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# Bibliometric Analysis of Research on Persuasive Technology in the Past Decade: A Web of Science-Based Study

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## ABSTRACT

In recent years, research in persuasion technology has matured and captured the attention of numerous experts and scholars. In this article, we analyze 1,714 papers from the Web of Science Core Collection database using CiteSpace software, systematically review the theoretical development, hot topics, and research frontiers of persuasion research, and propose future research directions. We summarize the contributions of three authors who have excelled in the field of persuasion and their significant achievements through the co- authorship knowledge graph. Additionally, we concentrate on four major areas of persuasive technology application: exercise and health, sustainability, education, and business, by filtering and categorizing keywords. We also identify research frontiers in persuasive technology through burst keyword analysis. We discovered that the foundational theory of persuasion is well-established and has been widely applied across various domains. Particularly, research in the domains of exercise and health has emerged as a significant area deserving of further investigation. Furthermore, recent developments in persuasion research have centered on exploring the influencing factors of persuasion, encompassing intrinsic aspects that represent user perspectives and extrinsic elements reflecting the impact of the Internet. Therefore, we encourage researchers to delve deeper into these aspects.

**Keywords:** Persuasive technology, Citespace, Knowledge graph, Bibliometric analysis

## INTRODUCTION

The concept of persuasion originally emerged in psychology and found its way into the field of computer science in the late 1990s (Fogg, 1997). Its primary focus is utilizing computers and information technology to influence attitudes and behaviors (Fogg, 2002). The significant increase in academic research contributed to the development of the Fogg Behavior Model (FBM), which analyzes the generation of behaviors through motivation, ability, and trigger (Fogg, 2009a). Cialdini (2001) identified the six fundamental principles of persuasion, which include liking, reciprocity, social proof, consistency, authority and scarcity. The Persuasive Systems Design Model (PSD) was subsequently introduced as a framework for designing persuasive systems, featuring four categories and 28 effective strategies (Oinas-Kukkonen and Harjumaa, 2009). As foundational knowledge continues to expand, persuasive technology has expanded into numerous domains, such as health,

 

exercise, and ecological consumption, garnering increased attention. Therefore, this paper seeks to cluster research on persuasion within the Web of Science (WOS) Core Collection database by bibliometric analysis. By employing bibliometric analysis through CiteSpace, we generate a scientific knowledge graph of the persuasion field, displaying recent findings in a user-friendly manner. This will facilitate the organization of the theoretical knowledge system of persuasion and enable researchers to comprehend the field's current status and noteworthy accomplishments.

## Research Method and Data Source

CiteSpace 6.1.R6 was used for bibliometric analysis, utilizing data from the WOS Core Collection database to create a scientific knowledge graph and reveal the development process and structural relationships of knowledge. The search criteria were as follows: TS=(persuasive design) OR TS=(persuasive technology) OR TS=(Persuasive strategies) OR TS=(personalized persuasion). The search covered the period from January 1, 2012, to December 31, 2022, resulting in a total of 3,050 literature records. The selected literature types for this study included articles, proceedings papers, and reviews. Since the focus of this research is mainly on the application domains of persuasive technology, unrelated literature was filtered out by reviewing titles, abstracts, and keywords. This process led to a total of 1,714 relevant research papers on persuasion.

## Basic Characteristics of the Literature

Through analyzing the relevant literature in the WOS Core Collection database, we investigated the temporal trends in the number of publications in the field of persuasion. From 2016 onwards, there has been a significant increase in publications, peaking at 219 in 2019. Since then, the publication count has remained stable, indicating a sustained scholarly interest in persuasion research over the past decade.

## Core Authors and Research Achievements

The co-authorship knowledge graph in persuasion research was generated using CiteSpace software (see Figure 1). The graph demonstrates a dense network of connections, signifying the active engagement of authors in persuasive technology research. This dynamic network has enabled productive collaborations and mutual connections among authors. The persuasive technology research community has nurtured effective multidirectional communication, interactive collaborations, and interconnected relationships, fostering a strong exchange of knowledge and information. These interactions play a significant role in the continuous progress and development of the persuasive technology field.

Fogg BJ, Oinas-Kukkonen H, and Orji R are prominent scholars who have made significant contributions to persuasion research, inspiring other researchers in the field. Fogg introduced the concept of persuasive technology, defining it as an information system designed to change people's attitudes or

behaviors. He proposed the use of computer systems to persuade users, outlining three approaches: tool, medium, and social actor. He then established the Persuasive Technology Lab, wrote books on persuasive technology, outlined specific steps, and created the well-known Fogg Behavioral Model (see Table 1).


**Figure 1:** Co-authorship knowledge graph in persuasion research (Generated in CiteSpace).

**Table 1.** Timeline of Fogg's persuasion research.

| Year | Main Contributions |
|---|---|
| 1997 | Fogg established the Persuasive Technology Lab at Stanford University. |
| 1997 | Fogg (1997) introduced Captology, which refers to the application of persuasive technology in the field of computer research. |
| 2002 | Fogg (2002) published Persuasive Technology: using Computers to Change What We Think and Do, proposing a definition of persuasive technology. |
| 2009 | Fogg (2009a) proposed the Fogg Behavior Model, which describes the three elements necessary for behavior change: motivation, ability, and trigger. |
| 2009 | Fogg (2009b) outlined the eight steps to designing for persuasion. |
| 2010 | Fogg and Hreha (2010) initiated the Behavior Wizard project and developed the Fogg Behavior Grid. |
| 2017 | Fogg changed the Fogg Behavior Model by replacing the term Trigger with Prompt, forming the B=MAP Behavior Model. |
| 2019 | Fogg (2019) published Tiny Habits: The Small Changes That Change Everything. |

Oinas-Kukkonen et al. (2009) defined an emerging information system as a behavior change support system that applies persuasive technology concepts.

These systems can be websites, mobile applications, or other interactive information systems. Oinas-Kukkonen also proposed the Persuasive Systems Design (PSD) model, which is a comprehensive theoretical framework for persuasion. The PSD model categorizes 28 specific strategies into four main modules, based on their intended impact on system design goals. It has been widely used for designing and evaluating intention-based behavior change systems (Halttu and Oinas-Kukkonen, 2017) (see Figure 2).

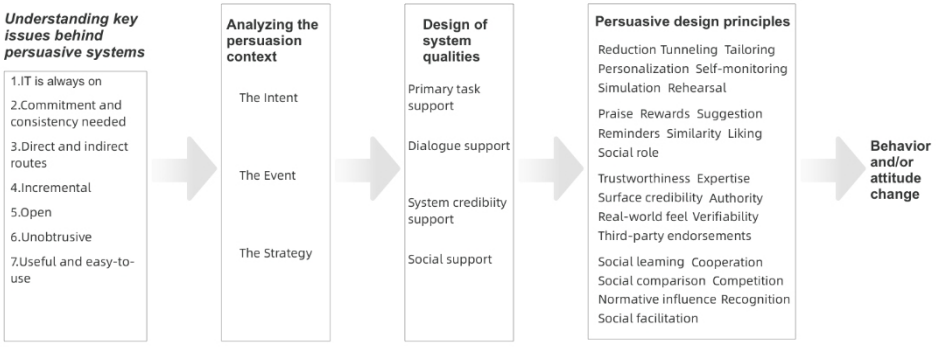


**Figure 2**: Persuasive systems design model (Adapted from Oinas-Kukkonen and Harjumaa, 2009).

Orji R et al. (2012) introduced four additional variables to expand the existing persuasive model in the health domain. They tested and compared the effectiveness of the expanded model with the original model in promoting healthy eating behaviors. Orji R focuses on researching gamification in persuasive interventions and commonly utilizes personalized persuasive strategies tailored to individual users. They design personalized interventions for different types of players (Orji, Nacke and Di Marco, 2017). In-depth investigations are conducted across various research domains to explore the limitations of one-size-fits-all persuasive strategies. Personalized persuasive strategies are then designed based on individual factors.

## Research Hot Topics

Scholars have established the theoretical foundation for persuasive technology research and conducted extensive studies on its application in relevant industries. By filtering and categorizing keywords (see Table 2), we identified and summarized the four major themes explored by scholars in persuasive technology research.

The first category of this research focuses on exercise and health, encompassing keywords such as physical activity (2013), health (2014), healthy eating (2014), health communication (2014), mobile health (2015), smoking (2016), and mental health (2016). Evolving lifestyles have led to an increased concern over unhealthy behaviors, making it imperative to shift lifestyle patterns and promote healthier living. The World Health Organization has outlined four key areas for healthy lifestyles: balanced diet, regular

exercise, abstaining from smoking or excessive drinking, and maintaining mental well-being. Consequently, research in this field has seen a steady rise in response to the growing importance placed on individual health. The timeline of research in exercise and health has transitioned from broader topics, such as physical activities and general health, to more specific areas, such as addressing unhealthy behaviors like smoking and focusing on mental health within the context of health promotion. This research has delved into various aspects, including technological design, research methods, and motivational factors. The advancement of digital technologies has opened doors for digital interventions that promote healthy behaviors, offering greater potential for embracing healthier lifestyles. (Lentferink et al. 2017) conducted a study on interventions for automatic healthy lifestyles using self-tracking and digital support technology. The study evaluated the impact, usability, and compliance of these interventions, ultimately enhancing the effectiveness of health interventions.

**Table 2.** Research hot topics related keywords.

| Category | Keyword | Year | Frequency | Degree Centrality |
|---|---|---|---|---|
| Exercise and Health | physical activity | 2013 | 54 | 20 |
| | health | 2014 | 57 | 16 |
| | healthy eating | 2014 | 2 | 6 |
| | health communication | 2014 | 14 | 10 |
| | mobile health | 2015 | 5 | 6 |
| | smoking | 2016 | 6 | 6 |
| | mental health | 2016 | 13 | 12 |
| Sustainability | energy conservation | 2012 | 6 | 7 |
| | donation | 2013 | 2 | 2 |
| | carbon footprint | 2013 | 1 | 3 |
| | climate change | 2016 | 21 | 18 |
| | green | 2020 | 3 | 7 |
| Education | adolescent student | 2020 | 1 | 1 |
| | learning disabled student | 2012 | 2 | 3 |
| | college student | 2012 | 4 | 8 |
| | student | 2014 | 10 | 11 |
| | education | 2014 | 12 | 18 |
| | higher education | 2016 | 2 | 2 |
| | health education | 2016 | 2 | 2 |
| | entertainment education | 2019 | 8 | 8 |
| Business | consumer | 2015 | 16 | 18 |
| | consumer behavior | 2019 | 2 | 4 |
| | food advertising | 2021 | 2 | 6 |

The second category focuses on sustainability, incorporating keywords such as energy conservation (2012), donation (2013), carbon footprint (2013), climate change (2016), and green (2020). The urgency of the climate crisis, including melting glaciers, global warming, and widespread disasters, has made environmental sustainability a critical global concern. With the implementation of sustainable development policies by various countries, the integration of persuasion and sustainability has emerged as a prominent topic in persuasion research. In traditional persuasion research, the effectiveness of persuasion is typically evaluated through experiments conducted over one to

two months, and sometimes up to three to six months. However, when it comes to promoting sustainable behaviors such as transportation choices, purchasing habits, and water and electricity usage, these decisions often vary with seasonal factors. This indicates that short-term measurements may not accurately capture the effectiveness of persuasion in promoting sustainable behaviors. (Anagnostopoulou et al., 2020) emphasized the significance of considering seasonality as a crucial factor in cultivating sustainable habits.

The third category explores education, covering keywords like adolescent student (2010), learning disabled student (2012), college student (2012), student (2014), education (2014), higher education (2016), health education (2016), and entertainment education (2019). Online education has gained popularity with the rise of the internet, further accelerated by the COVID-19 pandemic in early 2020. The integration of education with other domains, such as health education and environmental education, creates mutual enhancements. Applying persuasive design in education enhances students' learning continuity and motivation, providing an improved learning experience. Educational interventions, often incorporating gamification, captivate students' attention and encourage positive learning behaviors. (Elaish et al., 2019) developed a mobile gaming application that utilizes gamified learning to enhance students' motivation in learning English vocabulary. This study emphasizes the potential of persuasive strategies within gamification and offers valuable insights for designing game-based interventions.

The fourth category focuses on business-related aspects, with keywords such as consumer (2015), consumer behavior (2019), and food advertising (2021). The rise of the internet has made online shopping a prevalent consumer behavior. However, challenges persist, including the lack of appeal in the online shopping experience and consumer concerns. Persuasive technology can help attract consumers and address these shopping-related concerns. As a result, persuasive design in the business domain has garnered significant attention. (Ali et al. 2017) demonstrated the effectiveness and feasibility of persuasive design in the business domain by enhancing social support elements and improving the persuasive utility of the recommendation system in Malaysia.

## Research Frontiers

With CiteSpace, we performed a quantitative analysis of keywords to study their emergence over time. Burst keywords provide a clear representation of academic frontiers. The top 16 burst keywords in persuasive studies (see Figure 3) reveals three distinct stages of bursts.

During the first stage (2012-2014), the burst keywords included message, planned behavior, student, and involvement. This stage primarily focused on fundamental elements of persuasion research, such as message framing and planned behavior representation, with a particular emphasis on experimental studies involving student participants. Information played a crucial role in persuasion, and varying its delivery methods effectively influenced users' behavioral attitudes. Gallagher (2016) discovered that different modes of information delivery can impact the effectiveness of persuasion, despite conveying the same basic information.

**Top 16 Keywords with the Strongest Citation Bursts**

| Keywords | Year | Strength | Begin | End | 2012 - 2022 |
|---|---|---|---|---|---|
| message | 2012 | 3.37 | **2012** | 2017 | |
| planned behavior | 2012 | 4.03 | **2013** | 2015 | |
| student | 2012 | 3.28 | **2014** | 2015 | |
| involvement | 2012 | 3.19 | **2014** | 2015 | |
| persuasion knowledge | 2012 | 3.8 | **2015** | 2017 | |
| persuasive system | 2012 | 3.02 | **2016** | 2018 | |
| advergame | 2012 | 2.64 | **2016** | 2018 | |
| behaviour change | 2012 | 2.56 | **2016** | 2019 | |
| united states | 2012 | 2.97 | **2017** | 2018 | |
| support | 2012 | 4.26 | **2018** | 2020 | |
| system | 2012 | 2.7 | **2018** | 2022 | |
| disorder | 2012 | 3.36 | **2019** | 2020 | |
| satisfaction | 2012 | 3.36 | **2020** | 2022 | |
| gamification | 2012 | 2.94 | **2020** | 2022 | |
| persuasive design | 2012 | 2.54 | **2020** | 2022 | |
| intrinsic motivation | 2012 | 2.52 | **2020** | 2022 | |

**Figure 3:** Top 16 burst keywords in persuasion research (Generated in CiteSpace).

During the second stage (2015-2017), the burst keywords in persuasive research included persuasion knowledge, persuasive system, advergame, behavior change, and United States. This stage focused on refining and advancing persuasion theory, primarily led by American researchers. The study of persuasion emerged in the late 1990s and gained academic attention in 2005. By 2015, there was a significant body of research on persuasion, with continuous improvement in models such as FBM, behavior grid, persuasive technology functional model, and PSD. During this stage, researchers conducted systematic reviews and examinations of previous knowledge and systems in persuasion research. They identified limitations and made further advancements in the field. For example, (Orji et al., 2017) explored the effectiveness of social influence-related strategies through a large-scale qualitative and quantitative study involving 1768 participants. Adjustments were made to these strategies, and guidelines for their implementation were proposed to enhance persuasive effectiveness. Additionally, (Matthews et al. 2016) utilized existing persuasion system design models as an analytical framework to review articles on mobile applications for health behavior. The study revealed a substantial body of literature supporting task support, dialogue support tasks, and social support, but limited research on system credibility. Consequently, the study focused on investigating the credibility of system information to improve persuasion systems for health-related mobile applications.

During the third stage (2018-2020) of persuasive research, burst keywords included support, system, disorder, satisfaction, gamification, persuasive design, and intrinsic motivation. In this current stage, persuasion theory has undergone extensive and in-depth research. Factors influencing persuasion

have been subdivided, with a focus on studying intrinsic factors related to users and external factors related to the internet and environmental influences. The integration of emerging research has injected new vitality into persuasion. Regarding external research, stimulation of behavior has been achieved through persuasive technologies such as computer support systems, social support systems, and perceptual systems. In terms of intrinsic research, emphasis has been placed on user psychology and utilizing gamification to alter users' attitudes based on their intrinsic motivation. Xi and Hamari (2019) explored gamification factors in the context of intrinsic research and validated how different gamification features satisfy various dimensions of intrinsic needs. The study found a positive correlation between immersion-related gamification features and self-need fulfillment, confirming the positive role of gamification factors in influencing intrinsic motivation in persuasion.

## CONCLUSION

Persuasion research has gained global attention as a means of intentionally influencing attitudes and behaviors, leading to significant academic progress. In this study, we conducted a bibliometric analysis of 1,714 research articles on persuasion from the WOS Core Collection database, covering the period from 2012 to 2022. The findings can be summarized as follows: 1) In terms of publication trends, persuasive research underwent an exploratory phase from 2012 to 2015, followed by a substantial growth period from 2016 to 2019, and eventually stabilized from 2020 to 2022. 2) Highly cited literature in persuasive research predominantly emerged between 2014 and 2018. Influential authors like Fogg BJ, Oinas-Kukkonen H, and Orji R played critical roles in defining persuasion, establishing foundational theories and models, and conducting practical research in various domains, especially in health. They employed techniques such as gamification and personalization to delve deeper into the realm of persuasion. 3) Persuasive research has made significant contributions in four primary thematic areas: exercise and health, sustainability, education, and business. While concentrating on these core domains is expected to produce valuable results, applying persuasion theories to other fields offers potential for innovative accomplishments. 4) An analysis of the frontiers in persuasive research reveals an initial exploration of fundamental knowledge and essential elements, followed by a comprehensive review and consolidation of knowledge and systems in the field to address identified limitations. Furthermore, the differentiation between external physical factors and internal psychological factors in persuasive research has enriched the comprehension of influencing factors. To further enhance the depth and specificity of persuasive research, future studies should meticulously explore and investigate specific domains or issues.

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