

Do Persuasive Technologies Persuade? - A Review of Empirical Studies

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Abstract. This paper reviews the current body of empirical research on persuasive technologies (95 studies). In recent years, technology has been increasingly harnessed to persuade and motivate people to engage in various behaviors. This phenomenon has also attracted substantial scholarly interest over the last decade. This review examines the results, methods, measured behavioral and psychological outcomes, affordances in implemented persuasive systems, and domains of the studies in the current body of research on persuasive technologies. The reviewed studies have investigated diverse persuasive systems/designs, psychological factors, and behavioral outcomes. The results of the reviewed studies were categorized into fully positive, partially positive, and negative and/or no effects. This review provides an overview of the state of empirical research regarding persuasive technologies. The paper functions as a reference in positioning future research within the research stream of persuasive technologies in terms of the domain, the persuasive stimuli and the psychological and behavioral outcomes.

Keywords: persuasive technology, motivational affordance, gamification, persuasive computing, captology, game-based learning, behavioral change support system, sustainability, health technology.

1 Introduction

In recent years, technology has been increasingly harnessed in pursuit of persuading people and motivating them toward various individually and collectively beneficial behaviors. There are two dominant conceptual approaches: the longer-established persuasive technology¹ [1,2,3] and the more recent but increasingly popular gamification [4,5,6]. As Figure 1 shows, the number of gamification-related studies has rapidly increased; however, it seems that in the body of literature on persuasive technologies in particular, a relatively larger proportion of empirical studies exist [7]. Despite these differing titles, the conceptual core of both veins of development incorporates 1) the use of technology that 2) is aimed at affecting people's/users'

¹ Also referred to as "captology."

psychological attributes, such as attitudes or motivations, which are further presumed to 3) affect behavior. While the behaviors that are supported by these technologies may be similar, there are differences, which seem to stem mainly from the emphases in the articulation of the persuasive stimuli and the psychological mediators; whereas persuasive technology focuses more on social and communicative persuasion and attitude change, gamification centers more around invoking users' (intrinsic) motivations (through gameful experiences and affordances) (see e.g. [8]). The present paper contributes to research in this area by reviewing empirical studies of the persuasive technology field in particular.

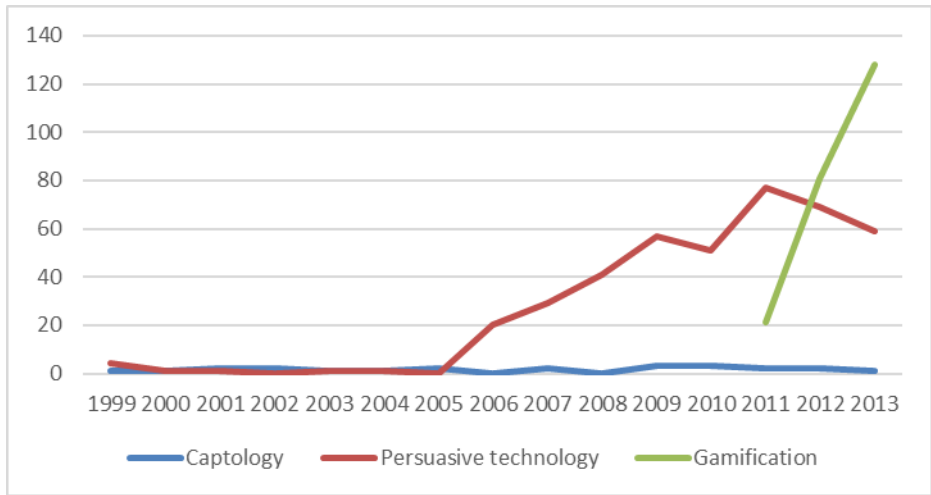


Fig. 1. Number of search hits, by year, for the main keywords associated with the relevant streams of research from paper titles, keywords, and abstracts in the Scopus database

The study of persuasive technologies first emerged in the academic environment in the late 1990s [9]. However, scholarly writing on them only truly began to proliferate in 2005. Since then, the amount of writing on the topic has been increasing steadily (see Figure 1). By 2013, research into persuasive technologies is abundant, with most of the studies being conducted in the field of human–computer interaction. A previous literature review [10] mapped research into persuasive technologies by looking at papers presented at the International Conferences on Persuasive Technology prior to 2009. The emphasis in its review of 51 studies (as compared to the 95 considered in the present work) was mainly on the design aspects presented in the studies.

Regardless of the conceptual framings and the steady increase in the quantity of related literature, it remains unclear what the actual empirical studies have investigated as persuasive stimuli, psychological mediators/outcomes, and behavioral outcomes. Consequently, there is still a dearth of coherent understanding of the field of persuasive technologies with respect to the research outcomes. This may be detrimental to future inquiries within these streams of research.

Therefore, this review systematically examines an extensive body of literature (95 studies) branding itself as addressing persuasive technologies. We investigate the system elements, the psychological mediators/outcomes, the behavioral outcomes, and the purposes for which persuasive technologies were harnessed in the reviewed studies. The results of the review provide insight into the field of persuasive technologies as a whole and enable comparison with parallel developments (such as gamification). Furthermore, the results outline the focus of the research so far and highlight which areas show a dearth of studies. For practitioners, this literature review provides a useful starting point for gaining an overview of the field of persuasive technologies.

2 Persuasive Technologies

Persuasive technologies have been defined as interactive systems designed for attitude and/or behavior change [1], [3], [9], [11]. Fogg [9] defines the concept of persuasion in more detail as “an attempt to shape, reinforce, or change behaviors, feelings, or thoughts about an issue, object, or action.” On a general level, motivational systems such as persuasive technologies and gamification build on the assumption that human behavior and attitudes may be influenced through technology. All information systems can be considered to influence the users in some way [2]. However, for a technology to be actually called “persuasive,” the persuasion has to be intentional [9]; that is, the technology must have been designed for the purpose of guiding the user towards an attitude or behavior change. It follows that a concept of a desired attitude or behavior has to guide the design process.

According to the literature defining persuasive technologies, in addition to the intentionality, the event of persuasion and the strategy must also be considered in the design of such systems [2,3]. As the intent determines the intended outcomes or changes in attitude or behavior, the event refers to the usage and user of the persuasive technology, and the strategy to the message and how it is delivered [2]. Previous discussion of the topic has emphasized the importance of contextual factors of persuasion and the interactions among persuader, user, and technology [3]. It has been suggested [2] that, for better discernment of the outcomes of persuasive technologies, these technologies could be categorized in terms of whether they are intended to 1) form, 2) alter, or 3) reinforce one of the following: 1) attitudes, 2) behaviors, or 3) an act of complying.

On the level of design, persuasive technologies have been considered to consist of 1) primary task support (i.e., features supporting the core activity or behavior), 2) computer–human dialogue support (i.e., feedback from the system), 3) perceived system credibility (i.e., features making the system seem credible and trustworthy), and 4) social influence (i.e., features inducing motivation through social influence) [2,3]. Design guidelines and principles for these elements have been presented [3].

Whether the actual empirical works on persuasive technologies implement these persuasive designs is as of yet unclear. Furthermore, regarding the aims of persuasive technology, the technologies seek to induce attitude change in addition to changing

behaviors. However, attitude as such is rarely studied as a psychological outcome in studies of persuasive technology (see Table 4). Therefore, mapping of the actual empirical works is required.

To connect the conceptualizations of persuasive technologies to a wider framework, we integrate the definition of persuasive technologies with the concept of motivational affordances and its relationship to psychological and behavioral outcomes [12], [4], [13] in information technology (see Figure 2). This conceptual framing is suitable for a literature review because of its level of abstraction, which enables identification of the aforementioned aspects in all of the empirical studies reviewed.

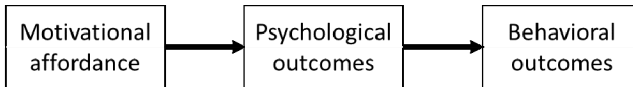


Fig. 2. The conceptual framing

3 The Review Process

3.1 The Literature Search and Criteria for Relevance

The review process began with selection of the sources to be used for the literature searches. We chose the Scopus database, the largest database of scholarly works, since it covers all the relevant publication venues for persuasion-related research. The search terms “persuasive technology” and “captology” were searched for in titles, abstracts, and keywords. The search produced 444 hits. For comparison, the IEEE database and ACM Digital Library yielded only 43 and 123 papers, respectively. However, the contents of both of these libraries are listed in the Scopus database.

For all hits in the search, the name and abstract were scanned, as was the information on whether the item was a full research paper rather than an abstract. All full research papers that potentially contained an empirical study entered a second round of review, in which the papers’ content was scanned for the inclusion of an empirical study, to rule out ambiguous cases. This procedure was carried out by two researchers individually. The two resulting sets of papers by the researchers were largely the same, and the few divergences were further discussed in a team that assessed their meeting of the selection criteria. As a result, 95 studies (in 89 papers) were selected for review (see Appendix). The following criteria were applied for inclusion of papers:

1. The paper included an empirical study.
2. The research methods were explicated.
3. The paper described the persuasive stimuli/technology.
4. The paper investigated relationships between persuasive stimuli, psychological mediators/outcomes, and behavioral outcomes in some combination.

The papers excluded from the review belonged to at least one of the following categories:

1. Conceptual articles and frameworks.
2. Descriptions of the development of a system/application but without evaluation of the system.
3. Papers that mentioned persuasive technologies but did not actually study a topic connected with such technologies.
4. Limited research reports (pilot studies reported in sufficient detail were included).
5. Abstracts (including extended abstracts) and posters.
6. Studies reported upon in a later paper (the later version was included instead).

3.2 Analysis

Analysis of the selected studies was a two-stage process following the guidelines of the well-regarded MISQ article by Webster and Watson [14]. The first step features an author-centric analysis wherein studies are listed in a table, one per row. Selected details from the papers are entered in the various columns. For this review, the details included 1) the reference, 2) the domain to which the persuasive technology was related, 3) the psychological mediators/outcomes, 4) the behavioral outcomes, 5) the results, and – related to methodology – 6) the sample size and 7) methods used (including the data source). The second stage with the literature review framework is concept-centric. In this step, the author-centric analysis was pivoted and coded (with some abstraction to connect related papers under a given category) into concept-centric frequency tables. These tables are reported as the results of this review in the next section of the paper.

4 Results

4.1 Reported Results

Table 1 summarizes the reported results for the reviewed studies. In all, 52 studies reported positive results for the persuasive technology examined. These account for 54.7% of the reviewed studies. Partially positive results refer to situations wherein some but not all of the studied elements showed positive results. Partially positive results were reported in 36 studies (37.9%). The category “negative and other” covers papers with fully negative results, no negative or positive results, or no results at all. As is evident from Table 1, fully negative results were reported in very few papers (as is to be expected).

4.2 Types of Studies

Table 2 reports the types of the studies – that is, the methodology used. Papers employing quantitative methods were in the majority. These included both inferential as well as descriptive research. Of all reviewed studies, 54.7% were fully quantitative.

Table 1. Reported results (codes refer to the full list of studies, in the appendix)

Result	Study	Total	% of all
Positive	A02, A04, A05, A06, A07, A08, A09, A10, A11, A13, A14, A15, A16, A18, A19, A21, A23, A25, A26, A27, A28, A29, A31, A32, A34, A37, A41, A43, A48, A49, A51, A52b, A52c, A54, A55, A56, A61, A63, A64b, A66, A68, A69, A70, A71, A73, A74, A75, A76, A78, A83, A85, A88	52	54.7
Partially positive	A01, A03, A12, A17, A20, A22, A24, A30, A33, A35, A38, A39, A40a, A42, A44, A45, A46, A47, A50, A52a, A53, A57, A58, A59, A62, A64d, A67, A72, A77, A79, A80, A81, A82, A84, A86, A87	36	37.9
Negative or other	A36, A40b, A60, A64a, A64c, A65, A89	7	7.4

Table 2. Types of studies (codes refer to the full list of studies, in the appendix)

Type	Studies with positive results	Studies with partially positive results	Studies with negative results	Total	% of all
Quantitative	A05, A06, A08, A10, A11, A13, A16, A23, A26, A27, A29, A31, A32, A34, A37, A41, A51, A52b, A52c, A54, A55, A61, A66, A69, A73, A75, A76, A78, A85	A03, A12, A17, A20, A33, A35, A38, A40a, A42, A44, A52a, A53, A57, A58, A59, A67, A77, A80, A84, A87	A36, A40b, A65	52	54.7
Qualitative	A02, A04, A07, A09, A15, A18, A49, A56, A68, A71, A74	A62, A79, A81	A60	15	15.8
Mixed methods	A14, A19, A21, A25, A28, A43, A48, A63, A64b, A70, A83, A88	A01, A22, A24, A30, A39, A45, A46, A47, A50, A64d, A72, A82, A86	A64a, A64c, A89	28	29.5

Studies using mixed methods formed another large category, accounting for nearly a third of all studies (29.5%). Fully qualitative studies were in the minority (15.8%).

The most frequently used quantitative methods were surveys, manual or automatic data logs, and statistical analyses. The main qualitative methods were user interviews, focus-group discussions, and observations from persuasive technology use.

The sample sizes in the reviewed studies varied greatly, from 2 to 1,704. Furthermore, not all studies reported a sample size, and in some cases, the study process was composed of several phases, with different methods and differing sample sizes. The sample size was clearly reported in 87 of the studies, for which the mean size was 102 and the median 26.

In light of the literature review, the typical methods of a study of persuasive technology could be described in the following manner. The studies usually describe an

implementation of a persuasive technology, often designed by the authors. A typical quantitative study included a survey or questionnaire for users of the implementation / test subjects and/or included tracking of use data. The qualitative studies mainly consisted of questionnaires or interviews carried out with users of the implementation. Typical mixed-method studies of persuasive technologies featured methods similar to those of the typical quantitative and qualitative studies.

4.3 Motivational Affordances

Table 3 reports the most prevalent motivational affordances in the reviewed studies. Some studies evaluated existing persuasive technologies, while in other papers the studied technology was a prototype or an application developed for purposes of the research.

Table 3. Motivational affordances (codes refer to the full list of studies, in the appendix)

Motivational affordance	Study	Total
Visual or audio feedback	A01, A09, A10, A11, A12, A13, A15, A21, A25, A34, A47, A48, A49, A50, A51, A54, A56, A59, A64b, A66, A70, A71, A72, A80, A83	25
Social support, comparisons, feedback, interaction, sharing	A13, A18, A25, A26, A28, A35, A36, A44, A46, A49, A58, A59, A64d, A66, A79, A81, A82, A83, A86, A88, A87, A89	22
Progress	A04, A10, A15, A18, A19, A39, A42, A45, A49, A54, A62, A68, A69, A79, A88, A89	16
Persuasive messages and reminders	A02, A04, A06, A13, A29, A42, A49, A53, A61, A62, A63, A65, A74, A77, A82, A86	16
Objectives and goals	A01, A04, A14, A15, A18, A27, A28, A39, A42, A49, A62, A63, A73, A75, A84	15
Rewards, credits, points, achievements	A04, A05, A08, A09, A10, A27, A36, A44, A49, A53, A60, A62, A64d, A70, A71, A80, A81	15
Ambient or public displays (displays embedded into the environment)	A18, A32, A37, A47, A48, A50, A64a, A64b, A64c, A64d, A70, A72, A83	13
Social agents (non-human, computerized assistants)	A02, A03, A31, A33, A34, A38, A55, A57, A58, A67, A73, A74	12
Competition, leaderboards, ranking	A04, A08, A09, A18, A25, A26, A27, A31, A36, A49, A81, A89	12
Emoticons and expressions	A03, A06, A34, A37, A53, A64a, A69, A74	8
Suggestions, advice	A27, A30, A49, A53, A69, A79	6
Tracking	A51, A80, A84	3
Video-based persuasion	A61, A76, A85	3
Positive reinforcement	A10, A68	2
Subliminal persuasion	A75	1
Not specified	A16, A17, A20, A23, A40a, A40b, A52a, A52b, A52c	9

The variety of motivational elements in the studies was wide. The affordances implemented most often were visual and audio feedback, social features, progress and persuasive messages, and reminders. In addition, many of the studied technologies featured also objectives and goals, rewards, and competition. Social agents and ambient displays were also found to be among the popular implementations.

4.4 Psychological Outcomes

Table 4 reports the studied psychological mediators/outcomes. As indicated by Table 4, most of the persuasive technologies studied in the reviewed papers featured design aimed at increasing engagement and encouragement, along with motivation through persuasion. Additionally, persuasive technologies increasing users’ awareness pertaining to, for example, health and ecologically sound consumption were studied.

It should be noted that not all of the studies actually measured psychological elements; rather, they are discussed as intended consequences of persuasion in the given implementation.

Table 4. Psychological outcomes (codes refer to the full list of studies, in the appendix)

Psychological mediators/outcomes	Study	Total
Engagement, encouragement	A01, A02, A05, A09, A14, A15, A18, A19, A21, A25, A26, A28, A29, A30, A36, A42, A47, A49, A55, A60, A62, A63, A66, A67, A69, A76, A81, A86	28
Motivation	A01, A02, A05, A08, A10, A15, A18, A26, A27, A28, A31, A36, A42, A44, A45, A51, A56, A62, A63, A67, A69, A80, A81, A85	24
Awareness	A08, A11, A12, A21, A24, A25, A27, A28, A43, A47, A48, A50, A61, A64, A70, A74, A76, A80, A81, A83, A88	21
Enjoyment, “fun”	A01, A04, A05, A08, A09, A10, A19, A25, A36, A45, A49, A72, A80, A89	14
Negative attributes	A01, A03, A12, A64, A66, A73, A78, A79, A81, A82, A89	11
Attitude	A04, A22, A33, A44, A49, A54, A67, A76	8
Self-efficacy	A10, A11, A39, A49, A51, A67, A85	7
Trust, credibility	A16, A17, A23	3
Commitment	A28, A85	2
Sense of community	A22	1
Adherence	A85	1

Some of the studies were also concerned with negative attributes of the persuasive technologies. Among these were frustration (A01), cognitive overload (A03), anxiety (A12), perceived amateurness (A23), peer pressure (A66), threat to personal autonomy (A73), and feelings of guilt from neglecting the behavior one is being persuaded to perform (A81).

4.5 Target Behaviors of Persuasive Technologies

Table 5 reports the domains of the target behaviors of the persuasive technologies in the reviewed studies. In all, 47.4% of the studies examined persuasive technologies in a health and/or exercise context. The second most frequently studied implementation domain was ecological consumption (21.1%); this included, for example, technologies aimed at conserving energy. In addition, persuasive implementations in the domain of education and learning were common among the studies reviewed.

Table 5. Domains of target behaviors (codes refer to the full list of studies, in the appendix)

Context	Studies with positive results	Studies with partially positive results	Studies with negative results	Total	% of all
Health, exercise	A02, A05, A07, A13, A14, A15, A18, A19, A26, A28, A31, A43, A49, A51, A52b, A52c, A54, A55, A63, A64b, A66, A68, A78, A85, A88	A01, A30, A35, A39, A42, A44, A45, A46, A52a, A53, A57, A62, A72, A77, A79, A82, A86	A36, A64a, A89	45	47.4
Ecological consumption and/or behavior	A08, A21, A25, A27, A32, A37, A48, A73, A74, A75, A83	A47, A50, A58, A59, A64d, A80, A81, A84	A64c	20	21.1
Education, learning	A06, A10, A29, A56, A70	A03, A22, A33, A67	A60	10	10.5
Economic, commercial, marketing	A16, A76	A17, A20, A38	A65	6	6.3
Security, safety	A04, A11, A34, A61	A12, A24		6	6.3
Entertainment	A09, A71			2	2.1
No specific domain	A23, A41, A69	A40a, A87	A40b	6	6.3

5 Discussion

Addressing the title of this literature review, it can be concluded that, in the published literature, persuasive technologies indeed seem to persuade people into various behaviors. In the reviewed studies, a diverse array of psychological factors were discussed or measured as antecedents of the target behavior and/or as outcomes of the effects of persuasive technology. However, even though persuasive technologies are, by definition [1], aimed at changing attitudes in addition to behavior, only a few of the papers explicitly included general attitude as a variable [15].

Expectedly, but interestingly, it seems that persuasive technologies are implemented especially in contexts wherein people would be willing to undertake the target

activities but find it difficult to start or continue working toward them. Among these activities are healthy habits, learning, and ecological behavior. This notion lends support to the idea that an important aspect with persuasive technologies and gamification is whether the encouraged activity is something the user is trying to accomplish regardless of the system or the user is instead persuaded toward a behavior that is valuable only for the designer of the system.

5.1 General Pitfalls in the Literature

Several shortcomings could be identified during the literature review. 1) The sample sizes were often rather small (median $N = 26$). 2) While many papers did measure experiences and attitudes with validated scales, many did not. 3) Some experiments lacked control groups and relied solely on user evaluation. 4) The persuasive system was often investigated as a whole instead of distinguishing between effects of individual affordances. 5) Many studies presented only descriptive statistics even though they could have easily made inferences about relationships among constructs. 6) Experiment timeframes were very short in most cases (novelty may have significantly skewed the test subjects' experiences). Finally, 7) there was lack of clarity in reporting the results. Further work should attempt in particular to avoid these pitfalls in order to refine research on persuasive technologies.

5.2 Limitations and Directions for Further Research

The literature search for this review included hits only for the keywords “persuasive technology” and “captology.” This might have limited the body of literature with a few papers. In addition, similar technologies may have been investigated outside technology-oriented fields. In fact, we found two related meta-analyses conducted in the field of medical sciences. However, no noteworthy overlap with the present study was detected with regard to the reviewed papers (see [16,17]).

Another limitation of the research at this stage is that the present paper does not yet comprehensively report and distinguish which specific affordances affect which psychological or behavioral outcomes. Therefore, this work must be regarded as an exploratory overview of the field. Further research should break down the results stemming from persuasive technology implementations in more detail in order to further the mapping of the field.

Furthermore, many of the reviewed papers do not properly measure psychological factors; rather, they hypothesize and discuss them as psychological outcomes of the given persuasive technology implementations. Therefore, further research should distinguish between studies in a more comprehensive manner regarding the employed research models while also reporting more accurately which aspects have been properly measured.

Since the reviewed studies vary in their methods and in the details of the research questions, they might not all be directly comparable. For example, although many studies might be categorized as having positive results, finer details would be needed to be able to assign studies into more comparable, commensurate groups. Therefore,

further studies should seek to establish more refined and detailed comparison regarding these issues.

One possible avenue for advancing the mapping of the field of persuasive technologies and related areas would be to conduct bibliometric analyses containing author, publication venue, year, keyword, and network analyses (see e.g. [19]). Bibliometric analyses facilitate distinguishing among sub-streams of research within and between disciplines / conceptual areas. They also support the consolidation of findings.

Although Scopus evidently features the most comprehensive collection of research papers related to persuasive technology, a meta-study could explore more database options, to guarantee the inclusion of all relevant research. We estimate that the searches of only Scopus captured most of the relevant studies.

Furthermore, one limitation of the paper is that, as in literature reviews in general, the possibility of publication bias must be considered. This bias, a tendency for papers with statistically significant or positive results to be more readily submitted and also accepted for publication, has been shown to exist (see e.g. [18]). For example, one analysis, looking mainly at studies in the medical field [18], has indicated that publication and outcome reporting biases are prevalent and affect the published research. According to that analysis, studies with positive findings were more likely to be published than were those with negative or null results. Even though the existence of publication bias among the studies included in this literature review is hard to ascertain, its potential effects on the findings should be kept in mind when considering the results of the review.

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Appendix

Appendix. Reviewed Studies

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