

Do videos improve website satisfaction and recall of online cancer-related information in older lung cancer patients?

Nadine Bol^{a,*}, Ellen M.A. Smets^b, M. Mattijs Rutgers^b, Jacobus A. Burgers^c,
Hanneke C.J.M. de Haes^b, Eugène F. Loos^a, Julia C.M. van Weert^a

^a Amsterdam School of Communication Research/ASCoR, University of Amsterdam, Amsterdam, The Netherlands

^b Department of Medical Psychology, Academic Medical Center/AMC, University of Amsterdam, Amsterdam, The Netherlands

^c The Netherlands Cancer Institute/NKI, Amsterdam, The Netherlands

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ABSTRACT

Objective: This study investigated the effects of personalized audiovisual information in addition to text on website satisfaction and recall of cancer-related online information in older lung cancer patients.

Methods: An experiment using a 3 (condition: text only vs. text with nonpersonalized video vs. text with personalized video) by 2 (age patient: younger [<65 yrs] vs. older [≥ 65 yrs]) between-subjects factorial design was conducted. Patients were randomly assigned to one of the three information conditions stratified by age group.

Results: Patients were more satisfied with the comprehensibility, attractiveness, and the emotional support from the website when information was presented as text with personalized video compared to text only. Text with personalized video also outperformed text with nonpersonalized video regarding emotional support from the website. Furthermore, text with video improved patients' recall of cancer-related information as compared to text only. Older patients recalled less information correctly than younger patients, except when we controlled for Internet use.

Conclusion: Text with personalized audiovisual information can enhance website satisfaction and information recall. Internet use plays an important role in explaining recall of information.

Practice implications: The results of this study can be used to develop effective health communication materials for cancer patients.

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1. Introduction

Many Western countries are rapidly aging [1,2]. In 2011, 650 million people worldwide were aged over 60 years and it is expected that this age group will increase up to two billion by 2050 [2]. Along with this trend, an increase in disease rating, such as cancer incidences, is shown as well [3,4]. It is expected that cancer incidence among older adults will increase with 40% between 2007 and 2020 [4]. At the same time, more cancer-related information is presented through the Internet [5]. Older patients increasingly use the Internet to find health-related information [6,7]. However, it has been found that older patients often struggle with information they find on the Internet [8]. This might be explained by the complexity of online health information [9] but also by older patients' relative inexperience with the Internet and declines in

functioning, such as cognitive (e.g., reduced working memory) and sensory (e.g., decreased visual acuity) impairments [10,11]. The inability to correctly understand information on health websites leads to dissatisfaction [8] and low levels of medical information recall. Website satisfaction can be defined as web users' "predispositions to respond favorably or unfavorably to web content" [12]. Satisfaction has been found to positively influence recall of information [13,14], which is the ability to remember and reproduce information [15]. The ability to correctly recall information is for instance important for patients' active role in the decision-making process [16] and adherence to medical regimes [13].

In an attempt to make online health-related information more 'senior-friendly' and consequently enhance website satisfaction and information recall, health websites can use compensatory multimedia strategies that support older patients' ability to cognitively process information [17]. One multimedia strategy that is expected to compensate for cognitive declines is using audiovisual materials in addition to written information rather than using written information alone. This is called the *modality effect* [18]. It is expected that audiovisual information, e.g., a video,

* Corresponding author at: Amsterdam School of Communication Research/ASCoR, University of Amsterdam, Kloveniersburgwal 48, 1012 CX Amsterdam, The Netherlands. Tel.: +31 020 525 2113; fax: +31 020 525 3681.

E-mail address: n.bol@uva.nl (N. Bol).

leads to enhanced website satisfaction and recall of medical information, which especially benefits older patients because audiovisual information can compensate for older adults' limited cognitive capacity [19]. In addition, presentation strategies, such as personalization, can play an important role in increasing satisfaction and recall of information as well. This is called the *personalization effect* and is referred to as presenting information in a personalized conversational style rather than a nonpersonalized formal style [20]. Personalization is often used in narrative communication, presenting personal stories or a description of an individual experience, e.g., providing information from a patient's perspective [21] and is frequently compared to nonpersonalized or informational communication, which refers to presenting factual information, such as expressing professional opinions, e.g., providing information from a health professional's perspective [22].

This study investigates the effects of multimedia (i.e., modality) and presentation (i.e., personalization) strategies on website satisfaction and recall of cancer-related information among older patients. We test the effect of modality and personalization among older patients as compared to younger patients in a 3 (text only vs. text with informational audiovisual vs. text with narrative audiovisual information) by 2 (younger vs. older age) experimental design. In assessing age differences, we chose age younger than 65 for the younger age group and age 65 and older as the older age group. These two age groups have been found worthy of separate analysis in several studies on adulthood development [23] and disease in adulthood [24].

2. Theoretical background

The cognitive theory of multimedia learning attempts to understand how people learn information in multimedia environments [25]. This theory is based on the assumption that people have separate information processing systems for visual and auditory materials [26] and that the cognitive capacity of these visual and auditory information processing systems are highly limited [27]. Multimedia messages can effectively expand one's limited cognitive capacity by providing people with well-developed multimedia messages, such as audiovisual materials combined with textual information, rather than with more traditional modes of information, such as textual information alone [28]. Previous research on this so-called modality effect has indicated that presenting information audiovisually increased satisfaction with the information [29] and elicited more positive feelings than text only information [30]. There is also ample evidence for the personalization effect. It has been found that personalized conversational style increases interest and is better liked [31,32]. One study also found enhanced satisfaction when using personalization in online multimedia environments, such as games [33]. Building on this previous research we expect that *showing text with audiovisual information will result in higher website satisfaction in younger and older patients than text only information (H1a)* and that *showing text with personalized audiovisual information will increase website satisfaction in younger and older patients compared to nonpersonalized audiovisual information (H1b)*.

In addition to website satisfaction, modality and personalization are also found to influence the extent to which information is recalled [20]. Empirical evidence has shown that audiovisual information leads to higher recall of information than written information only [34]. Nevertheless, not all audiovisual messages should be expected to be equally successful in promoting recall of information. It has been found that personalized conversational style is better recalled than nonpersonalized formal style [20]. For instance, Kreuter et al. [31] distinguished between personalized (narrative) and nonpersonalized (informational) videos and found

that personalized videos resulted in better recall of cancer-related information than the nonpersonalized video. In a follow up study, it was also found that a personalized video led to increased recall of information compared to a nonpersonalized video [35]. We therefore hypothesize that *showing text with audiovisual information will result in higher recall of cancer-related information in younger and older patients than text only information (H2a)* and that *showing text with personalized audiovisual information will increase recall of cancer-related information in younger and older patients compared to nonpersonalized audiovisual information (H2b)*.

Whereas much research has been conducted on the effectiveness of multimedia learning strategies among younger adults [36,37], less research has focused on the effect of multimedia strategies on older adults' recall of information [19]. The cognitive aging principle in multimedia learning [17] provides an integrative framework in which the cognitive load theory is combined with general views of cognitive aging. This theory states that limited working memory might be expanded by using one or more sensory modalities and thereby enhancing recall of information, especially for older adults. Older adults usually have a smaller 'total cognitive capacity' and might therefore benefit more from multimodal information [38]. Previous research has demonstrated a benefit of multimedia messages for older adults by reducing cognitive load and decreasing learning time of information [19,39]. We expect based on the cognitive aging principle in multimedia learning that *older patients recall less cancer-related information than younger patients, regardless of how information is presented (H3a)* and that *older patients benefit more from showing text with audiovisual information (vs. text only information) and thereby show a greater gain in recall of cancer-related information than younger patients (H3b)*.

3. Method

3.1. Design

A 3 (condition: text only vs. text with nonpersonalized video vs. text with personalized video) by 2 (age patient: younger [<65 yrs] vs. older [≥ 65 yrs]) between-subject factorial design was used with website satisfaction and recall of cancer-related information as dependent variables. Patients were randomly assigned to one of the three conditions stratified by age group. Power analysis with alpha set at .05, effect size at .25, and a probability level of .80 revealed that a sample size of at least 158 patients was needed to detect meaningful differences.

3.2. Stimulus material

A webpage of The Netherlands Cancer Institute (NKI) with information on Radio Frequency Ablation (RFA) treatment was developed for this study. RFA uses radiofrequency waves to eradicate lung tumors. RFA was deliberately chosen because RFA is a relative unknown treatment and lung cancer patients of the NKI rarely receive this treatment. We used information about RFA treatment for the webpage, because the aim of the study was to examine the effects of modality and personalization in presenting online cancer-related information on website satisfaction and recall of information without contamination by prior knowledge. The validity of the recall measurement would be warranted if patients had no prior experience with or knowledge about RFA treatment. Three different versions of the NKI webpage were created, resulting in text only information (text only condition), text with a nonpersonalized video (nonpersonalized video condition), and text with a personalized video (personalized video condition). The content of the information was kept constant across conditions. Using the written RFA content, the scripts of

videos were written. The nonpersonalized video included a health professional explaining the RFA treatment and the personalized video included a cancer survivor sharing his experience with RFA treatment. The health professional was videotaped behind his desk wearing a lab coat and the patient was filmed sitting on a couch. The content of the nonpersonalized video was identical to the text only information. The personalized audiovisual information contained the same factual information as the text only information and nonpersonalized video, however, unlike the formal third-person style of the nonpersonalized information, the personalized version contained sentences presented in the first person as if the narrator were talking to you. This is in line with how Mayer [20] defines personalization of information. For example, both versions included a passage on how RFA treatment is executed in which an additional sentence was added to the personalized version, stating “I suffered from lung cancer and was treated with the RFA method” (for complete script of the nonpersonalized and personalized versions, see Appendix). Furthermore, the same actor was used to keep the videos as similar as possible. Although we used a male actor for both videos, no differences were found between male and female patients in identification with the actor and perceived similarity to the actor, resp. $F(1, 110) = 0.31$, $p = .579$, $\eta^2 = .00$ and $F(1, 110) = 1.41$, $p = .238$, $\eta^2 = .01$.

3.3. Sample and procedure

Permission for this study was granted by the medical ethical committee of the NKI (trial number P12OLD). Lung cancer patients who were not newly diagnosed were recruited through this hospital between April 2012 and August 2012. To avoid undesired outcomes for participating patients, we used so-called ‘analog patients’ in this study. These are patients with a personal history with cancer who imagine a hypothetical treatment (i.e., RFA). A recent meta-analysis demonstrated the validity of using analog patients as proxies for clinical patients by showing insignificant discrepancies between perceptions of analog and clinical patients [40]. Patients were approached in the waiting room and were asked to participate in an online survey. When patients agreed, they signed informed consent and received an e-mail at home with a link to the online survey. Patients were eligible when (1) being aged 18 years or older, (2) being diagnosed with lung cancer, (3) being able to read and write in Dutch, (4) having access to the Internet, and (5) written informed consent was provided. Patients were excluded when reporting to have prior RFA knowledge (i.e., scoring higher than 4 on a 7-point scale) and not having completed the questionnaire him or herself. Patients were also excluded when being newly diagnosed. We felt that it is unethical to provide new patients with a treatment option that would not be available to them at the NKI while still discussing treatment options with their health professional.

When entering the online survey, questions on background and medical characteristic were shown. Next, patients were either exposed to the webpage with text only information, text with nonpersonalized video, or text with personalized video. The webpage was part of the online survey and could only be accessed through the survey. Patients were instructed to pay careful attention to the RFA information that was displayed on the webpage and were told that they would not be able to return to the webpage with text or text with video after turning to the next page. Patients could spend as much time on the webpage as they preferred. On average, patients spent 3.57 min on the webpage ($SD = 3.11$) and there was no difference between older and younger patients’ viewing time, $F(1, 165) = 0.01$, $p = .943$, $\eta^2 = .00$, neither between the different conditions, $F(2, 164) = 0.54$, $p = .586$, $\eta^2 = .01$. On the next page, the recall questions were shown. Following the recall questions, the patients were allowed to look at

the webpage again after which they filled out the three sub scales of the website satisfaction questionnaire.

3.4. Measures

3.4.1. Website satisfaction

Patients reported their satisfaction with the website on the Website Satisfaction Scale (WSS) [14,41]. The WSS was developed based on items of the website attitude scale [12,41] and the Leisure Satisfaction Scale (LSS) [42] and consisted of 12 items. Principle Component Analysis (PCA) revealed three website satisfaction sub scales which each showed high internal consistency: “satisfaction with comprehensibility” (3 items, $\alpha = .91$), “satisfaction with attractiveness” (5 items, $\alpha = .89$), and “satisfaction with emotional support” (4 items, $\alpha = .95$). Items included for instance “the website contains comprehensive language”, “the website is enjoyable”, and “the website helps dealing with stress” respectively for each sub scale using a 7-point Likert response scale, ranging from 1 ‘totally disagree’ to 7 ‘totally agree’. These sub scales were used and fully described in a previous study [14].

3.4.2. Recall of cancer-related information

Recall was assessed based on the format of The Netherlands Patient Information Recall Questionnaire [43]. Questions were produced from the RFA information text which resulted in 11 open-ended questions, such as “how much time does an RFA treatment take?” [14,44]. Corresponding answer options were “not discussed”, “discussed, but I can’t remember the details”, and “discussed, namely...”. Recall scores were allocated based on a codebook and could range from 0 (not recalled), to 1 (recalled partially), to 2 (recalled correctly). As RFA treatment is not discussed during consultations, recall scores were a result of exposure to the online information patients were provided with in this experiment. Over twenty percent ($n = 37$, 21.9%) of the recall scores were double coded by two independent coders and a good interrater reliability was realized ($\kappa = .88$, range .64–1.00). The 11 questions were computed into a total recall score, ranging from 0 to 22 and percentages of recall were calculated for interpretation of results.

3.4.3. Patient characteristics

Demographics assessed included patient’s age, gender, level of education, Internet use (hours per week), and prior medical knowledge (on lung cancer and RFA treatment). Medical characteristics included date since diagnosis (in months), type of treatment, and goal of treatment (curative or palliative). Patients’ frailty was assessed using the Groningen Frailty Indicator (GFI) [45]. This 15-item scale was used to determine the patient’s level of frailty by screening the loss of functions and resources in physical (mobility functions, multiple health problems, physical fatigue, vision, hearing), cognitive (cognitive functioning), social (emotional isolation), and psychological functioning (depressed mood, feelings of anxiety). Each item was rated with 0 or 1 point, resulting in a sum scale ranging from 0 to 15, with higher scores indicating more frailty.

3.4.4. Statistical analysis

Descriptive statistics were used to describe the sample characteristics. To determine whether experimental conditions and age groups differed on gender, age, educational level, Internet use, (RFA) medical knowledge, and frailty, F -statistics and chi-statistics were conducted where appropriate. For testing the main effects of condition and age, four separate ANOVAs were conducted with satisfaction with comprehensibility, satisfaction with attractiveness, satisfaction with emotional support, and recall of information as dependent variables, and condition and age groups

as factors. Additional Tukey's HSD tests were conducted to check for differences within conditions. The experimental conditions stratified by age group significantly differed on prior RFA knowledge, $F(5, 163) = 2.32$, $p = .046$, $\eta^2 = .07$, and Internet use, $F(5, 161) = 2.44$, $p = .037$, $\eta^2 = .07$. As controlling for these variables did not alter the main and interaction effects of age group and condition on website satisfaction, the unadjusted effects for website satisfaction are reported. However, the variables did alter the effects of age group and condition on recall of information and were therefore included as covariates. Both the unadjusted and adjusted effects are reported for recall of information.

4. Results

4.1. Patient randomization and characteristics

The recruitment flow is depicted in Fig. 1. A total of 377 patients were approached to participate, 296 (78.5%) of which gave written informed consent. Patients were not eligible to participate when they did not have access to a computer or the Internet (13.0%, $n = 49$), felt too sick or tired (4.5%, $n = 17$), declined to fill out informed consent (3.2%, $n = 12$), were not diagnosed yet (0.5%, $n = 2$), or were analphabetic (0.3%, $n = 1$). Another 65 patients (17.2%) dropped out before randomization, due to feeling too sick or too tired (5.0%, $n = 19$), passing away (0.5%, $n = 2$), or other reasons (11.7%, $n = 44$). In total, 128 younger and 103 older patients were randomized to be exposed to either text only information ($n = 71$), text with nonpersonalized video ($n = 76$), or text with personalized video ($n = 84$). Thirty-nine patients (10.3%) eventually did not receive the

allocated intervention due to not being able to view the video (3.4%, $n = 13$), technical problems (0.5%, $n = 2$), or other unknown reasons (6.4%, $n = 24$). This resulted in 192 patients (50.9%) who fully completed the questionnaire, of which 23 patients (6.1%) were removed from analysis because of having prior RFA knowledge (1.3%, $n = 5$), having someone else filling out the questionnaire (1.9%, $n = 7$), not understanding the purpose of the questionnaire (2.7%, $n = 10$), or filling out the questionnaire twice at the same time (0.3%, $n = 1$). This resulted in a sample size of 169 patients which is sufficient to detect meaningful differences according to the power analysis. Non-response analysis revealed that patients who were included in data analysis were more likely to be male than the patients who were ineligible or dropped out in a later stage, $\chi^2 = 4.51$, $p = .032$. Participating patients did not differ in age from non-participating patients, $F(1, 375) = 1.09$, $p = .297$, $\eta^2 = .00$.

Over half of the participants were male (58.6%) and the mean age was 61 years old ($M = 61.32$, $SD = 10.76$). Of these participants, 95 were younger patients (<65 yrs; $M = 54.19$, $SD = 8.57$) and 74 were older patients (≥ 65 yrs; $M = 70.47$, $SD = 4.54$; $F(1, 167) = 218.99$, $p < .001$, $\eta^2 = .57$). Besides age, $F(1, 167) = 218.99$, $p < .001$, $\eta^2 = .57$, the two age groups significantly differed on Internet use, $F(1, 165) = 9.16$, $p = .003$, $\eta^2 = .05$, and type of treatment (i.e., older patients were more often not treated than younger patients, $\chi^2 = 4.47$, $p = .034$, and younger patients received chemotherapy more often than older patients, $\chi^2 = 10.71$, $p = .001$). Patients were on average diagnosed 3.5 years ago ($M = 44.02$ [months], $SD = 57.87$) and equally received treatment with curative (49.7%) or palliative intent (45.0%). Patient characteristics are shown in Table 1.

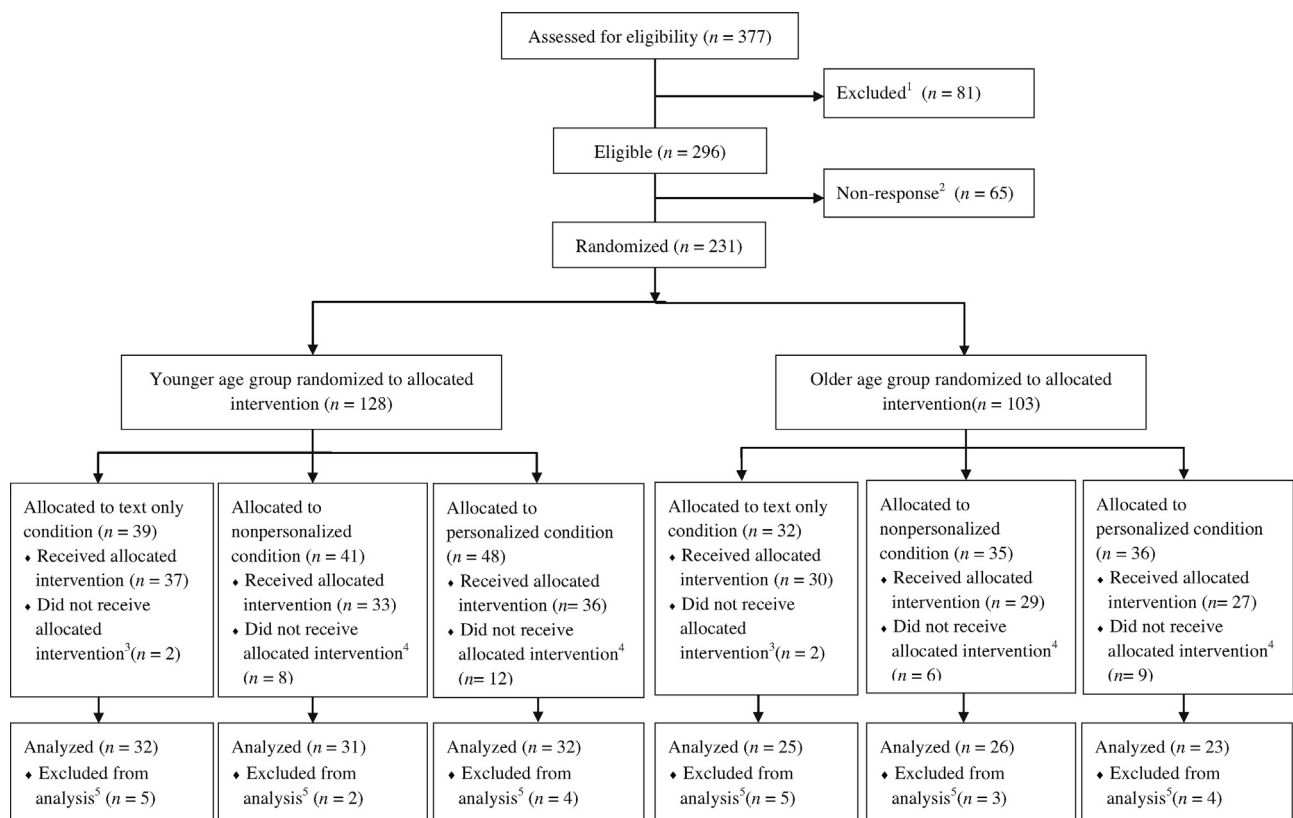


Fig. 1. Flow chart of participant recruitment.

Notes: ¹Did not have access to Internet/computer ($n = 49$), felt too sick or too tired ($n = 17$), declined to fill out informed consent ($n = 12$), not diagnosed yet ($n = 2$), analphabetic ($n = 1$); ²Felt too sick or too tired ($n = 19$), passed away ($n = 2$), other ($n = 44$); ³Unknown ($n = 4$); ⁴Not able to view the video ($n = 13$), technical problems ($n = 2$), unknown ($n = 24$); ⁵Too much prior RFA knowledge ($n = 5$), questionnaire filled out by someone else ($n = 7$), did not understand the questionnaire ($n = 10$), duplicate ($n = 1$).

Table 1
Background and medical characteristics (*n* = 169).

Variable	Younger patients (<65 yrs) <i>n</i> = 195		Older patients (≥65 yrs) <i>n</i> = 162		<i>p</i>
	<i>n</i>	(%)	<i>n</i>	(%)	
Gender					.143
Male	51	(53.7)	48	(64.9)	
Female	44	(46.3)	26	(35.1)	
Age					<.001
Mean (SD)	54.19 (8.57)		70.47 (4.54)		
Range	21–64		65–85		
Education					.108
Low	27	(28.4)	33	(44.6)	
Middle	28	(29.5)	18	(24.3)	
High	37	(38.9)	22	(29.7)	
Internet use (hours per week)					.004
Mean (SD)	11.63 (8.43)		7.96 (6.75)		
Range	0–40		0–35		
Medical knowledge about lung (scale 1–7) ^a					.076
Mean (SD)	3.04 (1.47)		2.65 (1.35)		
Range	1–6		1–6		
Medical knowledge about RFA (scale 1–7) ^a					.338
Mean (SD)	1.46 (0.91)		1.34 (0.75)		
Range	1–4		1–4		
Time since diagnosis (months)					.296
Mean (SD)	39.86 (45.24)		49.39 (70.93)		
Range	0–188		0–433		
Type of treatment					
Surgery	45	(47.4)	33	(44.6)	.720
Chemotherapy	81	(85.3)	47	(63.5)	.001
Radiation therapy	57	(60.0)	40	(54.1)	.438
Hormone therapy	6	(6.3)	5	(6.8)	.908
Immunotherapy	1	(1.1)	0	(0.0)	.376
Radio Frequency Ablation (RFA)	0	(0.0)	0	(0.0)	NA ^c
None	5	(5.3)	11	(14.9)	.034
Other	17	(17.9)	13	(17.6)	.956
Unknown	1	(1.1)	0	(0.0)	.376
Goal of treatment					.209
Curative	45	(47.4)	39	(52.7)	
Palliative	47	(49.5)	26	(39.2)	
Unknown	3	(3.2)	6	(8.1)	
Frailty (scale 0–15) ^b					.192
Mean (SD)	3.73 (2.46)		3.22 (2.52)		
Range	0–9		0–11		
Time spent on the website (in min)					.943
Mean (SD)	3.59	(3.88)	3.55 (1.75)		
Range	1.70–36.53		1.69–9.58		

Note: not all figures add up to 100% due to missing data. Conditions stratified by age did only significantly differ on RFA knowledge and Internet use. SD = Standard deviation.

^a A higher score indicates more knowledge.

^b A higher score indicates higher frailty.

^c Not applicable due to empty cells, i.e., no patient received RFA treatment.

4.2. Website satisfaction

We hypothesized that text with audiovisual information would lead to enhanced website satisfaction compared to text only information (H1a) and that text with personalized audiovisual information would increase website satisfaction compared to text with nonpersonalized audiovisual information (H1b). We found a main effect of condition on satisfaction with the comprehensibility of the website, $F(2, 163) = 6.31, p = .002, \eta^2 = .07$, satisfaction with the attractiveness of the website, $F(2, 163) = 4.97, p = .008, \eta^2 = .06$, and satisfaction with the emotional support from the website, $F(2, 163) = 4.53, p = .012, \eta^2 = .05$ (see Table 2 for means). Text with personalized audiovisual information resulted into higher satisfaction with comprehensibility and satisfaction with attractiveness than text only information, but not into higher satisfaction compared to the text with nonpersonalized audiovisual information.

Furthermore, personalized audiovisual information outperformed both text only and text with nonpersonalized audiovisual information in satisfaction with emotional support. We therefore found evidence for the modality effect (H1a) in satisfaction with the comprehensibility, attractiveness, and emotional support from the website. Furthermore, text with personalized audiovisual information significantly increased emotional support from the website compared to text with nonpersonalized information, partially supporting the personalization effect (H1b). No main effects of age nor interaction effects of age and condition were found on website satisfaction.

4.3. Recall of cancer-related information

H2a postulated that text with audiovisual information would result in higher recall of information than text only. We found

Table 2

Satisfaction with comprehensibility, attractiveness, and emotional support from the website stratified by condition and younger (<65 yrs) and older (≥65 yrs) patients (*n* = 169).

	<i>n</i>	Satisfaction with comprehensibility			Satisfaction with attractiveness			Satisfaction with emotional support		
		<i>M</i>	<i>SE</i>	95% CI	<i>M</i>	<i>SE</i>	95% CI	<i>M</i>	<i>SE</i>	95% CI
Text only	57	5.21	.16	[4.91, 5.52]	4.12	.15	[3.82, 4.42]	3.49	.19	[3.11, 3.87]
Younger patients	32	5.25	.21	[4.84, 5.66]	4.11	.20	[3.71, 4.51]	3.30	.26	[2.79, 3.81]
Older patients	25	5.17	.23	[4.71, 5.63]	4.13	.23	[3.68, 4.58]	3.68	.29	[3.11, 4.26]
Nonpersonalized video	57	5.65	.16	[5.34, 5.95]	4.52	.15	[4.22, 4.83]	3.32	.19	[2.94, 3.70]
Younger patients	31	5.75	.21	[5.34, 6.17]	4.43	.21	[4.02, 4.83]	3.50	.26	[2.98, 4.02]
Older patients	26	5.54	.23	[5.09, 5.99]	4.62	.22	[4.18, 5.07]	3.14	.29	[2.57, 3.70]
Personalized video	55	6.00 ^{a,***}	.16	[5.69, 6.31]	4.80 ^{a,***}	.16	[4.50, 5.11]	4.11 ^{a,*,b,*}	.20	[3.72, 4.51]
Younger patients	32	6.16	.21	[5.75, 6.56]	4.78	.20	[4.38, 5.18]	4.25	.26	[3.74, 4.76]
Older patients	23	5.84	.24	[5.36, 6.32]	4.83	.24	[4.36, 5.30]	3.98	.30	[3.38, 4.58]
Total	169	5.62	.09	[5.44, 5.80]	4.48	.09	[4.31, 4.66]	3.64	.11	[3.42, 3.86]
Younger patients	95	5.72	.12	[5.48, 5.96]	4.44	.12	[4.21, 4.67]	3.68	.15	[3.39, 3.98]
Older patients	74	5.52	.14	[5.25, 5.79]	4.53	.13	[4.26, 4.79]	3.60	.17	[3.26, 3.93]

Note: website satisfaction sub scales range from 1 to 7. A higher mean indicates more satisfaction with the website. *M* = mean; *SE* = standard error; CI = confidence interval.

^a Mean differs significantly compared to the text only condition (main effect).

^b Mean differs significantly compared to the text with nonpersonalized video condition (main effect).

* *p* < .05.

** *p* < .01.

*** *p* < .001.

Table 3

Percentages of information recalled correctly stratified by condition and younger (<65 yrs) and older (≥65 yrs) patients (*n* = 169).

	<i>n</i>	Recall of cancer-related information				<i>n</i> ^b	Adjusted recall of cancer-related information ^a			
		% recall	<i>M</i>	<i>SE</i>	95% CI		% recall	<i>M</i>	<i>SE</i>	95% CI
Text only	57	33.5	7.36	.62	[6.13, 8.59]	56	33.5	7.38	.64	[6.12, 8.65]
Younger patients	32	35.6	7.84	.83	[6.21, 9.48]	32	35.2	7.75	.83	[6.12, 8.65]
Older patients	25	31.3	6.88	.94	[5.03, 8.73]	24	31.9	7.02	.96	[5.12, 8.92]
Nonpersonalized video	57	46.2	10.17 ^{c,**}	.62	[8.95, 11.40]	56	46.0	10.11 ^{c,**}	.63	[8.87, 11.36]
Younger patients	31	51.8	11.39	.84	[9.73, 13.05]	31	50.5	11.11	.86	[9.42, 12.81]
Older patients	26	40.7	8.96	.92	[7.15, 10.77]	25	41.4	9.11	.95	[7.24, 10.98]
Personalized video	55	49.5	10.90 ^{c,***}	.64	[9.64, 12.16]	55	49.8	10.96 ^{c,***}	.64	[9.70, 12.23]
Younger patients	32	52.9	11.63	.83	[9.99, 13.26]	32	52.5	11.56	.83	[9.93, 13.19]
Older patients	23	46.2	10.17	.98	[8.25, 12.10]	23	47.1	10.36	.98	[8.42, 12.31]
Total	169	43.1	9.48	.36	[8.76, 10.20]	167	43.1	9.49	.37	[8.77, 10.21]
Younger patients	95	46.8	10.29	.48	[9.34, 11.23]	95	46.1	10.14	.49	[9.18, 11.10]
Older patients	74	39.4	8.67 ^{d,*}	.54	[7.60, 9.75]	72	40.1	8.83	.56	[7.73, 9.94]

Note: recall of information ranges from 0 to 22. The higher the score the more information was recalled correctly. *M* = mean; *SE* = standard error; CI = confidence interval.

^a Adjusted for prior RFA knowledge and Internet use.

^b The category sizes differ because of 2 fewer cases due to missing covariate values.

^c Mean differs significantly compared to the text only condition (main effect).

^d Mean differs significantly compared to younger patients (main effect).

** *p* < .01.

*** *p* < .001.

support for this modality effect: text with nonpersonalized audiovisual condition and text with personalized audiovisual condition resulted into higher recall scores as compared to the text only condition, $F(2, 163) = 8.85$, $p < .001$, $\eta^2 = .10$ (see Table 3 for adjusted and unadjusted means). Although the text with personalized video resulted into the highest recall scores, Tukey's HSD showed that the recall scores were not significantly higher than the recall scores in the text with nonpersonalized video condition. Therefore, the personalization effect cannot be supported (H2b). H3a expected that older patient would recall less information correctly than their younger counterparts. Our results confirmed that older patients recalled less cancer-related information than younger patients, $F(1, 163) = 4.95$, $p = .027$, $\eta^2 = .03$. However, when controlling for Internet use, these age differences disappeared, $F(1, 159) = 3.04$, $p = .083$, $\eta^2 = .02$, indicating that Internet use plays an important role in recalling online cancer-related

information. Post hoc analyses showed that Internet use was positively related to information recall ($r = .17$, $p = .029$) and negatively related to aging ($r = -.23$, $p = .003$), which further supports the role of Internet in explaining the effect on recall of information. Ultimately, simple effect analysis showed that older patients did not benefit more from text with audiovisual information, $F(2, 160) = 3.04$, $p = .051$, than younger patients, $F(2, 160) = 6.08$, $p = .003$, $\eta^2 = .00$, rejecting H3b.

5. Discussion and conclusion

5.1. Discussion

This study examined ways of effectively presenting health information to cancer patients by adding personalized audiovisual materials to online textual information. The results of this study indicate that supporting textual cancer-related information with

audiovisual information improves recall of cancer-related information and information with personalized audiovisual information enhances website satisfaction. Furthermore, satisfaction with emotional support from the website is more increased by exposure to text with personalized audiovisual information than to text with nonpersonalized audiovisual information. We thus found empirical evidence for the *modality effect* and the *personalization effect* [20] suggesting that text with audiovisual information improves recall of information and text with personalized audiovisual information enhances website satisfaction in cancer patients.

We also found that older patients recalled less cancer-related information than younger patients. However, when taking Internet use into account, the differences in recall between younger and older patients disappeared. Previous research has also revealed that Internet use is a more decisive factor than chronological age [46]. This is an important finding because it is expected that Internet use among older populations will grow due to the process of generational change and the use of computer and Internet facilities. Today's younger adults will be the future's older adults [47]. Together with our findings, this provides evidence for the notion that Internet use plays a crucial role in the effectiveness of health communication in older adults.

In conflict with the cognitive aging principle in multimedia learning, older patients did not benefit more from multimedia strategies such as modality and personalization than younger patients. This might be due to the fact that older patients spent equal time in viewing the webpage as younger patients, and it is found that time spent learning the information is a crucial ingredient of higher recall scores in older adults [48].

We used audiovisual information in addition to text information to compare to text only information. This is in line with the cognitive theory of multimedia learning assuming that information is better learned when presented both visually (e.g., text information) and auditory (e.g., audiovisual information) [18]. However, as we had no audiovisual only condition, it is difficult to conclude whether the added value of combining text with audiovisual information is because the additional video explained information in a different mode or because the same information was presented twice. There is research indicating that repeating information might increase recall of information [49]. Nevertheless, in a previous similar experiment among healthy adults, we found that the same audiovisual materials, presented as audiovisual only without additional text information, increased recall of information when the audiovisual information was personalized, but not when the audiovisual information was nonpersonalized [44]. This indicates that in the current study a modality and personalization effect occurred rather than a repetition effect.

Although this research contributes to our understanding of effective health messages, some limitations should be acknowledged. First, we did not include a personalized text only condition. Previous literature has acknowledged the positive effect of personalized written information as well [50]. Hence, we cannot tell whether we are dealing with a modality effect, a personalization effect or an interaction of modality and personalization to explain website satisfaction and recall of information. Furthermore, the questionnaire was administered online and patients were required to have a computer with access to the Internet. As we found that taking Internet use into account diminished age differences in information recall, we might have overestimated older adults' abilities to understand online information. Furthermore, there were no age differences in patients' frailty in this sample. Both older and younger patients were on average little to moderately frail as they scored (just) below the cut-off point of 4.0 on average [45]. Therefore,

we may not have reached the most vulnerable group of older patients. Thus, it is recommended to involve these patients as well when researching and developing effective health communication tools.

6. Conclusion

We found support for the *modality effect* which suggests that information should preferably be presented as text with additional audiovisual information rather than text only information. Text with audiovisual information was found to improve satisfaction with the comprehensibility and attractiveness of the website (H1a) and recall of information (H2a). We also found evidence for the *personalization effect*, stating that personalized conversational style of information is preferred over nonpersonalized formal style of information. The personalization effect was found in satisfaction with satisfaction with emotional support from the website (H1b), indicating that personalization is a powerful mechanism in perceiving emotional support from a website. Personalization did not increase recall of cancer-related information (H2b). Ultimately, we found, as expected, that older patients recalled less cancer-related information correctly than their younger counterparts (H3a). Furthermore, older patients did not benefit more from multimedia strategies such as modality and personalization than younger patients (H3b). When taking patients' Internet use into account, the age differences disappeared. Even though no interaction effects between age and Internet use were found, this result indicates that Internet use may minimize the differences between younger and older patients and may therefore be seen as an important factor in explaining recall of cancer-related information in multimedia environments.

6.1. Practice implications

Current multimedia environments are promising health communication tools in the provision of relevant health information. This study shows that health information can be optimized in terms of enhancing patients' satisfaction with a website and recall of information by adding audiovisual materials to textual online cancer-related information. Especially personalized audiovisual information, e.g., providing information from a patient's perspective, improved website satisfaction and recall of cancer-related information. Hence, website designers are encouraged to use these multimedia strategies to optimize the provision of health information.

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Conflict of interest

None declared.

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Appendix: personalized version for the patient script

I suffered from lung cancer and was treated with the RFA method. [RFA is a minimally invasive method, which] This means that they approached my [the] lung tumor through a very small nick. A special needle guided by a CT scanner was [will be] inserted into my [the] cancerous lung tumor. The needle was [is] connected to an electrical generator which produces electrical currents. And the electrical currents passing through the needle created [ing] heat that destroyed [s] the cancer cells. The treatment was [is] performed percutaneous which means that the needle electrodes are inserted through the skin.

The treatment takes about one and a half hour and will be performed using spinal anesthesia or sedation. I myself received sedation, but that depended [ing] on the location of the tumor. No surgical procedure is without risk, and also this procedure carries risks [and]. Despite all precautionary measures there is always a small risk of thrombosis, a blood clot inside a blood vessel, lung infection or wound infection.

In addition, RFA [this procedure] also carries the risk of other complications. During my surgery for instance, my lung collapsed. This is also known as a pneumothorax and occurs because of a hole that develops in the lung, which allows air to escape in the space around the lung. This is the most common complication. However, because I was sedated, I did not notice anything. A chest drain was immediately [will be] inserted into the chest cavity to remove the air. This drain helped [s] to reinflate my [the] lung and gradually expanded [s] to its original size.

Then, other complications can also occur, such as [are] (severe) bleeding, air-leak from the lung, pneumonia, and upper respiratory tract infection. Fortunately, I did not experience any of those. By taking precautionary measures in the hospital, they [we] do everything in their [our] power to minimize risks. This means that they explain very precisely what will happen in advance. And this was very pleasant, because in this way I knew what to expect.

Note: underlined portions were added to the personalized version (or replaced the bracketed words).

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