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Tailoring the Mode of Information Presentation: Effects on Younger and Older Adults' Attention and Recall of Online Information

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Previous studies have mainly focused on tailoring message content to match individual characteristics and preferences. This study investigates the effect of a website tailored to individual preferences for the mode of information presentation, compared to 4 nontailored websites on younger and older adults' attention and recall of information, employing a 5 (condition: tailored vs. text, text with illustrations, audiovisual, combination) × 2 (age: younger [25–45] vs. older [≥65] adults) design (N = 559). The mode-tailored condition (relative to nontailored conditions) improved attention to the website and, consequently, recall in older adults, but not in younger adults. Younger adults recalled more from nontailored information such as text only or text with illustrations, relative to tailored information.

Until now, online tailoring studies have mainly focused on adjusting the content of a message to match recipients' individual characteristics (e.g., demographics) and preferences (e.g., relevant topics). Tailoring, or providing information that is relevant to one unique person and their situation, is proposed to be more effective than generic and static information (Rimer & Kreuter, 2006). Although content tailoring (Rimer & Kreuter, 2006) has led to positive results, for example, in the health domain, the effect sizes have been small (Noar, Benac, & Harris, 2007). Therefore, novel tailoring strategies are strongly encouraged as a way to increase message effectiveness (Smit, Linn, & Van Weert, 2015).

One way to move beyond content tailoring is to tailor online information to individual preferences for the modality (i.e., mode) of information presentation (Smit et al., 2015). In this study, we refer to "mode tailoring" as adjusting information to match individual preferences for presentation modality, using verbal (text), visual (static illustrations), and/or audiovisual (videos) information (Mayer, 2001). Mode tailoring is important, as the way in which message content is processed and remembered very much depends on how this information is being delivered (Kreuter, Oswald, Bull, & Clark, 2000; Ritterband, Thorndike, Cox, Kovatchev, & Gonder-Frederick, 2009). The ability to correctly remember and reproduce information is often referred to as recall of information (Jansen et al., 2008; Lang, 2000). Subsequently, this study empirically tests the effect of exposure to a website that can be tailored to individual preferences for the mode of information presentation on attention and recall of information.

Mode tailoring may be especially relevant for target groups that may have difficulties processing and remembering online information, such as older adults. Older adults represent the most rapidly growing population group worldwide (World Health Organization, 2014), and are increasingly using the Internet in both Europe and the United States of America (Pew Research Center, 2014; Statistics Netherlands, 2011, 2013). There are several reasons why older adults are more likely to vary in their mode preferences for online information, and consequently more likely to benefit from mode-tailored information, as compared to younger adults. First, older adults often cope with age-related sensory impairments that might affect their mode preferences (e.g., loss of vision and hearing) (Kiessling et al., 2003; Ogozalek, 1994). Second, although cognitive declines seem to begin in early adulthood, the negative consequences of reduced processing performance are more likely to appear at older age (Salthouse, 2004). As cognitive decline might also influence information modality preferences in older adults (Wright et al., 2008), mode tailoring is expected to be particularly important for this target group. Relatedly, there is substantial variability in processing performance among older adults. Gerontology research has shown that variability in different domains such as cognitive functioning increases with age (Nelson & Dannefer, 1992). Given that older adults are a highly heterogeneous group, mode-tailored information might be particularly relevant for this age group as it adapts to individual mode preferences and abilities regarding information processing.

The aim of this experimental study is to gain insight into the effect of mode tailoring and its underlying mechanism, and whether this relation differs for younger and older adults. To this end, we will test the effect of a mode-tailored website versus four nontailored websites in a fixed format on attention to the website and recall of information among younger (25–45 years) and older (≥65 years) adults. As studies on the effects of mode tailoring online information are scarce, this study contributes to the existing tailoring literature. Furthermore, the results of this study can be used to guide designers and practitioners when developing appropriate websites for younger and older adults.

Theories of cognitive learning: unimodal or multimodal information?

Cognitive theory of multimedia learning (CTML; Mayer, 2001) suggests that individuals learn better from multimodal information (e.g., text accompanied with illustrations or audiovisual information) as compared to single-mode information (e.g., text or illustrations alone). CTML is based on dual coding theory (Paivio, 1971), which states that individuals learn via two different processing systems, namely via verbal associations and visual imagery. Multimodal information is expected to be especially relevant for older adults, as they have a reduced working memory capacity, which can be expanded by using multimodal information (Paas, Van Gerven, & Tabbers, 2005).

However, research investigating the effects of multimodal information yielded mixed results among both younger and older adults with respect to recall of information. Several studies have shown that combining text with visuals improved recall of information (e.g., Morrow, Hier, Menard, & Leirer, 1998), while other studies only found positive effects for younger but not for older adults (e.g., Morrell, Park, & Poon, 1990), or no effects for both younger and older adults at all (e.g., Bol et al., 2014). With respect to audiovisual information, several studies have shown that videos improved recall of information in both younger and older adults as compared to text (e.g., Bol, Van Weert, De Haes, Loos, & Smets, 2015), while other studies have not found any difference between text and video (e.g., Corston & Colman, 1997). These discrepancies may be the result of differences in individual mode preferences, and thus call for a more tailored approach when presenting information.

Tailoring the mode of information presentation

Preferences for the mode of information presentation might vary across individuals. For example, previous research has shown a distinction between people who prefer to read online information, and more audiovisual-oriented people who prefer watching videos (Heo & Cho, 2009). In addition, people may differ in their learning preferences for new information, ranging from watching and listening, to doing and thinking (Karakaya, Ainscough, & Chopoorian, 2001; Truluck & Courtenay, 1999). Hence, tailoring the mode of information presentation to individual preferences is proposed to enhance information processing and thus benefit recall of online information, as compared to fixed, nontailored information (Smit et al., 2015).

With regard to effect studies of mode tailoring, four studies that we know of have focused on tailoring to individual preferences for the presentation of online and offline information. The first study found that participants provided with their visual preference (for graphs or illustrations) had greater intentions for breast cancer screening (Jensen, King, Carcioppolo, & Davis, 2012). The second study found that at forehand offering choices between text, text with illustrations, and video had no effect on recall of breast self-examination instructions, but increased self-examination intentions (Linn, Alblas, van Weert, & Bol, 2015). The third and fourth study found no effects on physical activity behaviors when matching and mismatching participants

to their information mode preference (Lewis, Napolitano, Whiteley, & Marcus, 2006; Vandelanotte, Duncan, Plotnikoff, & Mummery, 2012).

These four studies have in common that participants were already asked to indicate their mode preference before they saw what the information materials or website looked like. Moreover, there was no option to switch between different modes once participants had chosen or had been assigned to a mode of information presentation. However, only after choosing or being assigned to a mode, and seeing the information in a particular mode, might one actually determine whether this is the preferred mode for receiving the information. Hence, it is not unlikely that participants may have chosen a mode of information presentation beforehand, which eventually turned out not to fit their preferences. Furthermore, participants may have a preference for multiple modes, but this option was not provided in the previous studies. As participants had no option to go back and choose a different or additional mode of presentation, this may have hindered information processing.

This study acknowledges that people may have a preference for one or multiple modes, and that mode preferences may change while viewing the information materials. Therefore, this study investigates the effects of a mode-tailored website where users can choose and switch to a different mode, or use multiple modes, at any time, on recall of information. The mode-tailored website is proposed to increase the likelihood that an individual will be exposed to the mode of presentation that facilitates optimal processing and learning, as the website is adjustable at any time while viewing. For this reason, we expect:

> H1: Exposure to a mode-tailored website (vs. nontailored websites) has a positive effect on recall of information for both younger and older adults.

The limited capacity model of motivated mediated message processing suggests that adequate message processing is dependent on an individual's motivation and ability to process information (Lang, 2000). First, a recipient may be less motivated and therefore choose to use fewer cognitive resources to process a message. Second, a recipient may not be able to optimally process a message, for example, when processing requires more resources than the recipient has available. Mode tailoring online information caters to both older adults' motivation (via adaptability to mode preferences) and ability (via adaptability to age-related limitations), both being important conditions that should be met for optimal message processing and recall of information.

Previous studies have shown that age-related cognitive and sensory impairments may affect individual preferences for information presentation, and have pointed out the heterogeneity in mode preferences among older adults. In a study in which different special target groups of people, including older adults with sensory impairments, could choose between different modes (i.e., combinations of text, audio, and/or video when receiving instructional information), there was no consensus in choices for modality within the older adult group (Soroka et al., 2006). For example, it has been shown that older adults with reduced working memory are more likely to

prefer spoken information to written information (Wright et al., 2008). Furthermore, a different study showed that older adults with visual impairments prefer to receive audiovisual information over text only (Ogozalek, 1994). Because tailoring the mode of information presentation can adapt to individual abilities and overcome these age-related limitations, making it particularly relevant for older adults, we expect that:

> H2: The positive effect of a mode-tailored website (vs. nontailored websites) on recall of information is relatively stronger for older adults than for younger adults.

The role of increased attention

Attention is an important prerequisite for recall of information (Lang, 2000). Obviously, information that is not attended to cannot be memorized. It is therefore considered important that viewers of websites attend to the website as long as possible, or at least for a substantial amount of time (Walter, 2007). This concept of "website stickiness" refers to the ability of a website to attract and hold visitors' attention (Koiso-Kanttila, 2005). Because research on mode tailoring and attention is largely missing, we draw upon traditional (content) tailoring literature (e.g., Hawkins, Kreuter, Resnicow, Fishbein, & Dijkstra, 2008). Most tailoring efforts aim to increase attention to the message, which in turn increases recall of information (Hawkins et al., 2008). For this reason, we may expect the same process when tailoring the mode of information presentation.

Several studies focusing on content tailoring have shown that tailored information indeed receives more attention and is more likely to be remembered than nontailored information (e.g., Ruiter, Kessels, Jansma, & Brug, 2006). More related to mode tailoring, one study implementing an online intervention tailoring both content and website design (i.e., font, colors) found that the tailored website received more attention than the nontailored website (Bernhardt, 2001). Hence, mode-tailored information is proposed to be more effective than nontailored information, because people are more likely to attend to information that is adapted to their preferences (Smit et al., 2015). For this reason, we expect that:

> H3: Exposure to a mode-tailored website (vs. nontailored websites) has a positive effect on attention to the website, for both younger and older adults.

Given evidence that declines in working memory capacity and processing speed increase with age, older adults are more likely to have difficulties with information processing than younger adults (Brown & Park, 2003; Salthouse, 2004). Research on website usage showed that older adults generally take more time to process the same amount of online information as compared to younger adults (Romano Bergstrom, Olmsted-Hawala, & Jans, 2013). However, previous studies have shown that when information is adequately attended to and processed, older adults, although they need more time to process the message, were able to recall equal amounts of information as younger adults do (e.g., Morrow et al., 1998; Van Weert et al., 2011; Bol et al., 2016). Moreover, the Bol et al. (2016) found a positive relationship between attention and

recall of information among older adults, while younger adults seem to adequately recall information regardless of the amount of attention. Therefore, this study proposes that the potential of mode tailoring to increase attention to online information by prolonging website visits, and consequently enhancing recall of information, may be especially relevant for older adults. Therefore, we expect that:

> H4: The relationship between exposure to a mode-tailored website (vs. nontailored websites) and recall of information is mediated by attention to the website for older adults, but not for younger adults.

Method

Design and materials

A 5 (condition: mode-tailored vs. text-only, text supported by illustrations, audiovisual, or a combination of modes) ×2 (age: younger [25–45] vs. older [≥65] adults) randomized between-subjects design was applied to examine the effect of mode tailoring on recall of information. The purpose of having these different age groups was to clearly distinguish younger from older adults. Ethical approval was given by the Institutional Review Board of the Amsterdam School of Communication Research.

The study websites contained health information, and were based on an existing webpage of a multidisciplinary outpatient clinic in the Netherlands (from now on referred to as "the clinic"). The clinic is a highly specialized center that provides fast diagnostics in complex cases of colorectal cancer within 1 day. Five different versions of the website were developed for this study, all containing the same information. The website content included general information about the clinic (e.g., how they work, what fast diagnostics entails, within what time period treatment starts) as well as specific topics of discussion patients should prepare for when dealing with colorectal cancer diagnosis (e.g., thinking about the course of physical symptoms such as stool and weight loss, genetics, medical history, current medicine use). We used a patient testimonial to communicate the information. Patient testimonials have been shown to be more effective in terms of recall of information than information given by a doctor (Bol et al., 2015). To control for gender effects, we developed a version with a male and a version with a female patient for each condition, to whom participants were randomly exposed (see Appendix for a pretest on how the actors were selected).

The text-only website contained a written version of the patient testimonial. The text with illustrations version contained the same written text, but was supported with illustrations. The audiovisual version contained a video with the patient testimonial, of which the spoken narration was exactly the same as the written text. The combination version contained all modes, namely written text, illustrations, and video. Finally, we based the mode-tailored website on a design by Soroka et al. (2006). We used a horizontal built-in navigation bar where participants could turn each mode of information presentation (text, illustrations, and/or video) on and off at any time

while viewing the website (see Figure 1 for the mode-tailored website and nontailored website with text and illustrations).

Because the clinic is a highly specialized center for diagnostics, and most people have no prior experience with colorectal cancer, we expected most participants to have no prior knowledge about the information that was on the website. This improved the validity of the measurement instrument for recall of information.

Participants and procedure

Data for the experiment were collected through an online panel of the ISO-certified research company Panelclix. Participants received a financial reward from the research company. A stratified sample was created in which gender, age groups (younger vs. older), and high and low levels of education were equally represented (for a similar stratification procedure, see Meppelink, Van Weert, Haven, & Smit, 2015). The younger age group consisted of participants aged between 25 and 45 years (stratified to 25–34 and 35–45 years), whereas the older age group consisted of participants aged 65 years and older (stratified to 65–74 and ≥75 years). This was done to ensure that all ages were equally represented in the younger and older adult group. Middle-aged participants (46–64 years) were screened out, in order to create two clearly distinguished age groups. Previous literature has described this group as 40–60 years old (e.g., Rose, Radziewicz, Bowman, & O'Toole, 2008). However, in order to have a comparable age range as with the older adult group, we made a slight variation in the proposed cut-off point for younger participants. Furthermore, middle-educated people were screened out to create a diverse sample, with lower and higher educated participants. Low education level included those who had no education, and those who finished primary education, lower vocational education, preparatory secondary vocational education, and intermediate secondary vocational education. High education level was specified by having a higher vocational education or university degree.

Participants were instructed to imagine that they had a possible diagnosis of colorectal cancer and that they would have to visit the clinic. The online questionnaire consisted of questions on background information, outcome, and mediating variables. After giving informed consent, the participants' gender, age, and level of education were recorded for stratification purposes. Based on age and level of education, participants were either screened out or left to continue with the questionnaire. Participants were randomized to one of the five conditions. In the mode-tailored condition, participants landed on a website where all the modes were turned off; they only saw the introductory text about the clinic. This was done to make sure that they had to make a selection of their preferred mode(s). All participants were told that they could take as long as they wanted to view the website, and that they would receive questions about the website content afterwards. Recall of information was measured immediately after exposure to the website. Finally, prior experience with cancer and the clinic were assessed.

Figure 1 Mode-tailored website with male patient (all modes turned on), and nontailored website with text and illustrations with female patient.

Inclusion criteria were: (a) participants in the mode-tailored condition had to select at least one mode of information (i.e., text, illustrations, or video) ($n_{\text{excluded}} = 36$); and (b) participants had to be exposed to the website for at least 30 seconds, which was the minimum time needed to view or read the information ($n_{\text{excluded}} = 200$). Participants were excluded if they (a) ignored the instructions by using a smartphone for filling out the survey and viewing the website ($n = 13$); (b) provided invalid data for stratification (e.g., zip code instead of age) ($n = 9$); (c) viewed the website longer than 45 minutes, interfering with our measurement of attention ($n = 3$); (d) provided uninterpretable answers for the open recall questions ($n = 3$); (e) indicated having technical problems with the survey or website ($n = 3$); or (f) received treatment at the clinic, because their prior experience might influence our main outcome measure recall of information ($n = 5$).

Sample characteristics
In total, 794 respondents completed the questionnaire. Of these, 70.4% ($N = 559$) fulfilled the inclusion criteria. Participants could meet more than one exclusion criterion, therefore the numbers do not add up to the total N excluded from analysis. The final sample consisted of 262 younger adults ($M_{\text{age}} = 35.39$, $SD_{\text{age}} = 6.41$, range 25–45, 47% male) and 297 older adults ($M_{\text{age}} = 72.63$, $SD_{\text{age}} = 5.67$, range 65–88, 51% male), with 102 participants in the mode-tailored condition, 99 in the text, 115 in the text with illustrations, 126 in the audiovisual, and 117 in the combination condition. Participants who did not fulfill the inclusion criteria were mostly younger adults, $\chi^2 = 47.78$, $p < .001$, but they did not differ from the included participants on gender, $\chi^2 = 1.44$, $p = .230$, and level of education, $\chi^2 = 0.28$, $p < .594$. A post hoc power analysis showed that the final sample size was adequate to detect small to medium main and interaction effects (statistical power level $= 0.80$, effect size $f = .15$) with an alpha level of .05, as we needed at least 536 participants (Cohen, 1988).

Measures
Recall of information
Recall of information was measured with an adapted version of the Netherlands Patient Information Recall Questionnaire (Jansen et al., 2008). Seven open questions were created based on the website content, such as "what does fast diagnostics entail?" Participants were asked to answer the open questions following the option "this information is given, namely …" Participants also had the option to select an alternative answer options when they did not know the answer, being "this information is not given" or "this information is given, but I cannot remember it anymore." A codebook was developed beforehand to calculate the recall scores for each answer. There were five questions where participants could score two points for each question; there was one question where they could score three points, and one question where they could score five points. Each correct element of an answer was worth 1 point, which resulted in a sum score ranging from 0 to 18 points. The final recall score was calculated by taking the percentage correctly recalled.

One researcher coded all answers and a second researcher double coded 26% of the recall answers ($n = 143$). There intercoder reliability was good (mean k = .874, $p < .001$).

Attention to the website

Attention to the website was conceptualized as website stickiness, and measured by the duration of the website visit in seconds (Bhat, Bevans, & Sengupta, 2002; Koiso-Kanttila, 2005).

Background information

Background variables included age, gender, level of education, frequency of Internet use in hours per week, being diagnosed with cancer, and having a close acquaintance diagnosed with cancer.

Statistical analyses

Chi-square tests were conducted to check for unequal distribution of background variables over the experimental conditions. Additional independent samples *t* tests were conducted to check whether background variables were related to our outcome variables. For testing the main effect of condition (H1, H3) and interaction effect of condition and age group (H2) on attention and recall of information, an analysis of variance (ANOVA) was conducted with recall of information as dependent variable, condition and age group as factors. Post hoc analyses with a Bonferroni correction were carried out when there was a significant difference. Additional simple effects analyses were conducted to look at the difference between conditions within the younger and older adult group, and between age groups within the conditions, on attention and recall of information.

For testing the mediation effects (H4), we used Hayes (2012) PROCESS macro in SPSS, which can test direct and indirect effects (Model 4). We used 5,000 bootstrap samples to estimate the bias-corrected bootstrap confidence intervals (BCBCI) with a 95% confidence interval (CI). Four dummy variables were created for each nontailored condition, using the mode-tailored condition as the reference group (nontailored condition = 1, mode-tailored condition = 0). As a result, PROCESS provides us with the effects and effect sizes of each nontailored condition, as compared to the mode-tailored condition. In the tested mediation model, one nontailored condition functioned as the independent variable, recall of information as the dependent variable, and attention as the mediator. The other three nontailored conditions were included in the model as covariates. As the mediator and dependent variable were measured on different scales, we standardized these scales using z scores ($M = 0$, $SD = 1$) in order to make them comparable. To test the differences between the mode-tailored condition and the other nontailored conditions, the analyses were repeated four times with each time another nontailored condition as the independent variable and the other conditions as covariates. The mediation analyses were conducted separately for younger and older adults.

Results

Randomization

The five conditions did not differ regarding age group, χ^2 (4, $N = 559$) = 2.22, $p = .696$; gender, χ^2 (4, $N = 559$) = 0.98, $p = .914$; level of education, χ^2 (4, $N = 559$) = 3.13, $p = .537$; being diagnosed with cancer, χ^2 (4, $N = 559$) = 3.80, $p = .434$; having a close acquaintance diagnosed with cancer, χ^2 (4, $N = 559$) = 5.30, $p = .258$; and frequency of Internet use, $F(4, 554) = 1.77$, $p = .134$, $\eta_p^2 = .01$. An additional analysis showed that older adults used the Internet as often as younger adults, $t(516,90) = 1.57$, $p = .116$. As the randomization of participants was successful, it was not necessary to include any background variables as covariates in the analyses.

Younger and older adults' website use characteristics

Participants performed 4.16 mode actions ($SD = 2.85$, range 1 – 19) on average, which refers to the number of clicks to (de)select the text, illustrations, or video mode. Younger adults used the mode tailoring function on the website more frequently ($M = 4.93$, $SD = 3.54$) than older adults ($M = 3.54$, $SD = 1.97$), $t(62.16) = 2.31$, $p = .024$. However, older adults generally took longer to choose their first modality than younger adults. Specifically, 53.5% of younger adults made their first mode selection within 30 seconds, against only 35.2% of older adults. Table 1 shows the website use characteristics of 97 participants in the mode-tailored condition.

The large majority of participants (91.7%) selected multimodal information, as opposed to unimodal information. Regarding specific mode choices, most participants (68.0%) first turned on text when they arrived at the website. When looking at the illustrations and video modes, we noticed that older adults were more likely to choose these as a first mode (respectively 27.8 and 11.1%), as compared to younger adults (respectively 16.3 and 7.0%). Most participants (73.2%) eventually turned on all three modes while viewing the website. Of the 75 participants who selected the video mode, only 42 participants (56.0%) actually started playing the video, while only 25 participants (33.3%) finished watching the video. Although not significant, it seems as if older adults (42.9%) were more likely to finish watching the video than younger adults (21.2%), χ^2 (1, $N = 97$) = 3.64, $p = .056$.

Effects of condition and age group on recall of information

There was no main effect of condition on recall of information (H1), $F(4, 549) = 1.07$, $p = .373$, $\eta_p^2 = .01$, suggesting that the mode of information presentation did not directly affect recall of information. Hence, H1 is not supported. Regarding H2, there was no significant interaction effect of condition and age group on recall of information, $F(4, 549) = 1.47$, $p = .210$, $\eta_p^2 = .01$. However, the results suggest that younger adults in the text-only ($M_{\text{difference}} = 10.56$, $SE = 4.28$, $p = .014$) and text with illustrations condition ($M_{\text{difference}} = 8.52$, $SE = 4.20$, $p = .043$) recalled more information than those in the combination condition, and younger adults in the text-only condition also recalled more than those in the mode-tailored condition ($M_{\text{difference}} = 9.25$, $SE = 4.61$, $p = .045$), $F(4, 549) = 2.21$, $p = .067$, $\eta_p^2 = .02$. For

older adults, there were no differences between conditions with respect to recall of information, $F(4, 549) = 0.32$, $p = .866$, $\eta_p^2 = .00$. There were also no differences between younger and older adults within each condition. Based on these results, H2 is not supported. Table 2 provides the means, standard errors, and CIs of recall of information for all groups.

Table 1 Mode-Tailored Website Use Characteristics

	Older Adults		Younger Adults		Total	
	$n = 54$		$n = 43$		$n = 97$	
	M	*SD*	*M*	*SD*	*M*	*SD*
Number of mode actions	3.54[a]*	1.97	4.93	3.55	4.16	2.85
Time until first mode (seconds)	25.37	29.17	25.91	56.31	25.61	43.09
Time between first and second mode (seconds)	16.18	29.82	13.98	21.37	15.18	26.19
% First mode ≤ 10 seconds	35.2		53.5		43.3	
% First mode 11–20 seconds	33.3		23.4		28.9	
% First mode > 20 seconds	31.5		23.1		27.8	

	n	%	*n*	%	*n*	%
First mode chosen						
Text	33	61.1	33	76.7	66	68.0
Illustrations	15	27.8	7	16.3	22	22.7
Video	6	11.1	3	7.0	9	9.3
Mode combinations						
All three modes	39	72.2	32	74.4	71	73.2
Text and illustrations	8	14.8	9	20.9	17	17.5
Text and video	—	—	—	—	—	—
Illustrations and video	1	1.9	—	—	1	1.0
Text-only	4	7.4	—	—	4	4.1
Illustrations-only	—	—	1	2.3	1	1.0
Video-only	2	3.7	1	2.3	3	3.1
Selected video mode	42	77.8	33	76.7	75	77.3
Started playing video (within)	25	59.5	17	51.5	42	56.0
Played entire video (within)	18	42.9	7	21.2	25	33.3

Notes: Web analytics were available for 97 participants in the mode tailored condition. As some participants had turned on private browsing, this disabled us to track their online actions.
[a]Mean differs from younger adults.
*$p < .05$.

Table 2 Recall of Information by Condition and Age Group

	Younger Adults				Older Adults				Total			
	n	M	SE	95% CI	n	M	SE	95% CI	n	M	SE	95% CI
Condition												
Text-only	50	35.89[a,b]*	3.15	[29.70, 42.08]	49	29.25	3.18	[23.00, 35.50]	99	32.57	2.24	[28.17, 36.97]
Text with illustrations	54	33.85[a]*	3.03	[27.89, 39.80]	61	30.24	2.85	[24.63, 35.84]	115	32.04	2.08	[27.95, 36.13]
Audiovisual	55	28.89	3.00	[22.99, 34.79]	71	27.93	2.64	[22.74, 33.13]	126	28.41	2.00	[24.48, 32.34]
Combination	59	25.33	2.90	[19.63, 31.03]	58	29.98	2.93	[24.24, 35.73]	117	27.66	2.06	[23.61, 31.70]
Mode-tailored	44	26.64	3.36	[20.04, 33.24]	58	32.28	2.93	[26.53, 38.03]	102	29.46	2.23	[25.09, 33.84]
Total	262	30.12	1.38	[27.38, 32.49]	297	29.94	1.30	[27.38, 32.49]	559	30.03	0.95	[28.16, 31.89]

Notes: Recall of information is measured in % correctly recalled. CI = confidence interval; *M* = mean; *SE* = standard error.
[a]Mean differs significantly compared to younger adults in combination condition. [b]Mean differs significantly compared to younger adults in mode tailoring condition.

*p < .05.

Effects of condition and age group on attention

There was no main effect of condition on attention to the website (H3), $F(4, 549) = 2.09$, $p = .081$, $\eta_p^2 = .01$. However, within the older adult group, participants in the mode-tailored condition paid more attention to the website than participants in the text-only ($M_{\text{difference}} = 124.82$, $SE = 41.52$, $p = .003$), and text with illustrations condition ($M_{\text{difference}} = 123.12$, $SE = 39.24$, $p = .002$), $F(4, 549) = 3.39$, $p = .009$, $\eta_p^2 = .02$. Within the younger adult group, there were no differences in attention between conditions, $F(4, 549) = 0.51$, $p = .728$, $\eta_p^2 = .00$. Furthermore, when looking at the differences within conditions, older adults in the mode-tailored condition ($M_{\text{difference}} = 127.14$, $SE = 42.77$, $F(1, 549) = 8.84$, $p = .003$, $\eta_p^2 = .02$) and combination condition ($M_{\text{difference}} = 109.15$, $SE = 39.56$, $F(1, 549) = 7.61$, $p = .006$, $\eta_p^2 = .01$) paid more attention to the website than younger adults in the same condition. To conclude, H3 was partly supported for older adults. Table 3 provides the means and standard deviations of attention to the website for all groups.

The mediating effect of attention

Figure 2 represents the statistical mediation model that was tested using PROCESS (H4). For older adults, the results in Table 4 show a significant indirect effect of the mode-tailored condition compared to the text-only (standardized $b = -0.12$, $SE = 0.05$, 95% BCBCI $[-0.22, -0.02]$) and text with illustrations condition (standardized $b = -0.12$, $SE = 0.05$, 95% CI $[-0.22, -0.03]$) on recall of information via attention to the website. Namely, older adults paid significantly more attention to the mode-tailored website than the website with text only (standardized $b = -0.57$, $SE = 0.24$, $p = .018$), and text with illustrations (standardized $b = -0.57$, $SE = 0.23$, $p = .013$), which consequently enhanced recall of information (standardized $b = 0.21$, $SE = 0.04$, $p < .001$). This effect was not found when comparing the mode-tailored condition to the audiovisual and combination condition. The results indicate that attention mediated the effect of exposure to the mode-tailored website on recall of information for older adults, as compared to the website with text only and text with illustrations. For younger adults, this mediation effect was not apparent at all (see Table 4 for all indirect effects of condition on recall of information). Based on these results, H4 is largely supported.[1]
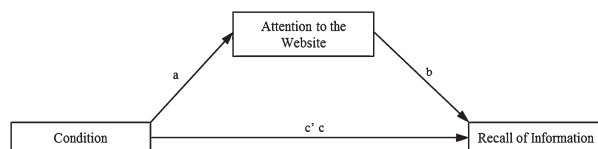

Figure 2 Tested mediation model: Effect of condition on recall of information via attention to the website for younger and older adults. The a-path refers to the effect of condition on attention. The b-path refers to the effect of attention on recall of information. The c-paths refer to the direct and total effect of condition on recall of information (Hayes, 2012).

Table 3 Attention to the Website by Condition and Age Group

	Younger adults				Older adults				Total			
	n	M	SE	95% CI	n	M	SE	95% CI	n	M	SE	95% CI
Condition												
Text-only	50	128.48	30.26	[69.04, 187.91]	49	139.74[a]**	30.56	[79.70, 199.77]	99	134.11	21.50	[91.87, 176.348]
Text with illustrations	54	115.22	29.12	[58.03, 172.41]	61	141.43[a]**	27.39	[87.62, 195.25]	115	128.33	19.99	[89.06, 167.59]
Audiovisual	55	157.05	28.85	[100.38, 213.72]	71	195.22	25.39	[145.35, 245.10]	126	176.14	19.22	[138.39, 213.88]
Combination	59	103.88	27.86	[49.17, 158.60]	58	213.03[b]**	28.09	[157.85, 268.21]	117	158.46	19.78	[119.60, 197.31]
Mode-tailored	44	137.41	32.26	[74.05, 200.77]	58	264.56[b]**	28.09	[209.37, 319.74]	102	200.98	21.39	[158.97, 242.99]
Total	262	128.41	13.28	[102.31, 154.50]	297	190.80	12.50	[166.24, 215.35]	559	161.89	9.20	[143.81, 179.96]

Notes: Attention to the website is measured by website visit time in seconds. CI = confidence interval; M = mean; SE = standard error.
[a]Mean differs from older adults in the mode-tailored condition.   [b]Mean differs from younger adults within the same condition.
**$p < .01$.

Discussion

The aim of this study was to gain insight into how younger and older adults process information from a mode-tailored website by investigating the effect of mode tailoring on recall of information, and how attention may explain this effect. Previous mode tailoring studies required participants to choose a modality of information, without the option to change the decision. Acknowledging this limitation, this study operationalized mode tailoring through a website where users could self-select their mode of preference, and modify this selection if desired. We found that mode tailoring enhanced older adults' recall of information via increased attention to the website, whereas younger adults recalled slightly more information from a fixed website with text only or text with illustrations. Furthermore, this study also provides insight into how younger and older adults' used the mode-tailored website. Specifically, the majority of participants selected multiple modes of information. Regarding differences between younger and older adults, older adults took longer to make their first mode choice and used the tailoring tool less frequently than younger adults, and that their modality choices seemed to vary more than those of younger adults.

For older adults, mode tailoring was effective at increasing attention to the website (H3). This consequently resulted in a higher recall for the older adults in the mode-tailored condition, as compared to those in the text-only and text with illustrations condition (H4). The results are in line with existing research, showing that older adults can compensate for their limited cognitive capacities, when they pay enough attention to information materials (Bol et al., 2016). This study suggests that mode-tailoring may be an effective tool to capture older adults' attention, which benefits processing and, consequently recall of information. A first explanation for our findings could be that older participants in the mode-tailored condition learned the information through repetition, as they were able to read the text, look at the illustrations and watch the video. However, the effectiveness of the mode-tailored website cannot only be attributed to repetition. Namely, the combination website also contained all modes of information, but it did not outperform the text-only and text with illustrations condition in terms of increased attention for older adults. Therefore, one of the active ingredients of the mode-tailored website was likely the mode-tailoring feature, enabling participants to tailor the information to personal preferences, which attracted older adults' attention and motivated them to process information, resulting in higher recall of information.

The data on how younger and older participants used the mode-tailored website nicely illustrates and supports the attention–recall relationship for older adults found in this study. Previous website usability studies have shown that older adults look longer at navigation areas of websites than younger adults, because they carefully think before they click on a menu item (Tullis, 2007). Therefore, a plausible explanation could be that older adults paid more attention to the mode tailoring navigation bar than younger adults, and therefore may have used the mode-tailored website different, or even better than younger adults. In line with previous studies (e.g., Tullis,

Table 4 Effect of Condition on Recall of Information via Attention for Younger and Older Adults

Age Group	Condition (Reference = Mode-Tailored)	Indirect effect of X on Y [95% BCBCI]		Effect of X on M (a)	Effect of M on Y (b)	Direct effect of X on Y (c')	Total effect of X on Y (c)
		Unstandardized	Standardized				
Younger adults	Text-only	−0.41 (1.89) [−5.25, 2.10]	−0.02 (0.08) [−0.22, 0.10]	−0.04 (0.12)	0.45*** (0.11)	0.43* (0.22)	0.41 (0.22)
	Text with illustrations	−1.01 (1.27) [−4.42, 0.77]	−0.05 (0.06) [−0.20, 0.03]	−0.10 (0.12)	0.45*** (0.11)	0.32 (0.22)	0.32 (0.22)
	Audiovisual	0.89 (1.34) [−1.77, 3.76]	0.04 (0.06) [−.07, 0.18]	0.09 (0.12)	0.45*** (0.11)	0.06 (0.21)	0.10 (0.22)
	Combination	−1.53 (1.38) [−5.46, 0.28]	−0.07 (0.06) [−0.23, 0.02]	−0.15 (0.11)	0.45*** (0.11)	0.01 (0.21)	−0.06 (0.21)
Older adults	Text-only	**−2.69 (1.15)** **[−5.02, −0.50]**	**−0.12 (0.05)** **[−0.22, −0.02]**	−0.57* (0.24)	0.21*** (0.04)	−0.06 (0.17)	−0.14 (0.18)
	Text with illustrations	**−2.65 (1.08)** **[−4.91, −0.58]**	**−0.12 (0.05)** **[−0.22, −0.03]**	−0.57* (0.23)	0.21*** (0.04)	0.03 (0.17)	−0.09 (0.17)
	Audiovisual	−1.49 (1.35) [−4.12, 1.25]	−0.07 (0.06) [−0.18, 0.05]	−0.32 (0.22)	0.21*** (0.04)	−0.13 (0.16)	−0.19 (0.16)
	Combination	−1.11 (1.48) [−3.76, 2.12]	−0.05 (0.07) [−0.17, 0.09]	−0.24 (0.23)	0.21*** (0.04)	−0.05 (0.17)	−0.10 (0.17)

Notes: X = condition, M = attention to the website, Y = recall of information. Z scores are used to standardize the scales to mean = 0, and standard deviation = 1. Standardized *b*-coefficients (with standardized boot *SE* between parentheses); BCBCI = bias-corrected bootstrap confidence interval using 5,000 bootstrap samples; significant indirect effects are in bold. $N_{younger\ adults} = 262$, $N_{older\ adults} = 297$.
*p < .05. ***p < .001.

2007), it is likely that younger adults clicked the modes on and off immediately as a try out, while older adults carefully considered which mode of delivery they would like to consult before they clicked. This might explain why older adults took longer to choose their first mode than younger adults, and why older adults (de)selected different modes less often than younger adults. An alternative explanation could be that older adults needed more time to understand how the mode-tailoring navigation bar worked. We tried to limit this possibility by providing clear instructions on how to use the mode-tailored website beforehand and by incorporating a short and clear instruction on the right side of the mode tailoring navigation bar. Moreover, as mode tailoring improved recall of information in older adults, it is likely that older adults used the time before their first mode choice to make a thoughtful decision about which mode to choose, rather than to unravel how the mode-tailored website worked.

A second explanation for our finding could be that older adults perceived the mode-tailored website to be more interactive, which increased their attention to the website and consequently their recall of information. A recent study by Oh and Sundar (2015) showed that modality interactivity on a website led to more favorable evaluations and greater cognitive engagement with the website. In fact, in a similar study we found that a mode-tailored website was perceived to be more interactive, which led to greater satisfaction with the website, as compared to nontailored websites (Nguyen, Van Weert, Bol, Loos, & Smets, 2016). As we found that the mode-tailored website only benefited older adults in terms of recall, it may be that this type of interactivity, which allows users to have an active control over how information is presented, particularly attracts older adults. Future research could examine the role of perceived modality interactivity of mode-tailored websites.

Surprisingly, the mode-tailored website did not directly enhance recall of information as compared to the nontailored websites (H1), and there were no differences between younger and older adults either (H2). Instead, younger adults recalled more from text only or text with illustrations than from mode-tailored information. A post hoc analysis showed that among higher-educated younger adults, the text-only condition outperformed audiovisual, combined and mode-tailored information, while this was not the case for lower-educated younger adults. The results suggest that particularly higher-educated younger adults did not benefit from mode-tailored information. It is likely that higher-educated young adults are well able to process plain textual information without visual additions (may that be tailored or not), and the mode tailoring tool might have caused some resistance to use this type of technology. In general, it might be that younger adults experienced the website with text only and text with illustrations as clear and concise, while mode tailoring may have just been an extra interactive feature with no effects on information processing and recall of information. Relatedly, younger and older adults grew up with different media technologies, which also explains why they used the mode-tailored website differently. This study showed that younger adults selected, and deselected, different modalities more often than older adults. This suggests that younger adults devoted much of their time on a mode-tailored website to turning modes on and off, whereas

older adults used their time on the website to actively think about which mode(s) to select and process the information they choose. As there were no differences in attention between the conditions for younger adults, it could be the case that the mode-tailoring tool distracted them from viewing the information, while this was not the case for older adults.

Looking at the results, it is important to note that the mode-tailored condition did not outperform the audiovisual and combination condition for older adults. Nevertheless, previous website usability studies have shown that older adults generally start reading or viewing all information that is available on a webpage, instead of filtering out what is relevant for them via the navigation areas (e.g., Bolle et al., 2016). On a mode-tailored website, however, individuals will have to select how they would like to view the information first, before they are able to attend to it. Hence, the mode-tailoring feature seems to be particularly relevant for older adults, as they have to make use of the navigation areas first, before there is any content to view. Mode tailoring may thus be a tool to reduce or prevent the information overload that may occur when too much information (via text, illustrations, and video) is placed on a non-tailored webpage at one time, and facilitate information processing for older adults. That being said, it still remains important to further explore how mode-tailored, or nontailored, online information can be best presented to different target groups.

Limitations

This study has several limitations that need to be addressed. First, although participants in the text-only, text with illustrations, audiovisual, and combination condition received fixed, nontailored websites, it could have been that a number of these participants received their mode of preference. However, the value of tailoring also relates to whether people perceive the information to be tailored (Hawkins et al., 2008). In our study, participants viewing the mode-tailored website were able to tailor the information presentation on the website themselves, giving them an active control over the look and feel of the website. As this feature is entirely lacking in the nontailored conditions, this precludes the participants viewing the nontailored websites of having this same experience of self-tailoring.

Second, because the majority of participants in the mode-tailored condition eventually selected all three modes (text, illustrations, and video), it was not possible to establish clear distinguished subgroups that could be compared to participants who were assigned to the nontailored conditions in terms of attention and recall of information. Furthermore, selecting a mode does not necessarily mean that participants also processed that information actively (e.g., what happened with the video mode). To be able to distinguish subgroups within the mode-tailored condition and investigate this further, additional data on which content participants actually attended to are needed. Future research could explore this by, for example, conducting eye tracking research, to obtain an objective measure of what participants read or viewed while being on the mode-tailored website. Nevertheless, this study provides

a first insight into how younger and older adults use a mode-tailored website with three different modalities.

Third, we asked healthy participants (i.e., analogue patients) to imagine that they were possibly diagnosed with colorectal cancer and that they would have to visit the hospital soon. Because each respondent could have imagined this scenario differently, they may have read and processed the information differently as well. However, we used noncancer patients to avoid that clinical patients would be influenced by their own experiences. A previous study showed that analogue patients who were instructed to imagine feelings and thoughts of cancer patients during the execution of the experiment produced similar outcomes as that from clinical patients (Van Vliet et al., 2012). However, whether the results of this study are comparable to those of clinical patients should be investigated in future research.

Finally, as the chances of getting colorectal cancer increase with age, it might be that the website information was more relevant to older adults as to younger adults. This might explain why younger adults were more likely to be excluded from the study sample. However, as we made use of an online research panel that received financial compensation for participating in our study, it was important to handle strict screening guidelines. If there was any suspicion of not following study instructions (e.g., viewing the information inadequately, or using a smartphone, etc.), participants had to be screened out in order to ensure the validity of the study results. Future research should replicate this study in clinical samples for whom this information is highly relevant, to validate the results of the current study.

Implications and directions for future research

This study provides practical and novel insights into how younger and older adults use a mode-tailored website, as well as the effects of mode tailoring on attention and recall of information. Although the effects are relatively small, this study shows that tailoring the mode of information presentation on the Internet can enhance recall of information via increased attention to the website in older adults. This study extends the existing tailoring literature by suggesting that tailoring the mode of information presentation is a promising method to increase attention to information materials and, consequently, improve cognitive outcomes such as recall of information. As both content tailoring and mode tailoring have now shown promising results, future research could examine the synergistic effects of combining the two different tailoring strategies. Perhaps, this method of "multidimensional" tailoring exceeds the individual effects of content tailoring and mode tailoring.

As this study is only a first step towards a better understanding of mode tailoring, this study should be replicated in other contexts and among clinical patients to ensure generalizability of the results. Furthermore, additional research is needed to gain more insight into how people use and process mode-tailored websites, for example, by using eye-tracking research. Specifically, cognitive attributes such as working memory capacity and speed of processing that might explain age differences (Salthouse, 2004), and consequently how individuals interact with and respond to

mode-tailored information, should be considered in future research. In addition, underlying mechanisms that might explain the effect of mode tailoring such as perceived modality relevance (Jensen et al., 2012) and perceived modality interactivity (Oh & Sundar, 2015) should be explored further. Finally, future research could extend this study by investigating other methods of tailoring the mode of information presentation. These methods may be, for example, matching the mode of information presentation with individual preferences, or taking into account individual learning styles (e.g., via verbal or visual information) (Kreuter et al., 2000; Smit et al., 2015).

To conclude, the results suggest that designers of websites, particularly of those aimed at information provision, should acknowledge the different needs of younger and older adults for the mode of information presentation. Fixed information such as text and illustrations seems to work better for the younger adult group, whereas for older adults a website containing multiple modes of information presentation which they can choose from, or which are adjustable to individual preferences, seems to have added value for recall of information. Moreover, this study shows that older and younger adults interact differently with a mode-tailored website, where they can self-tailor the modality of information presentation. How people actively choose their information online is a relevant insight that might inform future research in the field of online communication.

Appendix

Pretest

A pretest was conducted to select one male and one female patient character that would be featured on the website. Four different actors between the ages of 60–70 (two male, two female) were pretested in a within-subjects design among 23 participants ($M_{age} = 73.87$, $SD_{age} = 6.54$, range 65–86, 47.8% male). For this pretest, we only included participants of 65 year and older, because age congruency between the narrative character and viewer has been shown to be important for older adults, but not for younger ones (Bol, Van Weert, De Haes, Loos, & Smets, 2013). Participants were first instructed to read the website information about how one can prepare for the first consultation with the doctor and nurse for fast diagnostics in colorectal cancer. Based on a first impression of a photograph of each character, participants indicated who they found most suitable to tell this information by ranking them from 1 "most suitable" to 4 "least suitable" and by rating each character on a scale from 1 "not suitable at all" to 10 "very suitable". We selected the male (ranked as first choice eight times, $M = 6.52$, $SD = 2.37$) and female (ranked as first choice six times, $M = 7.26$, $SD = 2.05$) character that were ranked first most times and with the highest mean score on suitability for the final videos and illustrations in this study.

Acknowledgments

Note

1 Repeating the analyses with participants that were excluded, because they were not exposed to the website for at least 30 seconds (and were not already excluded for another reason), yielded similar results.

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