Designing digital health information in a health literacy context

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Publication date
2016
Document Version
Final published version

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Introduction and dissertation outline

In today's society, people are more than ever before expected to act responsibly with respect to their own health and disease self-management (Fransen, Van Schaik, Twickler, & Essink-Bot, 2011). To do this, people can use a variety of health information that is available through many different communication channels. For example, every piece of medication has its own prescription label, food packages contain a nutrition label and multiple logo's, and the Internet offers thousands of Dutch health websites (Gierveld & Schippers, 2011). In addition to this general information, individuals also receive personal invitations for preventive care such as vaccination or cancer screening. In those cases, the invitation often carefully outlines pros and cons of participation. The aim of providing such detailed information is to support people in making an informed decision, which means that the benefits and risks of screening are weighted (Marteau, Dormandy, & Michie, 2001).

Unfortunately, providing detailed information, both online and offline, does not automatically lead to informed health behaviors. Many people have limited health literacy, which means that they lack to some extent the ability to process and understand health information (Sørensen et al., 2012). As a consequence, existing health information materials are often less effective in this group. To make health information effective for everyone in society, it should be designed in a way that facilitates information processing among limited health literacy groups, without having undesirable effects in people with adequate health literacy. Although digital communication offers many possibilities for message design, it is unclear how health literacy impacts processing of health information. The aim of this dissertation is therefore to gain insight into how information processing is influenced by health literacy and to identify message design features that optimize health communication in order to improve people's opportunity to make informed health decisions.

Health literacy

The concept health literacy was introduced in the United States in the 1990s and was originally defined as "people's ability to process and understand health information" (Ratzan & Parker, 2000, p.vi). In the US, about 45% of the adult population has health literacy skills that are below adequate (Paasche-Orlow, Parker, Gazmararian, Nielsen-Bohlman, & Rudd, 2005). Although less European research on the topic has been done, a recent report about eight EU member states showed comparable figures; 47% has inadequate or problematic health literacy. In the Netherlands, 25% of the population does not have adequate health literacy (HLS-EU Consortium, 2012). Inadequate health literacy is problematic for society, because it is associated with several adverse health

outcomes, such as worse physical and mental health (van der Heide et al., 2013), hospitalization and long-term illness (HLS-EU Consortium, 2012).

Over the last decades, the health literacy concept has evolved. Initially, health literacy was mainly considered relevant in medical settings such as doctor-patient encounters. One of the first health literacy measures, the Rapid Estimate of Adult Literacy in Medicine (REALM: Davis et al., 1993), assesses patient's functional literacy in a medical context, or the ability to read patient information. In the following decades, the concept has expanded to a wide variety of skills that people need to function in a modern health care system (Sørensen et al., 2012). In line with this wider conceptualization, Nutbeam (2000) argued that health literacy not only comprises the ability to read and write, but also the ability to extract information, to derive meaning from different forms of communication, and the ability to critically analyze information. According to other scholars, health-related knowledge (Ishikawa & Yano, 2008), numeracy (Weiss et al., 2005), or motivation to process health information (Nutbeam, 1998) also belong to health literacy. As a result, more than 15 definitions and many measures to assess health literacy were presented in the last years (Mackert, Champlin, Su, & Guadagno, 2015; Sørensen et al., 2012).

In this dissertation, we see health literacy as a general personal characteristic that reflects people's overall health-related knowledge and expertise that supports health information processing in general. Health literacy is thus a result of learning and can be built during the life course. We therefore use the following definition: "health literacy is the degree to which individuals can obtain, process, understand, and communicate about health-related information needed to make informed health decisions" (Berkman, Davis, & McCormack, 2010, p.16), which is widely used (e.g., McCormack et al., 2010; Sun et al., 2013). Within this definition, our focus will be on people's ability to process and understand health information. Processing and understanding are crucial steps in health communication effectiveness which are likely to be influenced by the design elements of health messages.

Health literacy and health communication

As people with limited health literacy do not optimally benefit from health information, research needs to investigate how health literacy influences information processing and to what extent message design can be used to improve people's understanding of health materials. When health communication design is discussed in relation to health literacy, people often refer to the book 'Teaching patients with low literacy skills' (Doak, Doak, & Root, 1996). The guidelines in this classic book refer to communication with

people with *low literacy*. This is something different than people with *limited health literacy*, who may have basic reading and writing skills, but still have major problems with processing and understanding health information.

Furthermore, the book on teaching low literate patients was written almost thirty years ago. Since then, digital communication started to grow. Digital communication offers new opportunities for presenting health information that were not available before (Kreps & Neuhauser, 2010). For example, health websites and apps can easily incorporate verbal information, videos, or animations. Digital health information can be communicated through different channels. More than half of the Dutch adult population uses the Internet to find health information (Statistics Netherlands, 2014). Also, over two-thirds of the US adults population currently owns a smartphone and many people use their smartphone for health purposes (Fiordelli, Diviani, & Schulz, 2013; Smith, 2015). Research has shown that not only people with adequate health literacy have access to digital health information, as there appears to be no difference in technology access between health literacy groups (Jensen, King, Davis, & Guntzviller, 2010). This emphasizes the need for limited health literacy appropriate health information in a digital context.

Research on message design and health literacy has mainly focused on audiences with limited health literacy. It is therefore unclear whether messages that are designed for limited health literacy groups are also effective among people with adequate health literacy. Possibly, messages that are limited health literacy appropriate may lead to undesirable responses in adequate health literacy groups, such as less positive attitudes. However, this has never been tested and therefore needs to be investigated.

Health information processing

The outcomes of information processing and communication effects are always the result of an interaction between the message and the receiver. In health communication, this means that the level of health literacy that is demanded by a message is determined by the complexity and difficulty of the message. The more complex a message is, the more health literacy skills are required to understand the information and to incorporate it into someone's current knowledge base (Squiers, Peinado, Berkman, Boudewyns, & McCormack, 2012). This cognitive perspective on health information processing is in line with cognitive load theory (Sweller, 1994; Sweller, Van Merrienboer, & Paas, 1998). Cognitive load theory distinguishes two types of cognitive demands that are placed on readers by information materials. The first type, intrinsic cognitive load, refers to the

content of the message. When the subject of the information is difficult, the intrinsic cognitive load of the material is high. The second type, extrinsic cognitive load, is not dependent of the content, but rather the result of design-related factors such as reading level, font type, or organization of the text. To make health information easier to process, this extrinsic cognitive load should be reduced as much as possible (Wilson & Wolf, 2009). Based on cognitive load theory, it can be expected that design-related message features influence people's ability to process health information, particularly among limited health literate audiences.

Another way to reduce the cognitive demands of health messages is to add illustrations or narration to written information. According to the cognitive theory of multimedia learning, people learn better when new information is presented as both text and pictures instead of just text (Mayer, 2002). The multimedia effect, which is part of the cognitive theory of multimedia learning, is based on the assumption that people have separate channels to process words and images. Each channel has its own, limited, processing capacity. Consequently, information that is presented as text with corresponding illustrations reduces the likelihood that people will experience cognitive overload when they try to process the information compared to information that is presented as just text or pictures. Especially people with limited health literacy will primarily benefit from this. In addition to the multimedia effect, the cognitive theory of multimedia learning also incorporates the modality effect (Mayer, 2002). This effect is based on the assumption that once information is presented as both text and illustrations, people will learn better when the text is narrated, using a voice over, instead of written text. Again, presenting information this way is expected to reduce the cognitive demands of information processing. Based on this principle, it can be expected that especially people with limited health literacy will find it easier to process spoken information compared to written information. Finally, whether images are static or dynamic (i.e., moving as an animation) may also affect information processing (Höffler & Leutner, 2007). To successfully process new information, people create mental representations of the content. The more correct this mental representation is, the better it will be stored in memory and recalled on a later moment (Lang, 2000; Mayer, 2002). It could be assumed that, due to the movement, animations depict the content of a message better than static illustrations, supporting information processing. However, moving animations can also be more distractive than still images which makes this format sometimes less effective (Mayer, Hegarty, Mayer, & Campbell, 2005). Therefore, it should be tested whether animations are effective health communication instruments in different health literacy groups.

Based on the above theories, different features could be identified that influence the health literacy demands of health messages. The level of a message's complexity, presentation as text or illustrations, written text or narrated text, and moving animations or static illustrations are expected to facilitate or hinder information processing within limited health literate audiences. However, before messages can be processed, they need to be attended. According to the limited capacity model of motivated mediated message processing (Lang, 2006) information processing consists of three sub processes: encoding, storage, and retrieval. Every step requires cognitive capacity to be completed and if there is more capacity needed than people are able to devote to the task, the information will not be processed (Lang, 2000). Consequently, information that is not or hardly attended, or encoded, will not be processed. Therefore, research should also investigate how health literacy is related to people's attention towards health information.

The theories that have been discussed so far all focused on the relation between message design and information processing and understanding of health information. However, recall of information is not the only relevant outcome. In some contexts, the influence of health messages on people's attitudes and behavioral intentions is important as well. For example, decisions to participate in cancer screening are considered to be 'informed' when people have sufficient knowledge as well as attitudes that are in line with the screening behavior, which can be either positive or negative (Marteau et al., 2001). Today, little is known about how the combination of message design features and health literacy influence people's attitudes and behavioral intentions. Irrespective of health literacy, research has shown that more vivid information is generally more appealing and appreciated than non-vivid messages (Sundar & Kim, 2005). Based on the resources matching theory (Anand & Sternthal, 1989) it could be expected that the influence of message design on people's attitudes and intentions differs between health literacy groups. According to this theory, messages are most effective when the cognitive capacity that is demanded by a message during information processing matches the capacity that people have available for this task (Keller & Block, 1997; Peracchio & Meyers-Levy, 1997). From this perspective, it could be expected that messages that demand little processing capacity, are less persuasive among people who have much capacity available for processing; individuals with adequate health literacy. This would imply that messages of which the cognitive demands are maximally reduced to support people with limited health literacy, will be less effective among people with adequate health literacy.

Aim of the dissertation

The aim of this dissertation is to gain insight into how information processing is influenced by health literacy and to identify message design features that optimize health communication effects in different health literacy groups. The following questions will be answered:

1. To what extent do digital design features influence information recall, attitudes, and behavioral intention among people with different health literacy levels?
2. To what extent does health literacy influence people's attention to different features of online health information and how does this affect recall of information?
3. What mechanisms underlie the processing of online health information in different health literacy groups?

Dissertation outline

This dissertation consists of four studies, based on five different datasets. Each study is presented in a separate chapter. Figure 1.1 presents the relationship between the chapters. To gain insight into the direct effects of health information, chapters 2 and 3 study how different traditional and digital message features influence message effects among people with limited and adequate health literacy. It is also investigates whether message features that suit people with limited levels of health literacy cause different effects among adequate health literate groups. **Chapter 2** investigates whether the level of text complexity (non-complex versus complex) and the presence of illustrations in colorectal cancer screening messages influence people's recall of and attitudes towards the information. Furthermore, the influence of health literacy and message characteristics on informed screening decisions is investigated. In **chapter 3** it is tested how text modality (written vs spoken) and visual format (illustrations vs animations) of messages about colorectal cancer screening influence health information recall, attitudes, and screening intention and whether this differs between people with different health literacy levels. Then, the scope of studies widens and the information processing phases that precede health communication effects are taken into consideration. The aim of **chapter 4** is to gain insight into how people with limited or adequate health literacy attend to online health information that consists of text-only or illustrated text, and how attention to such information leads to adequate recall of information. In **chapter 5**, two separate studies investigate the mechanisms through which health literacy influences both information recall and website attitudes. Using two real health websites, the role of three possible mediators (cognitive load, imagination ease, and website involvement) is tested simultaneously. Finally, **chapter**

6 provides an overall discussion and conclusion of the dissertation as well as practical implications and directions for future research.

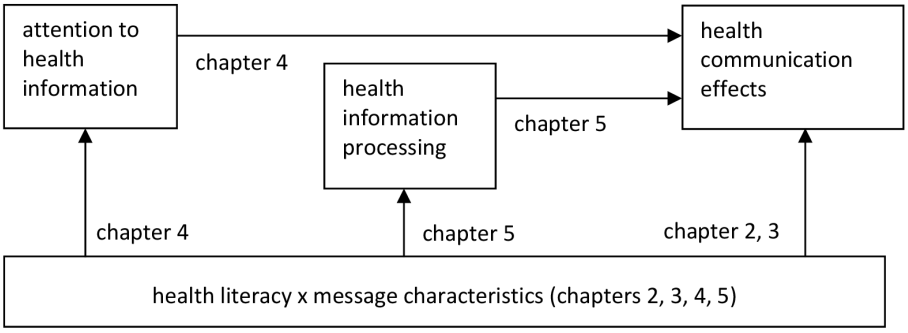

Figure 1.1 Outline of the dissertation.

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