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The Information Architecture of PDAs-Its Impact on User Comprehension and Risk Perception

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ABSTRACT

Nowadays, there is a trend for decision aids to be transformed into applications. This study aimed to understand the impact of information architecture on users of decision aids for patients. Results showed that participants using a reader-driven framework had significantly higher comprehension of medical information than an author-driven framework($p = 0.025$), but there was no significant difference in risk perception. Among those with good numeracy skills, the reader-driven framework performed significantly better than the author-driven ($p = 0.018$). Future development of information architecture for patient decision aids should consider the users' numerical skills.

Keywords: Information architectures, Author-driven framework, Reader-driven framework, Patient decision aids (PDAs), Risk perception

INTRODUCTION

Prevention of obesity is a global public health challenge (Afshin et al., 2017), and the World Obesity Federation estimates that the global obese population will reach 1 billion by 2030 (Federation, n.d.). The prevalence of diseases associated with obesity, such as type 2 diabetes, cardiovascular disease, and cancer, will also increase (Organization, 2021). It is estimated that by 2025, obesity-related healthcare spending will reach US$1.2 trillion per year (Federation, n.d.). In recent years, clinical guidelines for the prevention and treatment of obesity have been updated, and medical professionals are required to provide patients with the latest evidence-based medical advice and health information on diet, exercise, mental health, medication information, and surgical treatment. However, patients are not always able to effectively understand professional medical information, especially when they compare different types of weight loss drugs. Possible reasons for this may be poor health literacy and risk literacy, which may cause barriers to comprehension (Allan Jinan et al., 2018; Graham and Brookey, 2008), poor numeracy, which may cause difficulties in interpreting health risk values (Baker et al., 2007; Lipkus et al., 2001; Nelson et al., 2008; Peters et al., 2006), or bias (Lipkus et al., 2001). Decision aids for obesity are now widely used in these types of

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medical communication situations to help physicians explain to obese patients what is relevant to treatment, such as weight loss medication and surgery, and to compare the advantages and disadvantages of different treatment options, e.g., Healthwise (2022), Kaohsiung Veterans General Hospital (2020). Decision aids take a large amount of medical information and evidence-based data and organize it so patients can effectively understand and use it. It also translates system-related information into an information framework that users can easily understand (Institute, 2013). The information's content should be arranged so that it can be categorized, named, and hierarchically differentiated to provide an overview of the context of the information and a logical response to the information architecture. There are currently many different ways of arranging the data narrative of content in the information architecture of decision aids. They can be classified as linear or non-linear visual data narratives (Lindy, 2016). The visualization of data narratives falls somewhere between the extremes of author-driven and reader-driven attribution (Segel and Heer, 2010). We are not sure which type of data narrative is more appropriate for use in obesity decision aids. Further research is needed to study whether different information architecture narratives impact people's comprehension and risk perception. It is hypothesized that different information architectures will affect patients' risk perception and comprehension with different numeracy skills. The study aims to understand the impact of the information architecture of patient decision aids on user comprehension and risk perception so that medical information can be translated into simple, clear instructions that can be effectively understood and operated by users.

METHODS

The study evaluated participants' comprehension and risk perception through a questionnaire survey, semi-structured interview, and user-interface evaluation and usability testing through the System Usability Scale (SUS) and NASA-TLX assessment scales. The study participants were over 20 years old. They need to operate the interface independently and assist in the investigation and validation of the decision aid prototype. Only a single researcher explained the experimental procedure and situation and answered all questions related to the experiment to the participants.

DESIGN OF EXPERIMENT

We considered a wide range of topics for decision aids. The study focuses on the topic of obesity, and the patient decision-aid prototypes were designed with both author-driven and reader-driven frameworks. Participants with different numeracy skills were evaluated on their comprehension of the content, risk perception, usability, and mental load of the operating system. By inputting basic information and relevant medical history, participants can estimate future risks, e.g., type two diabetes, and cardiovascular diseases, based on evidence-based research. Also, the prototypes would provide the participants

with three currently FDA-approved weight loss drugs (Contrave, Liraglutide, Semaglutide).

We developed two prototypes based on Segel and Heer's author-driven and reader-driven data narratives (Segel and Heer, 2010). Author-driven is a linear sequential scene, suitable for massive information delivery but not interactive. In contrast, the reader-driven has no prescribed sequence and no information delivery but is highly interactive.

The procedure invited the participant to fill basic information questionnaire and the Berlin Numeracy Test (BNT). Afterward, the participant was given a task situation: "you were advised to control your weight due to a combination of internal and external factors causing your weight to increase. Your doctor invited you to use the decision aid about weight loss treatment to help you understand the information about appropriate medication. The information would give you the three most commonly used weight loss drugs in clinical practice, including their risks and side effects. You would be asked to browse and operate the aid. Remember the key information and discuss your treatment preferences with your doctor." While browsing and operating the aid, the participants were asked to think aloud about each process step. After the participant had completed the procedure, we evaluated their comprehension by asking their four questions, e.g., What are the main side effects of Contrave? What is the most common side effect of Liraglutide? We evaluated participants' risk perception by asking their two questions, e.g., which weight loss drugs have the highest risk of side effects of nausea and vomiting? Finally, a follow-up user-interface evaluation was conducted to understand the user's operational concerns. We invited participants to complete the SUS and NASA-TLX assessment scales, followed by a semi-structured interview.

RESULTS

A total of 38 participants were invited to the study, including 17 in reader-driven prototypes and 21 in author-driven prototypes. The participants were aged between 21–58 years, with an average of 26 years old. There were 25 (66%) males, 13 (34%) females and 29 (76%) were university education, 9 (24%) were master's degrees. According to the numeracy scale (BNT) completed by the participants, there were 29 participants good at numeracy and 9 participants who were poor at numeracy.

The results showed that the reader-driven participants were significantly more comprehensible than the author-driven ones ($p = 0.025$), but there was no significant difference in risk perception. In the usability section, author-driven farmworks SUS was higher (author-driven: SUS = 61.4, reader-driven SUS = 59.4), but overall it was still below the mean SUS value. In the mental load section (NASA-TLX), participants spent more mental, physical, time pressure, effort, and stress perceptions operating the reader-driven than the author-driven framework, especially in the time pressure section ($p = 0.011$). In addition, there was no significant difference in the performance of the two prototypes in terms of comprehension and risk perception between the two groups in terms of participants' numeracy skills. However, among those with good numeracy skills, reader-driven comprehension performance was significantly higher than author-driven ($p = 0.018$).

During the interviews, no significant differences were found in the comprehension and operation of the two prototypes. In the conversation analysis, the reader-driven prototype was found to have the following advantages: easy to compare reading risks (59%) and simple steps (65%), and disadvantages: high information load (29%) and skipping in reading order (18%). The advantages of the author-driven prototype were: systematic arrangement resulting in a low reading load (38%), progress guidance (38%), previous and next step guidance (38%), and drug description images (43%); disadvantages: ineffective comparison of drug risks (10%), and back-and-forth selection (19%). In terms of interface design, the analysis revealed that: the drop-down list of risks and side effects was easy for users to ignore; there was no hierarchy between the chronic disease menu and the following step guide in the basic information; and the array of icons and text descriptions were not effectively recognizable and understood by the participants.

DISCUSSION

The experiment results revealed that participants who used the reader-driven were significantly more comprehensible than author-driven ($p = 0.025$), but there was no significant difference in risk perception. This may be because the sample size of the poor numeracy participants in this study was not large enough to reflect the difference in numeracy in terms of information architecture. In terms of usability, although the prototype might help participants to understand the advantages and disadvantages of different drugs, there was still much space for improvement, especially for the poor numerically skilled user. Besides, some participants said that they were difficult to put themselves into the situation because they were not diagnosed as obese. Therefore, whether there is a difference between the study's results and the actual diagnosis of obesity needs to be further investigated.

CONCLUSION

We found that the information architecture in patient decision aids may impact user comprehension. Future development of information architecture for patient decision aids should consider the users' numerical skills.

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