when being in a competition (Franken, & Brown, 1995). Thus, being fond of “competition” can have many different reasons and might therefore explain the broad spectrum of different personalities that is attracted by this strategy. “Reward” and “praise” are often perceived as negative PT principles according to personality types (Halko & Kientz, 2010; Orji et al., 2014), and therefore should be applied with caution, especially by people who show the personality traits *Openness to experience*, *Extraversion* and *Agreeableness*. There is an overlap of the personality traits *Extraversion* and *Daredevil*, which both show excitement of risk taking/ thrill seeking. This similarity between the personality traits is also reflected in the reaction to PT strategies. For users with these personality traits it is difficult to be positively influenced by PT strategies, because they show many negative correlations with

PT strategies and if positively correlated only to one strategy (Halko & Kientz, 2010; Orji et al., 2014). It remains unclear why people having this personality trait do not perceive PT as positive for changing behaviour. The impact of personality in PT does not only accrue in the health care domain. Previous work has also stressed this relation among students improving their study behaviour (Adnan, Mukhtar, & Naveed, 2012). Knowledge about the impact of personality can be used in online interventions to enable an individual adaptation of strategies that match with the personality trait of the user. For instance, people with the personality trait *Conscientiousness* can benefit from the strategy “cooperation”. Therefore, the application should offer Social Support while giving users the possibility to cooperate with others. That people that are conscientious like to cooperate with others has also been found in previous work (Roberts, Chernyshenko, Stark, & Goldberg, 2005). These findings and the results of Halko and Kientz (2010) demonstrate that it can be helpful to think from the user’s perspective, since the participants reactions to the PT principles were often similar to their personality traits hence predictable. Furthermore, the results of this review indicate that non-active participants, non-believers and users that are low motivated, profit from strategies that make them see more benefits of the intervention, as “reward” or by increasing the fun factor “gamification”, because their reaction was positive to these strategies (Rodríguez, Roa, Morán & Nava-Muñoz, 2013; Ferron & Massa, 2013). These two strategies might also be effective for people who are not easy to convince, due to the fact a person who is low persuadable might even show signs of non-believe, passivity and low motivation. However, “reward” and “gamification” have not been tested for low persuadable participants in the reviewed articles and showed negative correlations with other PT strategies. Thus, this assumption needs to be tested in future research.

The effect of age on the effectiveness of PT principles remains unclear, due to disagreement of the authors. Koivisto and Hamari (2014) concluded that age does not affect the outcome of an intervention when using PT elements, however Blanson Henkemans, van der Boog, Lindenberg, van der Mast, Neerincx and Zwetsloot-Schonk (2009) elaborated opposite results. According to Blanson Henkemans et al. (2009) participants of young age were more motivated to maintain a healthy lifestyle after using an intervention that combined the strategies “tailoring”, “self-monitoring”, “personalization”, “praise” and “cooperation” than older people. However, this combination of PT strategies does not enable a deeper view about single strategies and their effect on age. In compliance with Koivisto and Hamari (2014) age mostly does not have a direct effect on the benefits of “gamification”, but nevertheless the elderly does not use “gamification” that often. This is explained by reduced



ease of use (Koivisto & Hamari, 2014). The unspecific results, related to the influence of age, reveal that more research is needed to examine whether age affects the effectiveness of PT strategies or not. Interacting with computer technology can be challenging for the elderly and might limit the enjoyment, since getting older is associated with the degeneration of cognitive-, sensory-perceptual processes, reaction time and motor abilities (Ijsselstein, Nap, de Kort, & Poels, 2007). Elderly users experience more than twice usability problems than users of younger age (Nielsen, 2002). This indicates that the elderly might not be as computer and technology literate as people of young age. Still, older people seem quite receptive to the use of new technology, if their purposes lead to sufficient benefits (Merlenhorst, 2002). For instance, the elderly is not willing to use technology, if it replaces face-to-face contacts (Eggermont, Vandebosch, & Steyaert, 2006). However, if technology supports additional social contacts, connects them with fellow sufferer, or in case of immobility helps them to stay in touch, the elderly is motivated to use new technologies.

With regard to gender this study has found that men and women differ in their reaction to PT strategies. In general females are more receptive to PT strategies than male and they seem to profit more from Social Support strategies than men (Orji, 2014; Kaptein, Lacroix & Saini (2010). This is in line with former studies, which claim that women are more cooperative than men and like working with others (Van Vugt, De Cremer, & Janssen, 2007). Not being perceived as persuasive for both gender were the strategies “reward“ and “tailoring“ (Orji, 2014). In the study of Orji (2014) users did not like “tailoring”, because the system did not tailor automatically but required the input of the users. This does not per se mean that “tailoring” is an ineffective strategy for men and woman, but rather indicates that it needs to be implemented in the right way. Thus, when using “tailoring” as a strategy the system should not ask too much input of the user. In that case users will perceive this strategy as annoying and the strategy will fail its purpose. Whereas perceived persuasiveness is more important for men, women prefer getting unobtrusive information. Thus, men should be treated with obvious PT strategies, while offering women PT strategies in a more unobtrusive way, for example suggesting different options.

The results indicate that a high educational status, great computer experience and great vocabulary predict the effectiveness of PT strategies (Blanson Henkemans et al., 2009). Amongst others, “self-monitoring” is perceived as a positive strategy to change behaviour. This strategy refers to the fact that people who are highly educated are usually good in reflecting on their behaviour and in controlling themselves. Moreover, they are used to be structured and to make plans, which is compatible with “self-monitoring”.

To conclude, the current findings highlight the importance to tailor specific PT strategies to different user characteristics. In sum, all user characteristics seem to have influence on the effectiveness of the PT principles. Still, it remains to be identified which user characteristics are most important to consider when applying PT strategies. Due to the fact that most of the reviewed articles refer to psychological factors, there is most evidence that psychological user differences affect the effectiveness of PT strategies. Based on this result, we should tailor to psychological factors. There seem to be overlapping elements related to this characteristic, which underline the relevance to focus on psychological variables. However, psychological processes are complex frameworks and they are less stable in contrast to demographic characteristics such as gender, education or age. Thus, creating more specific guidelines concerning psychological factors and applied PT strategies will imply a great challenge. Nevertheless, this study shows that psychological factors were often explored in previous work and occurred as a promising predictor of the effectiveness of PT strategies.

### ***Limitations***

A limitation of this study is that the PSD principles were coded based on the descriptions of the applied PT elements in the articles. Due to the fact that the precision of the descriptions varied, all PT principles that were investigated in the studies were captured and compared as accurately as possible. Moreover, only one researcher coded the PT principles. Furthermore, in this study exploratory studies were predominantly reviewed, which might be of limited value with regard to drawing definitive conclusions. Nevertheless, these studies are included in this review, since investigations related to user characteristics and PT strategies have not been conducted that frequently in the past. Another disadvantage of this quite new research field is, that there is not much information about separately applied PT strategies. Because PT strategies are most commonly applied in combination, it is difficult to distinguish which of the PT strategies was effective and which was not. In general, there do not exist many studies about implementing specific PT strategies to different users. One possible reason for this could be that interactions between user characteristics and PT strategies are complex and used in different contexts. In addition, designers of interventions might want interventions to fit to a wide range of population, participation numbers to be increased and health care costs to be decreased. Therefore, they might not contemplate for differences in user reactions. This would argue against a heterogeneous group of users, which wants products that reflect their

abilities and needs. Thus, an ethical dilemma occurs, when user requirements conflict with the intention of a system designer. However, this review shows that there is need to distinguish special PT strategies to different user characteristics. Accordingly, the challenge is to balance both, the interest of the user and the designer/health care society. Therefore, the advantage of tailoring PT strategies to different user characteristics needs to become well established in the future.

### ***Future research***

The results of this review provide suggestions for future research. Tailoring PT principles to user characteristics needs to be advanced, by evaluating user differences and their impact on PT. In this context future experimental investigations are needed that present separated PT elements to guarantee that the effectiveness of an intervention can be linked accurately to one PT principle. To assure this aim, future research can for instance make more use of storyboards in the implementation phase of interventions. Moreover, it would be advantageous to gain more insight into the users preferences, since this reveals how users react to different PT strategies. This could be also conducted by interviewing users. Collecting and allocating more PT elements on a clearly defined model such as the PSD-model, will enable a more detailed implementation of PT strategies that match with the users. Consequently, this will support improved outcomes of interventions and will clarify the important factors that influence the effectiveness of online interventions. Finally, this review will serve as a basis for future research, by giving a brief insight into perceived PT principles being effective for different user characteristics.

## 5. Appendix

Table 1.

*Keywords literature search*

Persuasive	Web-based	Health
Persuasive technology	bcss	Health*
Persuasive system	Behavior*r change support system application	Well*being Behavior*r control
Persuasive strategy*		
persuasive	mobile	Self*management
	Internet delivered	Self care
	Internet mediated	
	Internet supported	
	Medial informatics	
	Information technology	
	E health*	
	Ehealth*	
	E therap*	
	Telemedic*	
	telecare	
	telehealth	
	E mental health	
	Emental health	

Table 2.

*Characteristics of the selected articles*

Author of article <i>Study design</i>	Sample size; N = Total	Intervention description	Condition and purpose	<i>Persuasive Technology</i>	Differences among users	Study outcome
1. Blanson Henkemans et al., (2009)  <i>Study design:</i> RCT, double blinded	N =118	<b>DieetInzicht:</b> lifestyle diary Overweight people used four weeks the online lifestyle diary called DieetInzicht. Thereby some participants were given feedback on their self-management by a persuasive computer assistant animated <b>iCat</b> .	Lifestyle diary to reduce overweight  Help users obtaining better insight into a healthy lifestyle. The animated iCat should increase the adherence to self-management and thereby reduce overweight.	<i>Tailoring:</i> selection of feedback based on diary entries <i>Self-monitoring:</i> food and exercise reporting <i>Personalization:</i> individual goal setting, <i>Praise:</i> facial expression of iCat, support through feedback <i>Cooperation:</i> collected data sent to central server (MySQL), where they are analysed	Age, education level, computer experience, vocabulary and locus of control	Participants with a computer assistant showed a stronger decrease in BMI than participants without a computer assistant  Locus of control, BMI, vocabulary, computer experience and gender explained 23% of the diary use completeness.  BMI, computer experience, age and gender explained 37% of the variance in self-reported motivation to gain a healthy lifestyle in the middle of the study and 21% at the end of the study.  A more completely entering of the diary was seen among participants with a high internal locus of control, great vocabulary and a high computer experience.  More motivated to maintain a healthy lifestyle were: participants of young age with great computer experience and a high education level.
2. Drozd et al., (2012)	N = 128	<b>Ned i Vekt</b> Duration: 2 days per week, 6 weeks long	Healthier lifestyle  Examine user's	<i>Tunneling Suggestion</i>	Gender differences among perceived persuasiveness and	Gender differences in perceiving information

<p><i>Study design:</i> Exploratory test of a theoretical model</p> <p>Predictor analyse</p>	<p>Twice per week users receive an e-mail with a link to a program system called Ned i Vekt, that offers the day’s exercises. Every day an unique program is composed.</p> <ul style="list-style-type: none"> <li>- Psycho-education</li> <li>- Online exercises</li> <li>- Homework</li> </ul>	<p>perception of a web-based weight loss intervention</p> <p><b>3 aims:</b></p> <ul style="list-style-type: none"> <li>- Support users by changing their eating habits</li> <li>- Up-regulate pos. emotions/mood</li> <li>- Weight loss</li> </ul>	<p>Primary task support</p> <p>Dialogue support</p> <p>Perceived credibility</p> <p>Perceived persuasiveness</p> <p>No social support</p>	<p>intention, and unobtrusiveness and intention</p>	<p>Perceived persuasiveness is more important for men to intent behaviour change</p> <p>Unobtrusiveness seems to be more important for women to intent behaviour change</p>	
<p>3. Ferron et al., (2013)</p> <p><i>Study design:</i> Pilot study</p>	<p>N = 138</p> <p>N = 81 completed questionnaires</p> <p>N = 55 joined the evaluation phase</p>	<p><b>FitCity</b></p> <p>An adaptive, personalized approach (motivation level) for an active lifestyle is given that could be implemented as a persuasive mobile application in the future.</p> <p>After measuring the users performing by fitness test, they got personalized training plans. A posttest took place to evaluate the performance after 3 month. Two other questionnaires were taken to measure the stage of exercise behavior (TTM) and motivation</p>	<p>Promoting physical active lifestyle</p> <p>Developing an adaptive mobile approach</p>	<p><i>Tailoring</i></p> <p><i>Reduction:</i> Dissonance</p> <p><i>Self-monitoring:</i></p> <p><i>Rewards:</i> free excess to the fitness centre</p> <p><i>Suggestion:</i> exercises</p> <p><i>Liking:</i> visual feedback</p> <p><i>Normative influence:</i> peer-pressure, social influence</p> <p><i>Gamification</i></p>	<p>Believers and non-believers</p> <p>Low motivated participants</p> <p>High motivated</p>	<p>Best strategies in the <b>first half</b> process of TTM (pre-contemplation, contemplation, preparation): education, increase importance of cognitive dissonance, gamification and extrinsic rewards, persistent visual feedback</p> <p><b>second half</b> of TTM (preparation, action, maintenance): education, increase importance of cognitive dissonance, gamification, rewards, visual feedback, following strategies are added: social influence, overcome problem arising,</p> <p>Peer pressure techniques may be effective for <i>motivated</i> individuals</p> <p><i>Lower motivated</i> individuals may profit from gamification which provides an environment related to funny exercises</p> <p><i>Believers:</i> increase the importance</p>

						of the cog. dissonance  <i>Nonbelievers</i> : attitude towards the exercises should be changed by making them aware of the benefits by education
4. Halko et al., (2012)  <i>Study design</i> : Exploratory study, 4 online surveys	N = 240	The article focuses on physical activity applications and the relationship between personality and PT. Participants used a storyboard with different PT strategies. After assessing the personality types by using the Big Five Inventory (BFI), the users were asked 7 questions about their perception (enjoyment, likelihood of use, helpfulness, quality of life, ease of use, time saving, general comments) of the PT strategies represented on the storyboard.	Health promotion of physical activity  Guideline to develop future mobile persuasive technology applications by taking into account different personality types	<i>Praise</i> : positive reinforcement <i>Rewards</i> : positive reinforcements <i>Liking</i> : storyboards <i>Authority</i> : <i>Authoritative style</i> <i>Cooperation</i> <i>Competition</i>  <b>Original PT</b> <i>Instruction Style</i> Authoritative Non-Authoritative <i>Social Feedback</i> Cooperative Competitive <i>Motivation Type</i> Extrinsic Intrinsic <i>Reinforcement Type</i> Negative Reinforcement Positive Reinforcement	Personality  <b>Neuroticism</b> - Pos. relation with neg. reinforcement - neg. relation with cooperative strategies <b>Consciousness</b> - pos. correlation with cooperative and competitive <b>Agreeableness</b> - pos. correlation with competitive strategy - neg. correlation with pos. and neg. reinforcement <b>Extraversion</b> - neg. with extrinsic and intrinsic motivation and pos. and neg. reinforcement <b>Openness</b> - pos. correlation with authoritative and competitive strategies - neg. with extrinsic, intrinsic motivation and neg. reinforcement	Significant relationship between personality and PT; some personality types favouring with special PT strategies more than others and some even dislike some of the strategies.  Consciousness in general most pos. towards the technology (5 pos. correlations)  Consciousness individuals seem to prefer social-based technology  Agreeableness personality types do not favour with reinforcement strategies  Extraversion no pos. correlations; PT strategies do not seem to be eligible by this personality type. Maybe because of strong social network, there is no need  Openness: maybe authoritative and competitive technologies are not tried yet → to be inquired
5. Kaptein et al., (2010)	N = 276	This article estimates user's different stages	Health related activity: physical	<i>Authority</i> : Authority <i>Social facilitation</i> :	Individual differences in persuadability (low	Individual difference in compliance among health-related messages

<p><i>Study design:</i> RCT 2x2 between subject design</p>		<p>of persuadability and their compliance to persuasive health related messages</p> <p>In 2 experiments low- and high persuadables responded to health related messages which had 2 conditions: - persuasive implementation (PI) - no persuasive implementation (NPI)</p> <p>Experiment 1: lunchwalk (physical activity) Experiment 2: opinion about distribution of daily fruit snack</p>	<p>(walking) Food (fruit)</p> <p>Discover how the persuability of users induces their compliance to PT strategies dealing with health- and lifestyle related request.</p>	<p>consensus <i>Liking: Liking</i> <i>Suggestion: physical activity</i></p> <p><b>Original PT</b> Cialdini's 6 strategies: <i>Reciprocity</i> <i>Scarcity</i> <i>Authority</i> <i>Commitment and consistency</i> <i>Consensus</i> <i>Liking</i></p>	<p>and high persuadables)</p> <p>High persuadables show a pos. effect to persuasive messages → more interest, higher behavioural intention; but no sig. effect on actual behaviour</p> <p>Low persuadables comply less to persuasive text elements; show no significant or even neg. effect</p>
<p>6. Koivisto et al., (2014)</p> <p><i>Study design:</i> Online survey</p>	N = 195	<p><b>Fitocracy:</b> online game and social network helping users to improve their fitness. In this study the relation of demographic differences and benefits from gamification through exercises is elaborated. A link to an online survey was presented on the discussion forum of the gamification service Fitocracy</p>	<p>Physical activity, Improve fitness</p> <p>Examining age and gender differences in perceived benefits of gamification</p>	<p><i>Gamification</i> <i>Suggestion: exercises</i> <i>Reduction: exercises</i> <i>Social facilitation: forum</i> <i>Normative influence: join groups for exercise related topics</i> <i>Reward: achievement of badges for social activities</i> <i>Recognition</i> <i>Liking</i></p>	<p>Age, gender</p> <p>Women feel to have social profit by using gamification, they assess the social community as more positively, perceive greater benefit from social interchange</p> <p>Women perceived more positive perception of recognition</p> <p>Perceived benefits of different genders were admitted for aspects of facilitation, sociality, hedonic, use but not for utilitation.</p> <p>Woman's motivation to keep exercising is higher, they perceive the exercises as more playful</p>



Age mostly does not have a direct effect on the benefits of gamification

The elderly does not make use of gamification that often, because of reduced ease of use

7. O'Connor et al., (2009)	N = 170	<p>This article demonstrates the efficacy of an intervention to increase information seeking related to hypertension by tailoring health communication messages to user characteristics.</p> <p>Conditions of the messages:</p> <ul style="list-style-type: none"> <li>- frame: (loss vs. gain)</li> <li>- function: (detection vs. prevention)</li> </ul>	<p>Lifestyle promotion</p> <ul style="list-style-type: none"> <li>- Exploring the efficacy of a web-based intervention, that targets awareness of hypertension</li> <li>- Examining the influence of the personal variable – consideration of future consequences (CFC) to the effectiveness of the intervention</li> </ul>	<i>Tailoring</i>	<p>Age, gender, personal and familiar history of hypertension</p> <p>Consideration of future consequences (CFC) (low vs. high)</p>	<p>Health communication messages should be tailored to individual characteristics, like the participants' appraisal of long- and short-term consequences of their behavior</p> <p>Participants high in CFC spent twice as long as participants low in CFC reading the message containing the loss frame condition → low CFC do not prioritize long term outcomes; may perceive themselves as being at low risk → more responsive to gain frame message</p> <p>Participants high in CFC read faster than those low in CFC, when the message contained the gain frame condition</p>
8. Orji (2014)	N = 1108	<p>10 PT strategies were presented in a storyboard for promoting healthy eating. The participants were asked how strongly they agree with statements about the 10 surveys</p>	<p>Healthy eating</p> <p>Evaluating gender differences in persuadability of behaviour change strategies (BCSS)</p>	<p><i>Competition</i> <i>Comparison</i> <i>Tailoring: Customization</i> <i>Cooperation,</i> <i>Personalization,</i> <i>Praise</i> <i>Simulation</i> <i>Self-monitoring: feedback</i> <i>Suggestion</i></p>	Gender differences	<p>Female and male differ in persuadability</p> <p>Females are more receptive to most of the BCSS than men. They found 5 out of 8 strategies (personalization, simulation, cooperation, customization and praise) more persuasive.</p>

## Reward

### For both genders:

Reward and customization were not perceived as persuasive

Personalization and simulation were perceived as most persuasive

Advice: gender-dependent approaches would be more suitable to change behaviour

9. Orji et al., (2014)	N = 1108	Persuasive strategies of a persuasive game were presented in a storyboard for promoting healthy eating. After that the perceived persuasiveness was measured by asking 4 questions that could be answered on a 7. Likert-scale. 28 BrainHex questions were added to get to know the different gamer types. Estimating the relationship between persuasiveness and the 7 gamer types	Healthy eating  Develop guidelines to tailor persuasive strategies to individual gamer types	<i>Competition</i> <i>Comparison</i> <i>Tailoring</i> : Customization <i>Cooperation</i> , <i>Personalization</i> , <i>Praise</i> <i>Simulation</i> <i>Self-monitoring</i> : feedback <i>Suggestion</i> <i>Reward</i>	Different gamer types (7 gamer personalities) Achiever, Conqueror, Daredevil, Mastermind, Seeker, Socializer, Survivor	<p>Most gamer types are receptive to the strategies: <i>competition</i>, <i>comparison</i>, <i>self-monitoring</i>, <i>suggestion</i></p> <p><i>Reward</i> was the least sig. strategy to change behaviour</p> <p><b>perceived as pos.:</b>  <i>competition/ (comparison)</i>: conqueror, mastermind, seeker, socializer, survivor  <i>cooperation</i>: achievers, socializers  <i>customization</i>: masterminds, seekers  <i>personalization</i>: masterminds, seekers, conquerors  <i>praise</i>: seeker  <i>self-monitoring/(suggestion)</i>: achiever, conqueror, mastermind, survivor  <i>simulation</i>: conquerors, daredevil, mastermind  <i>reward</i>: achiever</p> <p><b>perceived as neg. to use the game to change behaviour:</b></p>
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						<i>competition/ (comparison):</i> daredevil <i>cooperation:</i> survivors <i>customization:</i> socializers, survivors <i>personalization:</i> <i>praise:</i> socializer <i>self-monitoring/(suggestion):</i> socializer, daredevil <i>simulation:</i> --- <i>reward:</i> survivors
10. Rodriguez et al., (2013)	N = 15 (Age: 63-86)	<b>CAMMIInA</b> (Calm Application for Motivating elders to Move by Interacting with their Age group)  Participants used the system one day while exercising in a Senior Center or Social Security. An introduction and training took place. After the exercise session the participants were interviewed about using the system.	Healthy lifestyle, physical activity  Motivating elders to adopt healthy lifestyle habits by implementing a mobile application	<i>Reduction:</i> Abstraction, trigger physical activity <i>Reminder:</i> trigger physical activity (audible and textual notifications) <i>Self-monitoring:</i> trigger physical activity, historical information and reflection <i>Reward:</i> positive and playful reinforcement (playing a game, getting coins)  <b>Original PT</b> <i>Abstraction</i> <i>Historical information and Reflection</i> <i>Triggers for exercising</i> <i>Positive and playful reinforcement</i>	Active (AE) and passive elders (PE)	Active elders prefer: - getting information that enables reflection on possible intrinsic benefits - seeing their exercise goals develop → Thus <i>self-monitoring</i> seems to be an important PT element to active elders  Passive elders prefer: - information that makes them aware of the extrinsic benefits of exercises like extending their social network → Thus <i>reward</i> in the context of social activities seems to be an important PT element to passive elders

Table 3.

*User characteristics linked to the study number and an overview about the used PSD principles per user characteristic*

Study	User characteristics			
	Psychological factors	Age	Gender	Education
S1	x	x		x
S2			x	
S3	x			
S4	x			
S5	x			
S6		x	x	
S7	x			
S8			x	
S9	x			
S10	x			
Total	7	2	3	1

Table 4.

*Overview of the PSD-principles used per user characteristic*

PSD-principles	User characteristics			
	Psychological factors	Age	Gender	Education
Primary Task Support	Reduction Tailoring Personalization Self-monitoring Simulation	Reduction Tailoring Personalization Self-monitoring	Reduction Tunneling Tailoring Personalization Self-monitoring Simulation	Tailoring Personalization Self-monitoring
Dialogue Support	Praise Reward Reminder Suggestion Liking	Praise Reward Suggestion Liking	Praise Reward Suggestion Liking	Praise
Credibility Support	Authority			
Social Support	Social comparison Normative influence Social facilitation Cooperation Competition	Normative influence Social facilitation Cooperation Recognition	Social comparison Normative influence Social facilitation Cooperation Competition Recognition	Cooperation
Gamification	Gamification	Gamification	Gamification	

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