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Optimizing online health information for older patients

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Chapter 8

Summary of findings and general discussion
The rapid growth of the Internet has made cancer-related information widely available and accessible. Many patients, including older patients (≥65 years), go online to search for cancer-related information (Huerta, Walker, Johnson, & Ford, 2016) to prepare for or complement information from medical consultations (Caiaia-Zufferey et al., 2010; Flynn et al., 2006; Medlock et al., 2015). Adequate information provision to cancer patients is essential for a number of different health-related outcomes, including patient empowerment, informed decision making, decreased anxiety, and better long-term quality of life (Elwyn et al., 2012; Faller et al., 2016; Gaston & Mitchell, 2005; Husson et al., 2010; Street Jr et al., 2010). Unfortunately, age-related factors may pose communication barriers for older cancer patients, making them at risk for poor communication with health care providers (Brown & Park, 2003; Cohen et al., 2017; Noordman et al., 2017; Williams et al., 2007). In general, older patients participate less actively in consultations (e.g., by asking questions; Goss et al., 2015), report more unfulfilled information needs (van Weert et al., 2013), and recall less information from medical consultations compared to younger patients (Jansen et al., 2008a). Supportive interventions to overcome these communication barriers are encouraged by both older patients and providers (Noordman et al., 2017). Given that online health information plays an important role in supporting patients to achieve their information goals (Friedman et al., 2011; Ryhänen et al., 2010), and older adults are increasingly making use of the Internet for health purposes (Pew Research Center, 2014; Statistics Netherlands, 2018), online health information may be especially relevant for older cancer patients.

This dissertation aimed to gain insight into how online health information can be optimized for older cancer patients by tailoring the mode of information presentation. In this dissertation, mode tailoring refers to the possibility for individuals to adapt the modality of information presentation on websites, using textual, visual, and/or audiovisual elements. The leading question in this dissertation was whether mode tailoring online health information is of added value for older patients (≥65 years), and whether effects of mode tailoring are different from younger patients (<65 years). The primary outcome was patients’ information processing, particularly focusing on knowledge acquisition and recall of online information and from medical consultations. Secondary outcomes included short-term (i.e., after viewing the website) and longer-term outcomes (i.e., during and after consultations), including evaluative (e.g., website satisfaction), psychological (e.g., anxiety), and communication (e.g., question-asking during consultation) outcomes. The studies in this dissertation addressed the following two research questions:
1. What are the theoretical mechanisms and effects of tailoring the mode of presentation (vs. no tailoring) on older (≥65 years) and younger adults’ (<65) website satisfaction and recall of online cancer-related information?

2. What are the effects of a mode-tailored preparatory website (vs. non-tailored websites) on older (≥65 years) and younger (<65 years) cancer patients’ evaluative (e.g., website satisfaction), cognitive (e.g., information recall), psychological (e.g., anxiety), and communication (e.g., question-asking during consultation) outcomes?

**SUMMARY OF FINDINGS**

**Chapter 2 and 3: Examining the effect of tailoring the mode of information presentation on website satisfaction and recall of online health information**

This dissertation started with two experimental studies \( (N = 559; N = 392) \) among the general population. These experiments aimed at investigating the theoretical mechanisms and effects of tailoring the mode of information presentation on older (≥65) and younger (25–64) adults’ evaluative (i.e., website satisfaction, website attitude) and cognitive outcomes (i.e., information recall). The first experiment, described in Chapter 2 and 3, tested the effectiveness of mode tailoring on website satisfaction, attention and recall in younger (25–45) and older (≥65) adults. The study encompassed an online scenario-based experiment, meaning that participants from an online research panel were instructed to view the website as if they were a patient. A website with cancer information was designed (based on an existing hospital website, see Chapter 5), enabling users to adjust the mode of information presentation via textual, visual and/or audiovisual information. This mode-tailored website was compared against four different non-tailored versions (e.g., with text-only, text with images, text with videos, or a combination of all modes). The results showed that mode tailoring was effective at increasing users’ satisfaction with the attractiveness and comprehensibility of the website (as compared to various versions of the non-tailored website), with no differences between age groups. Interestingly, the mode-tailored website increased attention in older adults only, and consequently, their information recall (as compared to the text-only and text with images website). In contrast, younger adults recalled more information from the text-only and text with images website compared to websites featuring all modalities (tailored and non-tailored). These effects could be explained by how younger and older adults used the mode-tailored website. First, older adults’ mode choices seemed to vary more than those of younger adults, as older adults were more likely to view the video mode. Second, older adults took slightly longer to make their first mode selection.
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and did not change their selection as much as younger adults after making a choice. This suggests that older adults made a considered mode selection, upon which they spent the remaining time viewing the website content rather than switching the different modes on and off. Younger adults were more likely to toggle between modes, which could have distracted them from the content, resulting in lower information recall than the non-tailored versions. In sum, Chapter 2 and 3 suggest that mode tailoring may be effective at establishing more positive website evaluations among both younger and older adults. Specifically for older adults, mode tailoring may increase their attention to the information, and consequently improve information recall.

Chapter 4: Unraveling the underlying mechanisms of mode tailoring effects on website attitude and recall of online health information

While the first experiment in Chapter 2 and 3 provided insight into the effects of mode tailoring on website satisfaction and information recall, the second experiment described in Chapter 4 focused on investigating what theoretical mechanisms could explain these effects of mode tailoring among a representative sample of the Dutch population (25–86 years). The elaboration likelihood model (ELM; Petty & Cacioppo, 1986) and limited capacity model for motivated mediated message processing (LC4MP; Lang, 2006) were used as a theoretical framework to understand how mode tailoring might contribute to the motivation and ability to process information, consequently affecting website evaluations and information recall. Based on existing mechanisms identified in the tailoring literature (e.g., perceived relevance, website engagement), and additional theoretical mechanisms that were deemed relevant for the mode-tailored approach (e.g., perceived active control, perceived cognitive load), a theoretical model explaining user-initiated mode tailoring effects was proposed. Again, the mode-tailored website enabled participants to self-select the mode of information presentation using textual, visual, and/or audiovisual information. The mode-tailored website was compared against one non-tailored version containing all modes, but then in a fixed standardized format. The study procedure was similar to that of the experiment in Chapter 2 and 3, including the scenario-based set-up. The results from a structural equation model showed that perceived active control functioned as a key driver in explaining mode tailoring effects. Mode tailoring triggered participants’ perceived active control, which in turn enhanced the perceived personal relevance of information, triggered greater website engagement, and decreased the perceived cognitive load while viewing the website. Interestingly, the data specified mechanisms (i.e., perceived personal relevance) responsible for enhancing website attitude, and other mechanisms (i.e., website engagement and perceived cognitive load) that explained improved information recall. These different pathways substantiate current theoretical and empirical research by providing a
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better understanding of why mode tailoring is effective (i.e., mechanisms of motivation vs. ability) and for which outcomes mode tailoring is valuable (i.e., website attitude vs. information recall). Together, Chapter 2, 3 and 4 suggest that mode tailoring can be a promising strategy to further maximize the effectiveness of online health communication efforts.

Chapter 5: Developing a mode-tailored preparatory website for newly diagnosed cancer patients

With the aim to replicate the findings in a sample of newly diagnosed cancer patients, the results from the experimental studies were translated to a clinical population. Chapter 5 described the development of the mode-tailored website (i.e., offering choices for text, visuals, and patient videos) containing information for patients to prepare for their first visit to a fast-track clinic for diagnosis and treatment planning. An existing hospital website was systematically redesigned in a co-design process with patients and professionals (i.e., researchers, clinicians, policymakers, website designers), to make it more user-friendly for older cancer patients (≥65 years). The redesign process consisted of three phases, where 1) both existing content and design were evaluated among older cancer patients; 2) a prototype website was developed based on these insights, which 3) was evaluated again before making final adjustments. Insights from existing literature, outcomes from qualitative and quantitative empirical studies conducted by our team (e.g., content analysis, usability studies), and expert knowledge from relevant stakeholders, were collected and discussed in multidisciplinary consensus meetings, and served as input for the redesigned website. The findings showed that the existing website was evaluated poorly by older patients and that information was difficult to find. The newly redesigned website, including the option to tailor the mode of information presentation, was evaluated as user-friendly for this target group. Overall, patients appreciated the option to choose their preferred information mode, as this allowed them to take in the information in a dosed manner. This chapter concludes with a roadmap on how to collaboratively redesign and optimize existing eHealth tools to make them suitable for and operational in clinical settings.

Chapter 6: Examining the relationship between anxiety and information recall in newly diagnosed cancer patients

Chapter 6 aimed at gaining insight into the level of and relation between anxiety and information recall from consultations in ‘standard care’ (i.e., without a website intervention). Since age differences (younger [<65] vs. older [≥65] patients) were a main research interest in this dissertation, this chapter also examined whether age moderated the anxiety-recall relationship. An observational field was conducted in which data were collected from 78 colorectal cancer patients visiting a one-
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day fast-track multidisciplinary outpatient clinic. All consultations that took place were recorded on video. The results showed that patients who visited the clinic for diagnosis and treatment planning recalled 60% of the information from medical consultations. Younger patients recalled on average 10% more information than older patients. Moreover, high anxiety levels after receiving a cancer diagnosis negatively influenced how much information patients remembered from consultations. Age did not influence the anxiety-recall relationship. This study was one of the first to examine the relation between anxiety and information recall in a clinical setting. The results suggest that interventions that are aimed at reducing patients’ anxiety as much as reasonably possible and support patients’ information recall are needed (e.g., preparatory information), at least in highly emotionally charged settings such as the cancer trajectory.

Chapter 7: Testing the effects of a preparatory mode-tailored website on cancer patients’ health-related outcomes in the context of a hospital visit

Finally, Chapter 7 describes a randomized controlled trial (RCT; \( N = 232 \)), which tests the effectiveness of the developed mode-tailored website intervention (vs. three non-tailored website versions) on younger (<65 years) and older (≥65 years) newly diagnosed cancer patients’ health-related outcomes before, during, and after consultation. These outcomes included cognitive (i.e., information recall), evaluative (i.e., website satisfaction), psychological (i.e., anxiety), and communication (i.e., question asking during consultation) outcomes. Patients received either a mode-tailored version of the website intervention (i.e., offering choices for text, visuals, and patient videos) or one of the three non-tailored versions (i.e., text-only, text with images, and text with videos) as a preparation tool before their hospital visit for diagnostic and treatment planning consultations. One day before their visit, participating patients were interviewed by telephone to assess their knowledge from the website. Patients filled out questionnaires before and after their visit assessing self-reported outcome measures. All their consultations that took place during their hospital visit were recorded on video for the purpose of this study. Within 36–48 hours after their visit, patients’ recall of information from the consultation and knowledge from the website were assessed by telephone. The results showed that the mode-tailored website did not outperform the non-tailored website in the abovementioned outcomes. However, when looking at age differences, it was found that younger patients who viewed a mode-tailored website prior to their visit were more satisfied with the website and were less anxious immediately after the consultation than those exposed to the website with text-only. Younger patients in the mode-tailored condition showed a significant reduction in anxiety from before the consultation to after the consultation, while this reduction was not found for patients in the non-tailored website versions. These effects were not found for older patients.
Furthermore, the website intervention was well used by patients ($M = 34$ min). Patients spent 10 to 17 minutes longer on the mode-tailored website than on the non-tailored websites, but this difference was marginally significant. Across all website conditions, patients who felt more involved with the website and were more satisfied with the comprehension of the website reported greater knowledge before consultation. Knowledge before consultation, together with time spent on the website in turn predicted knowledge after consultation and information recall from consultation. In sum, the results suggest that providing patients with preparatory online information had added value, independent of how the website was designed, since more time spent online and higher knowledge before consultation facilitates information processing and improves information recall from the website and consultations after their hospital visit. Moreover, offering this information in a mode-tailored format may increase website evaluations and help younger patients cope with their anxiety.

**GENERAL DISCUSSION**

**An integration of the main findings**

Overall, this dissertation has shown that mode tailoring can be an effective strategy to optimize online health information for patients. The results from the first three chapters indicate that tailoring the mode of information presentation (i.e., enabling individuals to select textual, visual, and/or audiovisual information) enhances website satisfaction and recall of online health information in non-clinical samples of younger (<65 years) and older adults (≥65 years). The effects of mode tailoring could be explained by underlying mechanisms of increased motivation (e.g., website engagement, perceived personal relevance) and ability (e.g., cognitive load) to process information, facilitated by perceived active control. An RCT among a clinical population of younger (<65 years) and older (≥65 years) cancer patients replicated relevant findings from these experimental studies. Specifically, in the RCT, younger patients reported higher satisfaction with the mode-tailored website (compared to a website with text-only). Furthermore, patients in the RCT who viewed the mode-tailored website, engaged slightly longer on the mode-tailored website than those viewing the non-tailored versions, irrespective of age. Qualitative data from the intervention development study also showed support for mode tailoring. Specifically, it was found that mode preferences varied across patients, and that tailoring the mode of information presentation could help patients to take in information in a dosed manner, thus supporting them in the ability to process information. Together, these results suggest that mode tailoring online health information can be of added value for both younger and older cancer patients. However, several noteworthy findings, as well
as inconsistencies between the results from the non-clinical and clinical setting, warrant further discussion. These implications will be discussed below.

**Comparing the experimental and clinical setting: The role of topic involvement**

The first point of discussion relates the different study settings examined and thereby the role of topic involvement, and the implications for the findings of this dissertation. Some inconsistencies in findings emerged among the different study settings. For example, in the non-clinical experimental studies, mode tailoring was found to increase website engagement (i.e., time spent on the website) and, consequently, information recall in older adults. In the RCT, both younger and older patients were slightly more engaged with the mode-tailored website (vs. non-tailored websites), but this did not increase knowledge before consultation. A plausible explanation for the inconsistent finding is the difference in topic involvement and thereby personal relevance of the information. The ELM suggests that information is more likely to be processed deeply when a person's interest for certain information is high, resulting in greater effects on outcomes (e.g. information recall, satisfaction; Petty & Cacioppo, 1986). Cancer patients were undoubtedly more likely to be involved in the topic (i.e., view the information as meaningful and important) than non-clinical participants in the scenario-based experiments, which is why patients perceived the information as personally relevant irrespective of which website version they received. This finding is in line with research showing that topic involvement is associated with higher perceived personal relevance of information, independent of whether this information is tailored or not (e.g., Lustria et al., 2016). Furthermore, the RCT website provided patients with information about a specific day (i.e., the fast-track procedure), in a specific disease context (i.e., colorectal, esophageal, and stomach cancers), at a specific moment in the cancer trajectory (i.e., diagnosis and treatment planning), making it even more relevant for patients. The fact that all website versions from the RCT were carefully redesigned in collaboration with patients and professionals might have increased the relevance of the website for patients even more. Taken together, this might explain why the RCT website was well used by patients, irrespective of which version they received, consequently revealing no differences in several patient outcomes. Overall, in clinical populations where information needs are high, such as with newly diagnosed cancer patients, the motivation to process information related to the disease is likely to be high as well. It could be that in clinical populations where the disease is less life-threatening and information needs and/or involvement are lower (e.g., chronic diseases like asthma, diabetes), mode tailoring plays a more distinct role in capturing patients’ attention for health information materials and enhancing recall of information. Whether mode tailoring yields greater effects on
different evaluative, cognitive, psychological, and behavioral outcomes in other disease contexts, warrants further research.

Comparing younger and older patients: From chronological age to age-related factors?

A second observation relates to discrepancies in age distributions within and between the conducted studies in this dissertation, and its implications for study outcomes. Two points regarding this matter will be discussed, followed by two implications for future research regarding online health information and aging. First, in the experimental setting, an added value of mode tailoring was found for older adults aged 65 years and older, when compared to younger adults from 25–45 years. Middle-aged adults (46–64) were not included in this study, since the goal was to investigate the added value of mode tailoring online health information for the older population, hence a significantly younger comparison group was included to emphasize the age differences. In the RCT, mode tailoring did not affect older patients (>65), but did show several beneficial effects for patients younger than 65 years. However, this ‘younger’ patient group was for the greater part not represented in the studies in the experimental setting. Moreover, since participants in the experimental setting were recruited via an online research panel, these older participants were likely to be healthier and have more Internet experience than clinical older patients in the RCT. It is possible that the older participants in the experimental studies were more similar to the younger patients in the RCT in terms of Internet experience, and other age-related background variables, explaining why mode tailoring benefited these groups. Second, in the RCT, most patients were aged in their sixties, which was close to the age cut-off of 65. An argument in favor of mode tailoring for older patients, is that they are more likely to be frail (e.g., face cognitive and sensory declines) that could influence their mode preferences and how they process information. However, in the RCT, older patients did not differ from younger patients on most age-related background variables, including frailty, which might explain why limited differences in mode tailoring effects were found between age groups. The similarity in younger and older patients’ background characteristics could be specific for the specialized outpatient clinic where this RCT was conducted. Many patients came in for a second (or even third) opinion, while vulnerable patients are generally more likely to stay in the first hospital, and thus were not reached by this study. Comparing the ‘older-old’ (>75 years), that are more likely to be frail, with younger patients who are likely to be less frail, could be more meaningful in the context of online health information.
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This brings us to the first implication for future research. Studies on aging and Internet use have shown that a ‘grey digital divide’ exists among older adults, where the young-old are more likely to use the Internet than the older-old (75–84 years) and oldest-old (≥85 years; Friemel, 2016; Hunsaker & Hargittai, 2018). Moreover, these age groups also show differences in other domains related to health and well-being, such as functional impairments (e.g., vision, hearing, mobility, strength; Smith, Borchelt, Maier, & Jopp, 2002), which possibly may influence their information needs and how they interact with (online) health information. While this dissertation looked at older patients ages 65 years and older, separating the young-old from the older-old and oldest-old, instead of handling a ‘one-cut-off-for-all’ could contribute to a richer picture of how online health information is used, processed, evaluated and consequently affects older patient populations. Second, although such age distributions matter, it can also be questioned whether a distinction based on chronological age is most meaningful. Studies show that age-related cognitive and sensory declines seem to start in early adulthood already (although more prevalent in older ages), with high variability between individuals (Humes, 2015; Salthouse, 2004). A recent study which examined older patients’ processing of online cancer-related information, showed that age-related factors such as patients’ frailty, health literacy, and future time perspective explained more variance in information recall than chronological age (Bol et al., 2018). Especially in life-threatening disease contexts such as cancer, future time perspective, might play an important role in how different modes of online health information are used, processed, and consequently affects health-related outcomes. Taken together, it might be more meaningful to study age-related factors as potential moderators of effects of online health communication interventions, rather than chronological age.

Does mode-tailored online health information benefit younger patients more than older patients?

A third observation relates to a particular unexpected finding from the RCT that warrants further discussion. In contrast to what was expected, mode tailoring benefited younger patients by enhancing website satisfaction and reducing anxiety, while this effect was not found for older patients. There are several explanations for this finding. First, from an uncertainty management theory perspective (Rains, 2014), literature on health information seeking and avoidance suggest that for most patients information plays an important role in reducing anxiety, but for a small select group it might do nothing or even increase anxiety (Miller, 2014; Pifalo, Hollander, Henderson, DeSalvo, & Gill, 1997). Generally speaking, younger adults are found to be less tolerant to uncertainty than older adults (Basevitz, Pushkar, Chaikelson, Conway, & Dalton, 2008), and perhaps more likely to seek information as a strategy to reduce this uncertainty (Carciooppolo, Yang, & Yang, 2016; Miller, 2014). It could
be that in the RCT study, younger patients were more intolerant to the uncertainty that came with a cancer diagnosis, and therefore exhausted all of their information sources (i.e., different information modes) to reduce this uncertainty, and thereby, their anxiety. Older adults, on the other hand, are generally better at tolerating uncertainty (Basevitz et al., 2008) and, therefore, possibly better able to manage anxiety, as well as less urged to reduce it by means of information. Information might even have reversed effects and increase anxiety in this group, especially among the ‘older- and oldest-old’ cancer patients (≥75 years), who more often prefer to leave information disclosure up to the health care provider (Jenkins et al., 2001; Thewes, Butow, Girgis, & Pendlebury, 2004). These age-related differences in uncertainty tolerance and information seeking/avoidance might explain why mode tailoring particularly benefited younger patients, while it had no effect on older patients’ health-related outcomes. In a similar way, socioemotional selectivity theory (SST) also presents an explanation for this finding (Carstensen & Mikels, 2005). SST posits that as people age, they perceive time as increasingly limited and therefore attach greater importance to emotionally meaningful goals (e.g., social connectedness) than to knowledge-related goals (e.g., to prepare for their future; Carstensen & Mikels, 2005; Löckenhoff & Carstensen, 2004). Since younger adults generally pertain more to knowledge-related goals as compared to older adults (Mather & Carstensen, 2005), online health information might have played a key role in helping younger patients to deal with their anxiety, and less so for older patients. In the context of this dissertation, it could be that being able to view information via different modes (i.e., text, images, video) in a tailored manner appealed more to younger patients, and was therefore successful in fulfilling their information needs, which consequently helped regulate their anxiety. While the effect on younger patients’ anxiety was small and could be incidental, the results are in line with previous studies showing that online patient education tools can reduce anxiety in cancer patients (Friedman et al., 2011). Future research is warranted to understand the role of uncertainty intolerance and information seeking/avoidance, as well as knowledge- versus emotional-related goals, in elucidating whether and how online tailored health information might accommodate to needs of and benefit health-related outcomes for older cancer patients, including the older-old (75–84 years) and oldest-old (≥85 years).

Reducing anxiety in cancer patients by means of online health information
A final observation worth considering is that the results of this dissertation imply that cancer patients’ anxiety might be reduced by providing online preparatory information. In the observational field study, where patients did not receive a website intervention prior to consultation, anxiety during consultation negatively predicted information recall from consultations. Interestingly, in the RCT, anxiety was not found to be a barrier for information recall anymore. A comparison between
the two samples reveals that patients in the RCT reported equally high anxiety levels as patients in the observational field study. This raises the question: could it be that offering patients preparatory online health information before their hospital visit helped them to attend to and process information from the consultation despite their anxiety levels? Previous studies have shown that highly anxious cancer patients have higher information needs (Davison & Breckon, 2012), and patients with fulfilled information needs report to be less anxious (Husson et al., 2010). These findings, together with the results from this dissertation, suggest that knowledge (i.e., by means of online health information) plays an important role in patients’ anxiety management overall. Presenting this information in a tailored manner may reduce anxiety even more for younger patients. However, to answer this question with more accuracy, future research is warranted to understand the added value of offering online preparatory information on patients’ fulfillment of information needs, knowledge/information recall, and the anxiety-recall relationship.

IMPLICATIONS FOR THEORY BUILDING

Over the past decades, acknowledged tailoring scholars have called for research exploring a wider range of tailoring strategies, using different formats, examining different types of outcomes, and teasing out the mechanisms that explain tailoring effects (e.g., Brug, Oenema, & Campbell, 2003; Jensen et al., 2012; Rimer & Kreuter, 2006; Smit et al., 2015). This dissertation answered to this call and contributes to the theoretical body of knowledge on tailored health communication as it investigated the effects of mode tailoring as a novel tailoring strategy, identified the theoretical message processes that explain these effects, and examined the conditions under which mode tailoring is effective. The implications of this dissertation for theory regarding tailored health communication, as well as cognitive learning theories, are discussed below.

Re-envisioning tailored health communication

First, this dissertation examined mode tailoring as a novel tailoring strategy to increase the effectiveness of online health information. The results of this dissertation suggest that tailored health communication interventions should not only consider what content is relevant for which individual, but should also take into account how this information can be presented to match individual preferences and abilities in the most optimal way. Especially in contexts where the aim is to convey information (e.g., patient education materials), mode tailoring can be a relevant strategy to achieve greater impact on relevant outcomes (e.g., satisfaction, information recall). Furthermore, this dissertation is one of the few to examine a user-initiated tailoring approach in the context of online health
communication. Specifically, individuals were able to self-select relevant information elements on a health website themselves, as opposed to the more traditional system-initiated approach where tailoring is done via an assessment of individual characteristics upon which a preprogrammed algorithm decides which information is deemed relevant for this person. The findings of this dissertation indicate that user-initiated tailoring can trigger important underlying mechanisms that explain effects on health-related outcomes (which are discussed in the next section). Given the opportunities of computerized online health information for collaborative tailoring of information in real-time by both the user and the system, health communication interventions can thus range from more system-initiated, algorithm-based tools to those that are more user-initiated, perhaps even allowing for combinations of such strategies. Together, this dissertation has made a first step in re-envisioning ‘tailored health communication’ by proposing a novel approach to, and extension of, traditional tailoring research in today’s digital information environment.

Towards a comprehensive overview of tailoring effects
Second, this dissertation examined the conditions under which mode tailoring is effective. In both non-clinical and clinical populations, this dissertation investigated whether mode tailoring had added value for older adults’ (≥65 years) health-related outcomes and whether this differed for younger adults (<65 years). Different tailoring strategies might be more relevant for certain target groups than others. Since effect sizes of tailored health communication interventions are typically small (Krebs et al., 2010; Lustria et al., 2013; Noar et al., 2007), a better understanding of which tailoring strategies work effectively for which target groups on which outcomes helps us in optimizing tailored communication efforts. The results from this dissertation can be used as input for systematic and meta-analytical reviews examining moderators of tailoring effects, working towards a comprehensive overview that informs us on what aspects of health information to tailor, whom to tailor information for, and for which outcomes which tailoring strategies are expected to be effective. An example of such a comprehensive theoretical framework in the context of media effects is the differential susceptibility to media effects model (DSMM), which explains why some individuals are more susceptible to mediated communication than others, how these individuals are influenced by mediated communication, and how the effects can be enhanced or reduced (Valkenburg & Peter, 2013). In the past, tailoring scholars have already initiated such overviews (e.g., Dijkstra, 2008; Hawkins et al., 2008), but these overviews are still limited and can be complemented with novel insights as tailoring research develops. The current dissertation adds to this body of knowledge by identifying for whom (i.e., younger vs. older patients) a specific tailoring strategy (i.e., mode tailoring) is effective, in a specific disease context (i.e., cancer). However, as novel tech-
nologies and possibilities continuously evolve the ‘art and science’ of tailored communications, future research should strive to continue explore the conditions (e.g., which target groups, disease contexts) under which different tailoring strategies are effective.

**Proposing a theoretical model of mode tailoring effects**

A third way in which this dissertation contributes to the tailoring literature is by identifying which theoretical mechanisms explain why mode tailoring is effective. Earlier studies on tailored health communication have mainly dealt with the question whether tailored health materials were more effective than non-tailored materials on the intended outcomes (Rimer & Kreuter, 2006). Explanatory theoretical mechanisms of tailoring effects, such as perceived personal relevance and attention to health materials, were certainly proposed by scholars (Kreuter & Wray, 2003; Ruiter et al., 2006). However, it has not been until more recently, that tailoring scholars have started to empirically test underlying mechanisms of tailoring effects using mediation and structural equation models (Dijkstra & Ballast, 2012; Jensen et al., 2012; Lustria et al., 2016). As there are still many mechanisms left to explore (Jensen et al., 2012; Lustria et al., 2016; Rimer & Kreuter, 2006), this dissertation contributed to testing the most important tailoring mechanisms identified in the literature (e.g., perceived relevance, website engagement) and proposed additional mechanisms that were deemed relevant for mode tailoring in particular (e.g., perceived active control, perceived cognitive load). Since this dissertation adopted a user-initiated approach to mode tailoring, perceived active control was examined as mediator of tailoring effects. Furthermore, previous research has suggested that tailored information can enhance processing by limiting the amount of information and thus avoiding information overload (e.g., Jensen et al., 2014b), but to our knowledge, no studies have explicitly examined this as a theoretical concept to better understand effects of tailored communication. By integrating perceived active control and perceived cognitive load as explanatory mechanisms of tailoring effects (Chapter 4), this dissertation proposed a theoretical model of user-initiated mode tailoring effects which complements and extends current theoretical models of tailored communication (e.g., Lustria et al., 2016) in a digital information environment. Knowing which factors explain the effectiveness of different types of tailored health communication, and thus which underlying ‘processes’ should be targeted, helps us unravel the active ingredients of tailoring and can inform intervention designers to develop more effective tailored health communication materials.

**Mode tailoring as an extension of cognitive learning theories**

Finally, the ELM (Petty & Cacioppo, 1986) and LC4MP (Lang, 2000) were useful theoretical frameworks in understanding how mode tailoring could enhance mechanisms of motivation (e.g., website
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engagement, perceived relevance) and ability (e.g., perceived cognitive load) to process information, consequently affecting outcomes. Beyond the ELM and LC4MP, the current dissertation also provides important insights for information processing models such as cognitive theory of multimedia learning (CTML). CTML has often been used as a framework to design multimodal information as well as to understand their effects on learning (i.e., information processing and recall; Mayer, 2002). CTML is based on dual coding theory (Paivio, 1971), which states that people learn via different processing systems, namely via verbal associations and visual imagery. Furthermore, CTML relies on cognitive load theory, which assumes that too much cognitive load inhibits learning because people have limited working memory capacity (Sweller, 1994). In a nutshell, CTML suggests that combining multiple modes (i.e., text with visuals, or visuals with narration) increases learning (as compared to unimodal information), because cognitive resources are spread over different processing systems, decreasing overall cognitive load and fostering deeper information processing (Mayer, 2002). The current dissertation complements and extends CTML in two ways. First, while there is much evidence supporting CTML, a recent review has identified a number of situations in which multimodal information can be inferior to unimodal information (Ayres, 2015). For example, variability in a person’s prior knowledge or working memory capacity can influence how information is being processed, and therefore the CTML’s notion that deeper learning is facilitated by multimodal information is not always guaranteed (Ayres, 2015). This suggests that multimodal information should not only be carefully designed, but also tailored to individual characteristics to achieve optimal information processing. This dissertation showed that mode tailoring can prevent cognitive information overload and benefit information recall, which corresponds to the CTML’s goal to facilitate learning. Second, in its essence, CTML focuses on enhancing individuals’ ability to process information (i.e., decrease cognitive load) by using multimodal information, while ignoring the role of motivation in understanding how information is processed. However, besides ability, motivation can play an important role in multimodal information processing as well (Bol, 2015). More recently, Mayer (2004) started considering how certain design features (e.g., affective visuals) can motivate and enhance information processing. The current dissertation can be relevant in shaping the CTML further, as it shows that mode tailoring not only facilitates the ability, but also the motivation to process information (e.g., via increased engagement), consequently improving learning outcomes (i.e., information recall). Taken together, limitations of CTML can be accounted for by considering variability in individual preferences, needs and/or abilities for the mode of information presentation (i.e., tailoring) in the design of information. As such, mode tailoring could be integrated into CTML as a design principle to optimize multimedia information and learning, especially in contexts where audiences are likely to vary in processing preferences and abilities (e.g.,
older adults). Moreover, future research could combine parts of the CTML with established theories applied in the tailoring literature, such as the ELM and LC4MP, to understand how tailoring the mode of information presentation facilitates information processing via increased motivation and ability.

**OTHER DIRECTIONS TO MOVE TAILORING RESEARCH FORWARD**

Two relevant topics for future research fall outside the scope of our research, but are important to our understanding of tailored health communication in a digital society. First, developing system-initiated tailored communication interventions can be a costly process (Lairson et al., 2004), especially when tailoring algorithms and intervention materials become more sophisticated (Lairson et al., 2008). One argument in favor of user-initiated tailoring is that it can relieve some of the costs, as part of the tailoring algorithms are replaced by users tailoring information themselves. A larger question that tailoring scholars have been working on pertains to whether tailored health communication interventions are also more cost-effective than non-tailored materials (Ishikawa et al., 2012; Lairson et al., 2008; Lennox et al., 2001; Smit, Evers, de Vries, & Hoving, 2013). Future research could look into user-initiated strategies of tailoring and examine whether these are indeed less costly in the development/maintenance phase, and whether they are able to yield similar effect sizes as those of traditional system-initiated tailored interventions. Furthermore, several scholars have started examining placebo-effects of health information materials that are ‘suggested’ to be tailored but are in fact merely targeted (i.e., using the participants name, other simple demographic information like gender and age, or simply by mentioning the materials are tailored for them; e.g., Webb Hooper, Rodríguez de Ybarra, & Baker, 2013; Webb, Simmons, & Brandon, 2005). In these studies, placebo tailoring has yielded positive outcomes on people’s appreciation of the information, as well as health-related outcomes such as self-efficacy, behavioral intention and actual health behavior, especially among individuals who tend to process information more heuristically (Webb Hooper et al., 2013; Webb et al., 2005). It may be worthwhile to compare such placebo-tailored materials to more sophisticated tailoring strategies (i.e., content tailoring, mode tailoring) in their effectiveness and cost-effectiveness.

A second area for future research is to identify the optimal ‘level’ of tailoring in terms of costs and benefits. If less cost-intensive tailoring strategies do not do the trick, and more sophisticated tailored health communication interventions are not considered to be more cost-effective than non-tailored materials, it might be worthwhile to look into to what extent health communication interventions should tailor their materials. Varying levels of tailoring can be integrated into health
communication interventions. For example, a recent meta-analysis examining the effects of ‘cultural tailoring’ in cancer communication (i.e., adapting content to match cultural characteristics of an ethnic group) showed that messages tailored more deeply (e.g., cultural norms, values, traditions) were more effective than superficially tailored messages (e.g., language, appearance, diet; Huang & Shen, 2016). Huang and Shen (2016) considered the level of cultural tailoring as a dichotomous variable (e.g., deep vs. surface tailoring), but the level of tailoring in general could be considered more as a continuum that stretches from more sophisticated, theoretically driven, multi-dimensional, algorithm-based tailoring to more simplistic, unidimensional, superficial tailoring, leaving more room for user-initiated design, with varying levels of tailoring in between. In sum, over the last decades, tailoring research has evolved much given the rapid developments in computer-based, networked technologies, opening up new opportunities to optimize tailored communication interventions. Still, there is much left to explore about the ‘art and science’ of tailored health communication. One of the questions is to unravel the most optimal combination of ‘active ingredients’ of tailored health communication, given a certain target audience, context, and outcome, to reach the most optimal effects against the lowest cost.

**IMPLICATIONS FOR CLINICAL PRACTICE**

The results of this dissertation have several practical implications for the development of online health information tools for older patients, which will be discussed below. First, the results suggest that offering online health information as a preparation tool before consultations has added value for cancer patients. The website intervention was well used by patients in the RCT, suggesting a need for preparatory information for their hospital visit. Moreover, patients’ recall of information after the consultation was explained by variables that all related to website experience outcomes, suggesting that information processing can be enhanced by offering high quality preparatory online health information. It should be noted that not all patients, especially older patients, prefer computer-based information sources (Burton et al., 2017). Even if this is expected to change in the future as younger generations grow older, there may still be patients who prefer other information sources (e.g., print brochures, books, face-to-face counselling) over online information. Many patients report that they do not know which online information to trust and worry about being exposed to irrelevant information (Lee, Hoti, Hughes, & Emmerton, 2014; Miller & Bell, 2012). There is, however, a difference in when patients seek for information on the Internet themselves, or when the health care provider recommends a hospital website designed for patients. In case of the latter, this can essentially be regarded as an online form of a traditional information brochure, but with
multimedia elements that may increase the effectiveness of information (e.g., interactive features, videos). Recommended hospital websites that come from a reliable source are more likely to be trusted by patients than websites they find during their own Google searches where they have to wade through a bulk of information (Dutta-Bergman, 2003; Sbaffi & Rowley, 2017). This also suggests that for online health information to be an effective patient education tool, the health care provider has an important role in directing patients to credible and trustworthy websites/online health information tools. Online health information can also be integrated in logistical procedures: appointment letters by regular mail could for example direct patients to such (hospital-affiliated) online patient education tools. Likewise, online patient portals could be linked to trustworthy websites that might be relevant for patients.

Second, the results of this dissertation suggest that integrating mode tailoring in online health information can have added value for patients in terms of enhancing website evaluations, increasing information recall, and decreasing anxiety. Mode tailoring may thus benefit outcomes that could play an important role in fulfilling patients’ information needs. A critical question that may arise is whether websites should not just include all information modes, without the option to tailor the information. Based on the results of this dissertation, this strategy is not recommended. A non-tailored website combining all modes (vs. a tailored website) was evaluated more poorly, might increase cognitive load while using the website, and could inhibit patients from taking in information in a dosed manner. Together with evidence from a previous usability study among older cancer patients, which found that putting too much information elements on a web page can be too overwhelming (Bolle et al., 2016), the results of this dissertation underline the importance of tailoring the mode of information presentation on health websites for patients.

Subsequently, a next question that arises pertains to how mode tailoring should be integrated into online health information. This dissertation found that the majority of participants selected text as their primary information mode. This makes sense, as this dissertation was conducted in the Netherlands, which is a Western, text-based society, and websites without text can therefore be difficult or strange to navigate. Considering that visual and audiovisual information were chosen to supplement the text, and there was considerable variance in whether these modes were used between and within younger groups and older groups, differences in information mode preferences, needs and abilities should be considered to ensure optimal information processing for everyone. A concrete practical recommendation for online patient education materials would be to offer textual information as the fixed, primary information mode. However, for older patients it remains
important to limit the amount of text on one web page, which can be done by providing the option to consult more information in so-called ‘pull-down’ menus (Bolle et al., 2016). This way, patients can tailor the amount of textual information themselves and take in the information in a dosed manner. Additional visual and audiovisual modes (e.g., images, illustrations, photos and videos) can be offered in a tailored manner, allowing patients to select these modes themselves if needed. This way, the information on a web page is limited as much as possible, with options to consult additional content or different information modes. These recommendations are relatively easy to implement and might make a real difference for patients consulting online health information.

STRENGTHS, LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

The findings in this dissertation should be considered in light of several strengths and limitations. One of its strengths is that this dissertation extensively studied the added value of mode tailoring online health information for newly diagnosed patients at the start of their cancer trajectory. While challenging, the inclusion of a large number of patients during one of the most stressful moments in their lives (i.e., cancer diagnosis and treatment planning), is highly unique. Another strength is that in all studies involving a website, website use data was logged and coupled with self-report measures. This allowed for a deeper understanding of how the websites were used, and helped explain how the effects played out on outcome variables. Especially in the RCT, the website log data was valuable, as it gave insight in how patients used online health information prior to their consultation (i.e., their natural behavior). However, the findings of this dissertation are limited to online health information in the cancer context. Whether the website use patterns, mechanisms, and effects are similar or different in other disease contexts (e.g., less life-threatening chronic diseases, such as asthma, diabetes, and so forth) should be investigated in future research to ensure the generalizability of results.

Exploring the relative effectiveness of mode tailoring versus other tailoring strategies

One of the goals of this dissertation was to explore mode tailoring as a novel strategy to maximize the effectiveness of online tailored health communication efforts. By employing both experimental study designs, as well as an RCT in a clinical population of cancer patients, this dissertation was able to study the effects and theoretical mechanisms of mode tailoring both in isolation and in a real-life setting. However, in doing so, this dissertation was not able to compare mode tailoring with other previously examined tailoring strategies, such as content tailoring, and thus no conclusions
Summary and general discussion

about the *relative* effectiveness of these tailoring strategies can be drawn. Future research could employ study designs that compare content tailoring and mode tailoring to gain insight into the relative effect sizes of content tailoring and mode tailoring, as well as whether they induce similar or different mechanisms (i.e., motivation, ability), and impact similar or different outcomes (e.g., evaluative, psychological, cognitive, behavioral). Moreover, mode tailoring can also be combined with content tailoring to maximize effects of tailored communication materials. This dissertation showed that mode tailoring online health information may improve website evaluations, information processing and recall, and even psychological patient outcomes such as anxiety, but the effects remained small. Future studies in the tailoring domain could examine whether combining mode tailoring with content tailoring leads to synergistic effects that exceed the impact of each tailoring strategy separately. Such studies are valuable, as it is important to know how tailored health communication interventions can yield greater effects on health-related outcomes than have been found to date.

**Unravelling the theoretical mechanisms of ‘user-initiated’ and ‘mode’ tailoring**

This dissertation was one of the first to investigate a user-initiated approach to tailored communication in a health context. While it shows that *user-initiated mode tailoring* can have added value for online tailored health communication, the question remains whether mode tailoring from a *system-initiated* perspective would have yielded similar effects. Relatedly, this dissertation showed that user-initiated mode tailoring enhanced perceptions of active control over the website, which in turn triggered relevant mechanisms that explained mode tailoring effects on website evaluations and information recall. The studies in this dissertation, however, did not compare the mode-tailored website to a website version where participants had control over the content or other non-information elements of the website (e.g., background color, font types). Thus, a question that remains is whether tailoring the *mode of information presentation* or having *active control* over the information mode triggered the effects. It seems plausible that theoretical mechanisms such as perceived personal relevance and reduced cognitive load are more likely to be experienced – through perceived active control – when information elements are tailored (e.g., content, presentation mode) and not when design elements (e.g., background color, font type) can be adjusted. Still, replication of these findings is needed to ensure generalizability of the results. Future research could contribute to our understanding of both mode tailoring and user-initiated tailoring by teasing out the specific effects of each element.
Exploring possibilities for system-initiated mode tailoring

In mode tailoring research to date, the few studies that have examined a system-initiated perspective found positive effects on cancer screening intentions of adapting information to visual preference (i.e., charts/graphs vs. illustrated visuals; text vs. text with images vs. video; Jensen et al., 2012; Linn et al., 2015). In other studies, the benefits of system-initiated mode tailoring were less convincing (i.e., print brochures vs. phone; text vs. video vs. both; Lewis et al., 2006; Spittaels et al., 2006). These studies have in common that they asked participants simple questions about how they would like to receive the information (e.g., text vs. video) beforehand, but it might have been difficult for participants to make a choice that would work best for them without having seen the information first. For this reason, this dissertation adopted a user-initiated tailoring approach, where participants could self-select and toggle between modes while viewing the information. However, this raises several questions for future mode tailoring research to delve into deeper. For example, are there better ways to assess people’s modality preferences, abilities, and/or needs, which can be used as input for assessment-based system-driven tailoring of information? Mayer and Massa (2003) have for example distinguished three facets of the verbal/visual learning dimension, encompassing cognitive ability (i.e., high vs. low spatial ability), cognitive style (i.e., thinking with words or pictures), and learning preference (i.e., preferring textual or visual information). These different components of the verbal/visual learning dimension could explain how people process information, and could be used as variables to tailor information presentation modes to match the characteristics of unique individuals with more precision. Furthermore, measures of visual/auditory functioning may also be useful indicators in deciding which information modalities work best for people (e.g., Gatehouse & Noble, 2004; Steinberg et al., 1994). Since information mode preferences may not only vary between individuals, but also within individuals across different contexts (e.g., types of information, information goals) and over time, it could be the case that there are no measures (yet) that adequately predict through which mode information can be optimally presented to an individual. If people’s preferences, abilities, and/or needs for information modes can be adequately captured, studies comparing the effectiveness of system-initiated and user-initiated mode tailoring could shed new light on how mode tailoring can best be operationalized in different contexts. Such insights are valuable for scholars and intervention designers in optimizing tailored health communication interventions.
FINAL CONCLUSION

In light of the rapid growth of health information on the Internet, it is of vital importance to look at tailored online health communication from new perspectives. This dissertation aimed at investigating *mode tailoring* as a novel tailoring strategy to optimize online health information for older cancer patients. In doing so, this dissertation shifted from a more traditional system-initiated tailoring approach to a user-initiated strategy, where patients were able to self-tailor modalities of information presentation to their preferences, abilities, and needs (i.e., using textual, visual, and/or audiovisual information). The central question in this dissertation was whether mode tailoring online health information had added value for older patients (≥65 years), and whether effects of mode tailoring were different from younger patients (<65 years). First, this dissertation showed that the use of online health information (both tailored and non-tailored) as a preparation tool for hospital visits benefited health-related outcomes in both older (≥65 years) and younger (<65 years) cancer patients. Second, presenting this information in a tailored manner facilitated the motivation (i.e., via increased perceived active control, website engagement, and perceived personal relevance) and ability (i.e., via reduced cognitive load) to process online health information. Via these pathways of enhanced motivation and ability, mode tailoring had added value for health-related outcomes such as higher satisfaction with information, better recall of medical information, and improved emotion regulation. In the non-clinical setting, mode tailoring showed promising results for older adults. Conversely, in the clinical sample, the benefits of mode tailoring were more promising for younger patients than for older patients, but there were no detrimental effects of mode tailoring for older patients. Qualitative insights from older patients revealed that older patients did value the option to receive information via different modes in a tailored manner. Together, this dissertation has demonstrated that mode tailoring is a promising strategy to optimize the effectiveness of online health information for cancer patients. The results of this dissertation are relevant for communication scholars and intervention designers in developing more effective tailored online health information materials. Moreover, this dissertation advances our theoretical understanding of tailored health communication by confirming and extending current theoretical models of tailored communication, investigating different conditions under which mode tailoring is effective, and making a first step towards re-envisioning tailored health communication in a digital information era.