

REVIEWING THE WELLBEING CONCEPT IN PERSUASIVE TECHNOLOGY

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ABSTRACT

The term wellbeing is widely used in the field of persuasive technology, especially when helping people to achieve positive changes in their attitudes and behaviors. However, wellbeing as a concept is often poorly understood, thus making it difficult to evaluate the success of such technology-supported behavioral interventions. This is especially critical as the definition of persuasive technology is grounded in the benefits that individuals and society derive from its use. In this paper, we present a literature review of the wellbeing concept in the field of persuasive technology. We propose a working definition of wellbeing and its dimensions for further refinement. We provide an example of how persuasive technology design can integrate this understanding. It helps assessing wellbeing as a measurable construct, thus provides ways for proper evaluation of persuasive technology and its effects on people at various scales.

Keywords: Wellbeing, Definition, Literature Review, Persuasive Technology, Transforming Wellbeing Theory

INTRODUCTION

The term wellbeing is often used to describe an ultimate form of living, where everything is aligned in the best possible way for everyone to strive and prosper. In the advent of this century, wellbeing has also become a popular discourse in the field of persuasive technology (Fogg 2003). Many behavioral interventions and persuasive technology designs aim at fostering human wellbeing and related constructs, such as quality of life, life satisfaction, wellness, and happiness. Persuasive technology research seems to assume a common understanding of wellbeing as a concept. Yet, most studies lack a definition and measures of wellbeing. In the present paper, we review 68 papers containing the terms *persuasive technology* and *wellbeing*. In this literature review, we elicit definitions of wellbeing in persuasive technology research and create the basis for discussion and measurement of *persuasive wellbeing*.

To verify the effects of technological interventions on human wellbeing, it is crucial to define the concept in the context of respective study. To allow for substantiated conclusions, an empirical measurement of the wellbeing construct, using self-reporting scales or other appropriate measures, is inevitable. This paper invites to expand the scientific discussion on the wellbeing concept in persuasive technology and facilitate further advancements on the related discourse. Finding and proposing a conceptual definition of wellbeing as a construct is an important prerequisite for its further assessment, which is crucial for evaluating the potential of persuasive technology contributing to that goal. Thus, we offer an analysis of wellbeing targeted persuasive technology research by addressing this question: *How to properly conceptualize and operationalize wellbeing in the field of persuasive technology?*

WELLBEING IN PERSUASIVE TECHNOLOGY

Persuasive technology has been explicitly addressing wellbeing since the first international conference on Persuasive Technology for Human Wellbeing in 2006 (IJsselsteijn et al. 2006). After that, various studies have aimed for the improvement of human wellbeing through persuasive technology in diverse domains, such as health, active and assistive living (AAL), work environment, urban design, and sustainability.

In other fields of closely related research, for example, psychology and affective computing, wellbeing is mostly conceptualized as a construct that encompasses several aspects. Among the most visible are affective aspects (positive emotions, absence of negative emotions), eudaimonic aspects (a person's perception of meaningfulness and purpose), and overall life satisfaction. Moreover, wellbeing can comprise of engagement, relationships, and accomplishment (Seligman 2012). Distinctions are made between subjective and objective wellbeing, in particular among different research disciplines. While psychologists and (moral) philosophers focus on people's subjective thinking and feeling about their own wellbeing, as well as on what's ultimately good for an individual, economists and sociologists emphasize objective economic and collective aspects, such as social equality and social cohesion. This involves different measurement methods, ranging from subjective self-reports to objective measurement of factors, such as one's financial status, age, and the fulfillment of basic nutritional needs.

The prevalence of studies and interventions aiming at improving wellbeing through persuasive technology does not guarantee that a sound definition of wellbeing exists. In practice, it is often assumed that by targeting certain attitudes or behaviors, such as physical activity or healthy food consumption, the respective persuasive technology elicits positive changes for individuals and society. Usually, such attitudes and behaviors were not explicitly linked to wellbeing. Therefore, it has been challenging to assess whether studies and interventions stating to increase wellbeing by addressing other supposedly wellbeing-related constructs are actually reaching their ultimate goal. Due to an increasing interest in developing and using technology to enhance wellbeing among users, it is necessary to provide a mutual basis of understanding for various stakeholders including researchers, technology designers, practitioners, and public authorities, as well as unifying evaluation approaches and methodologies for handling wellbeing properly.

LITERATURE REVIEW

The literature review collected papers that contain the terms *wellbeing* / *well-being* / *well being* and *persuasive technology* / *persuasive technologies* in their title, abstract or keywords. We searched for studies in the Elsevier Scopus database (scopus.com), the largest abstract and citation database of peer-reviewed literature, without any topic or language restrictions. The search was conducted in year 2017 and identified 82 papers, which were screened for quality and method. Consecutively, more rigorous criteria for inclusion and exclusion of articles were applied.

According to the inclusion criteria, we incorporated articles that focus on persuasive technology related to wellbeing or a synonymous concept. In line with the exclusion criteria, 14 of the 82 papers were removed from the study corpus as they did not address wellbeing in a persuasive context or were proceeding volumes. The full texts of remaining 68 articles were reviewed and coded according to an iteratively developed coding sheet. Data extracted from the full text considered the frequency of the term wellbeing, whether and how it was defined or assessed by measurement, and which dimensions, synonyms, or aspects were mentioned. The domain the papers pertained to was additionally noted.

The review identified six domains (Table 1), however not all papers could be ascribed to exactly one domain. Eight papers belonged to two domains to the same degree. Overall, the number of studies targeting wellbeing by using persuasive technology has been growing over the last few decades. *Health* turned out to be the major domain. Other domains, such as *urban design* and *sustainability*, emerged or became more prominent only recently. The reviewed studies mention the term wellbeing as little as once up to 83 times with a median of 3.5 times.

Table 1. Number of papers per domain, references to definitions and assesment.

Domain	Papers	Definition	Assessment
Health	40	Bolier et al. (2014), Kraft et al. (2009), Spanakis et al. (2016)	Bolier et al. (2014), Kaipainen et al. (2010), Sundar et al. (2011), Vidyarthi & Riecke (2014)
Technology Design	14	Golsteijn et al. (2008), Ludden et al. (2015), Sakamoto & Nakajima (2015)	Golsteijn et al. (2008)
Sustainability	9	Lisson & Hall (2016)	-
Active and Assisted Living (AAL)	5	-	-
Work Environment	5	Bolier et al. (2014), Ludden & Meekhof (2016)	Bolier et al. (2014), Ludden & Meekhof (2016)
Urban Design	4	-	-

DEFINING WELLBEING

Eight papers gave a definition for wellbeing (Table 2). Two of them (Ludden et al. 2015, Sakamoto & Nakajima 2015) are based on Seligman's definition of wellbeing (Seligman 2012). The PERMA model considers wellbeing as a measurable construct with five elements: *Positive Emotions*, *Engagement*, *Relationships*, *Meaning/Purpose*, and *Accomplishment*. Both Kraft et al. (2009) and Lisson & Hall (2016) use the concept of subjective wellbeing, *a person's cognitive and affective evaluation of his or her life*. While Kraft et al. (2009) operationalize this definition as average levels of positive and negative affect, Lisson & Hall (2016) include pleasant and unpleasant affect, as well as life and domain satisfaction in their conceptualization. Lisson & Hall (2016) furthermore differentiate between an individual level of wellbeing (e.g. enjoying a safe financial position) and a communal or pro-social level of wellbeing (e.g. living

in an equal society). While Bolier et al. (2014) also include subjective wellbeing (positive affect, life satisfaction), they define two additional types of wellbeing: psychological wellbeing (e.g. level of positive functioning) and social wellbeing (e.g. level of social integration).

Ludden & Meekhof (2016) on the other hand concentrate solely on positive affect, while Golsteijn et al. (2008) define wellbeing as *a personal balance of mental, social and physical being, influenced by life circumstances and life factors* [such as] *emotions, engagement, life satisfaction, intentional activities and social network*. They also note that *wellbeing reflects how people rate the quality of their lives*. Spanakis et al. (2016) acknowledge that *wellbeing is a widely used term encompassing various constructs [...] and addressed by several theoretical models*, yet equate the constructs of wellbeing and wellness. Two papers do not explicitly state any foundation of their definitions.

Table 2. Definitions of wellbeing.

Definition of Wellbeing	Domain	Dimension	Reference
PERMA model (Seligman 2012): Positive Emotions, Engagement, Relationships, Meaning/Purpose, and Accomplishment	Health, Technology Design	D2, D3, D5, D6, D7	Ludden et al. (2015), Sakamoto & Nakajima (2015)
Subjective wellbeing defined respectively as - average levels of positive & negative affect - cognitive & affective evaluation of quality of life (pleasant & unpleasant affect, life & domain satisfaction) individual level, e.g. safe financial position communal level, e.g. living in an equal society	Health, Sustainability	D2, D3, D11	Kraft et al. (2009) Lisson & Hall (2016)
3 types of wellbeing: - subjective wellbeing (positive affect, life satisfaction) - psychological wellbeing (level of positive functioning) - social wellbeing (e.g. level of social integration)	Health, Work Environment	D2, D3, D4, D11	Bolier et al. (2014)
A personal balance of mental, social and physical factors	Technology Design	D1, D2, D4	Golsteijn et al. (2008)
Positive affect	Work Environment	D2	Ludden & Meekhof (2016)
Several theoretical models for wellbeing and wellness	Health	D3, D4, D11	Spanakis et al. (2016)

Some definitions of wellbeing found in the reviewed papers are conceived on a broader level, while others are adapted to the specific study domain. In some domains with a broad self-conception, e.g. *technology design*, or ones that affect the human habitat in its entirety, e.g. *urban design*, effects of technologies on wellbeing should be conceived from a holistic perspective and therefore base assumptions and measurement on integrated definitions of wellbeing, as in the approach by Golsteijn et al. (2008) for *technology design*. Given the heterogeneity of approaches, it seems necessary to carefully consider the most appropriate definitory framework for each study purpose and the corresponding measurement approaches. Ideally, such a definitory framework would encompass as many dimensions as possible into a stringent working definition of wellbeing. However, a construct based on such an excessive definition of wellbeing would be difficult to assess in its comprehensiveness. Therefore, it might be more applicable to analyze, which dimensions of wellbeing should be addressed in a given study, and then choose a respective definition as well as appropriate assessment.

WELLBEING DIMENSIONS

Taking a closer look at the papers that note definitions of wellbeing, it becomes apparent that it is – inherently or explicitly – interpreted very differently. Yet it also shows that some common themes emerge, which we subsume as dimensions of wellbeing (Table 3). The literature review yielded 21 dimensions, which contain a number of different aspects. The dimensions are ranked according to their frequency of occurrence in the reviewed papers. Most often, dimension D1 is addressed, consisting of physical aspects of wellbeing. Some of these dimensions are more prominently represented in the definitions than others. Social (D2) and emotional (D3) aspects, as well as aspects related to positive functioning (D4) and subjective wellbeing (D11), are alluded to most often. Physical aspects (D1) are mentioned most often in the literature. However, in the definitions of wellbeing, they tend to be disproportionately underrepresented. The dimensions D5-D7 are enclosed in the PERMA model (Seligman 2012). Most other dimensions are mentioned in the literature, but lack a definitory basis, which precludes adequate measurement of wellbeing.

Table 3. Dimensions of wellbeing.

	Dimensions of Wellbeing	Domain	References
D1	Physical wellbeing: physical activity, health, diet & nutrition, weight management, longevity	AAL, Health, Technology Design, Work Environment	IJsselsteijn (2006), Kaipainen et al. (2010), Ludden & Meekhof (2016), Spanakis et al. (2016)
D2	Social wellbeing: social integration, connectedness, contribution & support, relationships	Health, Work Environment	Bolier et al. (2014), IJsselsteijn (2006), Kaipainen et al. (2010), Kraft et al. (2009), Sakamoto & Nakajima (2015), Spanakis et al. (2016)
D3	Emotional wellbeing, positive emotions, affect	AAL, Health, Work Environment, Technology Design	Bolier et al. (2014), Kaipainen et al. (2010), Kraft et al. (2009), Ludden & Meekhof (2016), Ludden et al. (2015), Sakamoto & Nakajima (2015), Spanakis et al. (2016)
D4	Psychological/mental wellbeing, Positive Functioning	Sustainability, AAL, Health, Technology Design	Bolier et al. (2014), Boon et al. (2015), Kaipainen et al. (2010), Sundar et al. (2011)
D5	Achievement & Accomplishment	Health, Technology Design	Ludden et al. (2015), Sakamoto & Nakajima (2015)
D6	Engagement	Health, Technology Design	Ludden et al. (2015), Sakamoto & Nakajima (2015)
D7	(Sense of) Meaning	Health, Work Environment	Bolier et al. (2014), Sakamoto & Nakajima (2015)
D8	Stress management, regulation & recovery	Health, Technology Design, Work Environment	Kaipainen et al. (2010), Ludden & Meekhof (2016), Vidyarthi & Riecke (2014)
D9	Work/life balance, time management, fun & leisure time	Health, Technology Design	Kaipainen et al. (2010)
D10	Sleep quality & quantity	Health, Technology Design	Liu et al. (2015)
D11	Subjective wellbeing	Health	Kraft et al. (2009)
D12	Ecological & environmental wellbeing	Health, Sustainability	Boon et al. (2015), Spanakis et al. (2016)
D13	Quality of Life, Life Satisfaction	Health	Sundar et al. (2011)
D14,	Goal Setting, Mastery	Health,	Bolier et al. (2014)
D15		Work Environment	
D16	Substance use	Health	Kaipainen et al. (2010)
D17	Domestic health & wellbeing	Health	Kim & Paulos (2010)
D18	Sense of control, Dominance	Technology Design	Ludden et al. (2015)
D19-21	Intellectual, spiritual and occupational wellbeing	Health	Spanakis et al. (2016)

Not all definitions of wellbeing fit equally good in different contexts. For example, some definitions of wellbeing focus very little on physical aspects of wellbeing. Such aspects are clearly underrepresented in the definitions of wellbeing stated in the papers included in the literature review. Only one definition acknowledges the importance of physical aspects explicitly in the definition of wellbeing (Golsteijn et al. 2008). This fact is diametrically opposite to the purpose of the majority of persuasive technologies reviewed: promotion of physical health. Physical wellbeing and its aspects are also the most noted dimension of wellbeing.

In view of the high number of persuasive technology designs targeting physical activities, a definition encompassing physical aspects of wellbeing seems more appropriate. A clear and direct link between wellbeing and physical activity needs to be firmly established based on scientific research evidence. For example, an extension of Seligman's PERMA model, the PERMA+ model extends the PERMA approach by the physical health factors *physical activity*, *nutrition*, and *sleep*, based on findings that established indirect links between physical factors and wellbeing. Other findings indicate a moderate positive association between physical activity and certain dimensions of wellbeing, such as emotional (D3) and subjective wellbeing (D11), as well as cognitive functioning (D4). Correspondingly, measurement approaches need to be extended to physical aspects as well.

APPLICATION EXAMPLE

To shift from theory to practice, we present one example of a study within the context of urban design. This study, as many others, aims at wellbeing without explicitly considering any particular definition or assessment. That helps us demonstrating how much research and practice can benefit from defining, measuring, and assessing wellbeing, as well as how persuasive technology research could handle wellbeing as one of its core concepts.

Our selected example is an extensive bicycling study that was designed and conducted over a period of six weeks during the Fall of 2015 in the Greater Boston area, Massachusetts, USA (Millonig et al. 2016). The study aimed at investigating ways to improve wellbeing in cities through a socially influencing system (Stibe 2015) that encouraged more people commuting to work by bicycle. The study combined urban design (Stibe & Larson 2016) and persuasive technology (Fogg 2003) to fostering physical activity, thus improving overall wellbeing. However, wellbeing – and wellbeing in cities in particular – was not defined in this study. Moreover, no theoretical evidence was given for a positive connection between physical activity and wellbeing. Taking a closer look, the bicycling study primarily targets the dimension of physical wellbeing (D1, see Table 3), while its aim to increase bicycling as an eco-friendly mode of mobility also addresses the environmental wellbeing dimension (D12). Facilitating social integration and connectedness of the implemented system targets social wellbeing (D2), while the use of a leaderboard might contribute to the achievement and accomplishment dimension (D5). Therefore, the bicycling study should have started by conceptualizing wellbeing as a composition of physical activity, environmental wellbeing, connectedness, and achievement. Based on that, it would then be possible to select adequate measures to ensure high-quality outcomes.

The bicycling study chose mainly a quantitative approach for measuring outcomes. The participants were reporting their commuting behaviors using a simple web-based interface, suitable for smartphones, tablets, and personal computers. During the signup process, they were asked to report the distance of their everyday commute in miles. That made reporting easier for frequent bicyclists, as it was sufficient for them to reconfirm each day of bicycle riding, which automatically recorded their preset mileage into the system. Outputs of the system were displayed on large screens in the offices of participating companies. During the study, bicycling as physical activity (D1) was quantified through a list of variables, including the number of miles ridden on average, the number of miles made in total (D12), a percentage of participants riding each day (D2), and an increase of that percentage over time (D2). To leverage these metrics, the bicycling study employed a specially designed socially influencing system to persuade participants to further engage in cycling (D5).

The attempt to increase physical activity and environmentally friendly modes of travel through bicycling was assessed using a quantitative method based on partial least squares structural equation modeling. This methodology enables scholars to discover how relevant aspects (e.g. persuasive, social prompts) explain behavior (e.g. engagement in physical activity). The implemented socially influencing system contained several persuasive and social aspects to encourage commuting by bicycle. Three socially influencing aspects, namely social facilitation, cooperation, and competition (Stibe 2015), public screen use and leaderboard rankings. The selection of persuasive technology design should have been explicitly based on prior research that indicates a firm relationship between social engagement and wellbeing. However, this choice was made only implicitly. All five aspects were operationalized as variables in a research model that was assessed using the applied method. The data for assessing the model was collected using a specially designed survey instrument that required participants to respond with their individual perceptions about the system and particular experiences.

In the bicycling study, the most significant contributors to engagement were the socially influencing principles of cooperation and competition. The former can be supposed to affect a stronger collaborative environment inside each participating organization, which could have improved social wellbeing through increased connectedness. Analogically, competition amongst the participating companies could potentially lead to an increased sense of achievement and accomplishment, which also promotes wellbeing. Therefore, as the second step, the study should have established this relationship explicitly and from the beginning. Since the study measured the level of contribution of cooperation and competition only, it falls short of reaching this point: it shows an increased striving for cooperation, achievement, and accomplishment. Whether its attainment, as dimensions of wellbeing, was sufficiently reached, should as the third step be monitored longitudinally for each participating company by assessing the increase in the core measure, i.e. percentage of bicyclists, which was framed and communicated as enthusiasm.

To conclude, by properly defining wellbeing, establishing links with relevant related variables, and being able to choose appropriate measures, it is possible to refer outcomes directly to different dimensions of wellbeing and making statements about the beneficial effects of the respective persuasive technology on wellbeing for its users. In this case, the socially influencing system designed to encourage bicycling could have been effective with regards to the physical, social, environmental, as well as achievement-related dimensions of wellbeing. Yet, the study has not explicitly indicated whether that was the case. Establishing the respective theoretical foundations in the initial stage of the study and choosing appropriate outcome indicators would extend its meaning – from *how to persuade best?* towards *how persuasion can increase wellbeing* – facilitating interpretations and allowing inferences on how the socially influencing system is actually affecting wellbeing.

In this section, we chose the bicycling study to exemplify how important it is for researchers and practitioners to have and apply rigorous methodologies when designing persuasive technology for wellbeing, and how they can benefit from them. Our selected example demonstrates that many studies, although having strategically important and meaningful goals, might often lack an in-depth understanding of their role and place in the realm of persuasive wellbeing. Thus, we support our argument for the necessity of a better-structured approach that should empower designers and scholars of persuasive technologies to advance their wellbeing related work.

IMPLICATIONS

Having demonstrated how much persuasive technology research can benefit from defining, measuring, and assessing wellbeing, we now want to put these beneficial effects into a larger context and show, which definitions and dimensions could be relevant. New urban design concepts enable multiple ways of advancing behaviors related to wellbeing in future cities. For example, behavior change interventions can target choices involving physical activity (e.g. stair-use, jogging, and bicycling) as well as nutrition. Urban design could activate social comparison motives by publicly displaying how quickly bicycles move compared to cars on the same street via street signage. Available sensing technologies can identify the number of people taking stairs, elevators or escalators in shopping malls, also the level of physical activity in parks and bicycling activities in neighboring districts. These dynamics can be visualized on public screens or through ambient lighting to emphasize physical activity choices and encourage people changing their behavior. The essential task is to convert this inflowing data into influential urban feedback loops, for example providing counts from different city areas to engage people in more active lifestyles through social cooperation or competition. Healthier nutrition choices can be similarly promoted by creating databases on healthy versus unhealthy selections in shopping baskets and then showing the aggregated results of all baskets that day on public screens around the store.

Such technology design might argue that adequate physical activity and proper nutrition are main factors in the fight against obesity and that, to support this fight, places can be digitally transformed by introducing seamless persuasive technology, empowering people to succeed in achieving healthier lifestyles. Thus, digital innovations can be created to help people acquiring healthy everyday routines. The studies might then conclude, that addressing this physical aspect should ultimately add to the wellbeing of individuals and societies. To substantiate that claim, persuasive technologies in the context urban design would address this last assumption specifically: While they firstly assess whether they indeed increase the target behavior (e.g. physical activity or nutrition) and measurably impact individual health, the target behavior must also be placed within a wellbeing framework. In case of our example, nutrition and fitness fit best with Seligman's PERMA+ model. Providing this link, our example study is able to claim that they do address one specific facet of wellbeing through impacting their target behavior. They would then estimate the impact of the facet they are targeting and additionally link their target behavior to other markers used in wellbeing theories – e.g. the influence of their target behavior on other aspects of the PERMA+ model. To achieve that, the persuasive technology would use additional measurements apart from target behavior increase, such as positive emotion measures or sleep diaries. It would then be able to gauge their overall effect on wellbeing.

CONCLUSION

Improving human wellbeing is an objective of many persuasive technology designs. However, quite many can produce only minor effects as they lack a proper definition of wellbeing, and consequent inability to evaluate the success of their technology-supported behavioral interventions. This is especially critical as the definition of persuasive technology is grounded in the benefits individuals and society derive from its use. In our literature review, the absence of a common perspective on the definition and assessment of wellbeing in the area of persuasive technology became

apparent. We showed, how academic as well as applied research could benefit from applying rigorous methodologies when designing persuasive technological interventions for wellbeing.

Summarizing our work, we argue for the consideration of definitory conceptualizations of wellbeing in persuasive technology studies that claim to positively influence sub-aspects or the overall wellbeing of users. Moreover, we argue for the need to actually measure wellbeing in the evaluation of persuasive technology in order to be able to interpret empirical results in a meaningful way. This will guide the research field towards an actual, assessable vision of wellbeing as well as to ultimately create an explicit, tangible, and shared definition of wellbeing for the persuasive technology community. Using one of our own studies as an example, we show the tangible benefit of defining and assessing wellbeing in one specific context of persuasive technology. Our work highlights and reemphasizes the importance and necessity of having a holistic understanding about proper ways for designing persuasive technology and progressing towards transforming wellbeing theory (Stibe et al. 2019).

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