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Online Behaviors, Offline Consequences? Linking Online Traces of Health Information Use to Observed Communication During Medical Consultations

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Research suggests that online health information (OHI) influences offline communication with doctors. However, previous studies have largely examined this with self-reports that are subject to bias. Drawing from unique website trace data and videotaped observations of 232 patients, this study investigates how OHI use relates to participatory communication behaviors during consultations (i.e., question asking and concern expression about various topics). Multivariate analyses showed that the number of Web pages viewed related to greater question asking, unlike the time spent viewing these Web pages. Relying behavioral data, we provide empirical evidence showing that these online activities associate differently with people's offline communication with doctors. Specifically, it is not how long but rather the various information people are exposed to that matters. This study gives insight into the offline consequences of online behavior in the health context and discusses the implications for theorizing the role of computer-mediated communication in today's digital information society.

Keywords: digital trace data, video observations, information seeking, online health information, interpersonal communication, patient participation, question asking, patient-provider communication

Given the widespread use of digital media for a broad range of everyday life activities, online behavior likely has consequences for offline communication processes. One area where this point has often been raised is the health context. Health information seeking is one of the main uses of the Internet in many countries (Pew Research Center, 2010, 2015), and many people first turn to the Internet before consulting other sources (e.g., health professional, traditional media; Jacobs, Amuta, & Jeon, 2017). People can use the Internet to inform and prepare themselves (Medlock et al., 2015; Tan & Goonawardene, 2017) and use this knowledge during a consultation with a doctor (Castro, Van Regenmortel, Vanhaecht, Sermeus, & Van Hecke, 2016). As such, the use of online health information (OHI) can shape the patient-provider relationship: It can supplement communication with the doctor, increase people's participation during consultations, or even replace face-to-face communication (Dedding, van Doorn, Winkler, & Reis, 2011). This study investigates how OHI use relates to people's communication during consultations, particularly focusing on their verbal contribution in the form of asking questions and expressing emotional concerns (Street & Millay, 2001).

People's ability to communicate effectively with their providers should not be taken for granted. Research shows that patients typically ask few questions and experience difficulties in sharing concerns with providers (e.g., Linn, van der Goot, Brandes, van Weert, & Smit, 2019). Active patient participation can facilitate good patient-provider communication, thereby creating a higher level of trust and motivation in patients, and consequently increasing treatment adherence, overall well-being, and improved health outcomes (Iverson, Howard, & Penney, 2008; Shay & Lafata, 2015; Street, Makoul, Arora, & Epstein, 2009). When people express their preferences, needs, and concerns about treatment, shared decision making can take place resulting in higher-quality treatment decisions and greater patient satisfaction (Shay & Lafata, 2015; Street et al., 2009).

Cross-sectional studies have shown that people using OHI are more likely to prepare and ask questions compared with nonusers (Bass et al., 2006; Iverson et al., 2008; Kivits, 2006). With the exception of a few studies (Han, 2012; Han et al., 2009, 2017), research to date has often been based on self-report measures of OHI seeking and/or patient participation and is thus subject to self-report bias (e.g., Bass et al., 2006; Iverson et al., 2008). To date, studies using website trace data of OHI use in combination with observational data of offline communication during consultations are not yet present in current literature, yet the observational nature of such data can overcome self-report biases and provide a unique understanding of how OHI use relates to patient participation.

This study draws on unique website trace data and video observations of 232 patients newly diagnosed with cancer who received a website as part of an educational intervention before their hospital visits. Specifically, we examine how their OHI use (i.e., the educational website) before their visits relates to offline communication in the form of patient participation (i.e., question asking, emotional concern expression) during consultations with a medical provider. We make a theoretical distinction between different OHI use patterns by looking at the *various information topics* consulted as well as the *duration of their website use*. Overall, this study makes a unique contribution to current scholarship on consumer empowerment in an eHealth era and advances our broader theoretical understanding of the interaction between online and offline communication processes in today's digital society.

How Is Online Health Information Use Related to Patient Participation?

Channel complementary theory (CCT; Dutta-Bergman, 2006) offers theoretical guidance to explain the relationship between OHI use and patient participation during medical consultations (Xiang & Stanley, 2017). CCT posits that different information sources work complementary, as people who seek information through a certain channel to fulfill a particular information need are also more likely to use other channels that address those same needs (Dutta-Bergman, 2006). Research on CCT has shown that people indeed strategically select complementary health information sources—ranging from online and offline mediated sources to health care providers—to satisfy their information needs (Rains & Ruppel, 2016). In the context of OHI use and offline communication between patients and health care providers, CCT suggests that patients' use of OHI can strengthen their involvement in medical consultations (Xiang & Stanley, 2017).

There are several explanations for a positive relationship between OHI use and offline patient participation. First, OHI can form a "training ground" for people to prepare themselves for consultation, for instance, by acquiring relevant knowledge and making a list of questions (Dedding et al., 2011; Xiang & Stanley, 2017). Moreover, OHI seeking can increase people's confidence in communicating with their doctors, for instance, about being involved in treatment decisions, and through asking questions and expressing concerns during consultation (Bass et al., 2006; Sillence, Briggs, Harris, & Fishwick, 2007). With adequate preparation, people can enrich conversations with providers with their input and expertise. Second, OHI can also help patients to better cope with their illnesses (Beaudoin & Tao, 2007). This may stimulate their self-disclosure during consultation (e.g., by expressing concerns) and allows opportunity to build a partnership with their providers (Dedding et al., 2011). Finally, OHI use may indirectly increase patient participation during consultation through a "priming effect." For instance, when a health care provider introduces a topic that the patient has read about on the Internet, this can trigger people to further ask questions or express their concerns about this topic (Tan & Goonawardene, 2017; Wald, Dube, & Anthony, 2007; Xiang & Stanley, 2017).

However, there is also valid reason to believe that OHI use may lead to less patient participation during medical consultations. Since basic knowledge has already been obtained online before the consultation by people, potentially fewer questions need to be discussed during the consultation (Wald et al., 2007). This might result in more efficient use of the consultation and perhaps even a reduction of clinical time (Wald et al., 2007). Furthermore, conflicting information between what people find online and hear from their doctors may make people insecure and challenge their trust in their health care providers (Erdem & Harrison-Walker, 2006). This could explain why people might ask fewer questions or express fewer concerns during a consultation (Eggly et al., 2011). In these scenarios, OHI use could lead to less active patient participation during medical encounters. This hypothesis, however, is less often explored in current literature.

Different Patterns of Online Health Information Use, Different Effects?

People consult online information in different ways depending on their information needs and preferences and individual characteristics (e.g., Loos, 2011; Tullis, 2007). Specifically, people scan Web pages differently in terms of the various content explored and time spent viewing this content (Loos, 2011; Tullis, 2007). Previous scholarship in health communication has theorized various ways to code website trace data, such as by separating the amount of use (e.g., number of logins, time spent online, number of Web pages viewed) from patterns of use (e.g., continuous use, time span of use, intensity of use; Han, 2011). Patterns of use are particularly relevant in evaluating people's uses of eHealth systems that can and are encouraged to be used over a longer period of time, as it is only then that we can develop measures that capture patterns over weeks or months that people have engaged with an online health system. Research by Han and colleagues (2009) has shown that measures of commitment over time to an interactive eHealth tool based on Web trace data were predictive of self-reported health participation, whereas overall time spent on the tool did not. In another study by Han and colleagues (2017), the number of Web pages viewed showed to be a good predictor of patients' self-confidence in obtaining and using cancer-related information. Given that the current study focuses on an educational website intervention that is delivered to patients several days before their hospital consultations, we intend to focus particularly on a set of measures that reflects the amount of use during these days, rather than usage patterns covering longer time spans (i.e., weeks, months).

Inspired by previous communication scholars' operationalizations of measures reflecting the amount of Internet use (Han, 2011; Shklovski, Kraut, & Rainie, 2004), this study distinguishes between different website uses by focusing on (a) the *various information topics* that people explore and (b) the *amount of time* spent on exploring this information on a health website. Such differentiation in Internet use patterns have been suggested to be valuable in understanding the different impact that online activities have on people's offline communication behaviors (Han, 2011; Shklovski et al., 2004). In context of this study, a person who browses a website to explore a wide range of different topics (many topics) in a five-minute time frame (little time) may pick up different knowledge than someone who consults only a few topics of interest (few topics) but spends this same time on each of these few Web pages (longer time).

Given that different patterns of OHI use likely affect the knowledge benefits that people derive from it (Bayram & Bayraktar, 2012; Bol et al., 2016) and consequently the knowledge they bring with them to the doctor, both the various topics explored as well as the time spent on these information topics may influence patients' participation during medical consultations.

The Current Study

This study aims to examine the relationship between OHI use and patient participation using observational measures while also controlling for contextual factors (i.e., sociodemographics, medical background, information seeking, and consultation characteristics). First, we explore how people use OHI by distinguishing between different online use patterns for various information topics, namely (a) the *number of Web pages viewed* as well as the (b) *time spent on various Web pages*. Our research question is as follows:

RQ1: How do patients consult OHI before visiting the hospital for diagnosis and treatment planning, specifically looking at the number of Web pages viewed and time spent on Web pages?

Next, we test the relationship between people's use of OHI and patient participation in the form of verbal communication during medical consultations, to answer the question of whether OHI use associates with higher or lower levels of patient participation. Given the contrasting views on this relationship, as well as our nuanced operationalization of OHI use in the current study, we pose the following research question:

RQ2: How does patients' use of OHI (i.e., number of Web pages viewed and time spent on these Web pages) relate to their verbal participation (i.e., asking questions and expressing concerns) during consultations with their medical providers?

Method

The study design involved tracking people's use of a hospital website, self-report questionnaires, and video observations of consultations between patients and medical providers. The present study is part of a larger project, in which a randomized controlled trial was conducted to test the effects of this website on self-reported outcomes, such as information processing and satisfaction (Nguyen, Smet et al., 2019). The medical ethical review board of Amsterdam University Medical Centers, University of Amsterdam, and the ethics committee of the Amsterdam School of Communication Research, University of Amsterdam, approved the study.

Participants

We recruited participants from December 2015 through September 2018 at an academic multidisciplinary outpatient clinic (Gastro-Intestinal Oncological Center Amsterdam [GIOCA], Amsterdam University Medical Centers) that specializes in fast-track diagnosis and treatment planning within one day. Participants were patients who were highly suspected of having gastrointestinal malignancies (i.e., colorectal, stomach, esophageal), or came for a second opinion. They had typically not started treatment yet, as they were still in the diagnosis and treatment-planning phase. To be eligible for the study, patients had to meet the following inclusion criteria: (1) 18 years or older; (2) speak Dutch language; (3) no cognitive impairments according to the medical record; (4) Internet access. A total of 232 patients were included in the final analyses. An overview of participant inclusion, reasons for nonresponse, and dropout rates is shown in Figure 1. A nonresponse analysis revealed no differences between participating and nonparticipating patients in age, $t(689) = 1.52$, $p = .129$, and gender, $\chi^2(1, N = 691) = 3.26$, $p = .071$.

Participants were on average 63.5 years (*SD* = 9.06; range 36–86). Most of the sample was male (68.1%, *n* = 158), which represents global figures that gastrointestinal malignancies are more common among men (Bray et al., 2018). Most people were already aware of a preliminary diagnosis before their visits (76.6%). Table 1 provides an overview of all background information.

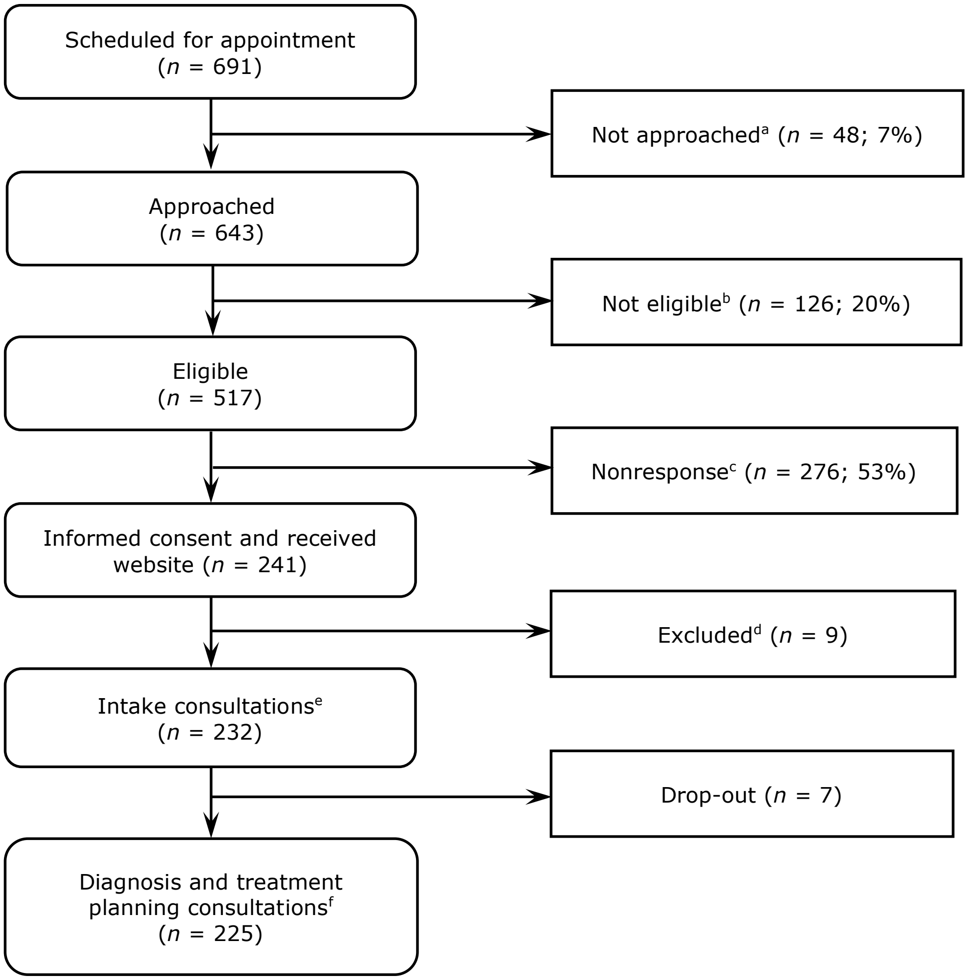


Figure 1. Flowchart for patient inclusion and exclusion and reasons for nonresponse.

Note. [a]Unreachable before visit (*n* = 37), incomplete contact details (*n* = 11). [b]No computer or e-mail address or not competent to work with computers (*n* = 74), insufficient command of Dutch language (*n* = 22), appointment cancelled (*n* = 6), hospitalized or cognitive impairment (*n* = 24); [c]No time or too burdensome (*n* = 108), privacy issues (*n* = 22), no interest in additional (online) information (*n* = 22), no specific reason given (*n* = 117), other (*n* = 7). [d]Another nine patients were excluded from data analysis because they did not use the website intervention, resulting in a final sample size of *N* = 232. [e]Missing data from 10 cases. [f]Missing data from six cases.

Table 1. Patient Background Characteristics.

	N	Frequency (%)	Mean (*SD*)
Sociodemographic information			
Age in years (range: 36–86)	232		63.50 (9.06)
Gender (female)	232	74 (31.9)	
Education level	231		
Lower		146 (62.9)	
Higher		85 (37.1)	
Medical background information			
Diagnosis known before visit	232	178 (76.6)	
Cancer type	232		
Colorectal		187 (77.9)	
Esophageal/stomach		45 (22.1)	
Second opinion	232	43 (18.5)	
Treatment goal	232		
Palliative		31 (13.4)	
Curative		170 (73.2)	
Unclear		31 (13.4)	
Health literacy (range: 0–22)	182		16.66 (4.66)
Information seeking characteristics			
Information coping style (range: 1–5)	229		3.75 (0.87)
Information preference	229		
Not all information (at once)		56 (24.5)	
As much information as possible		173 (75.5)	
Additional information received	218	150 (64.7)	
Searched for other information online	232	131 (56.5)	
Consultation characteristics			
Companion(s) at visit			1.26 (0.64)
Consultation time (min)			50.07 (28.66)
Gastroenterologist		137 (59.1)	
Surgeon		154 (66.4)	
Medical oncologist		41 (17.7)	
Radiation oncologist		24 (10.3)	

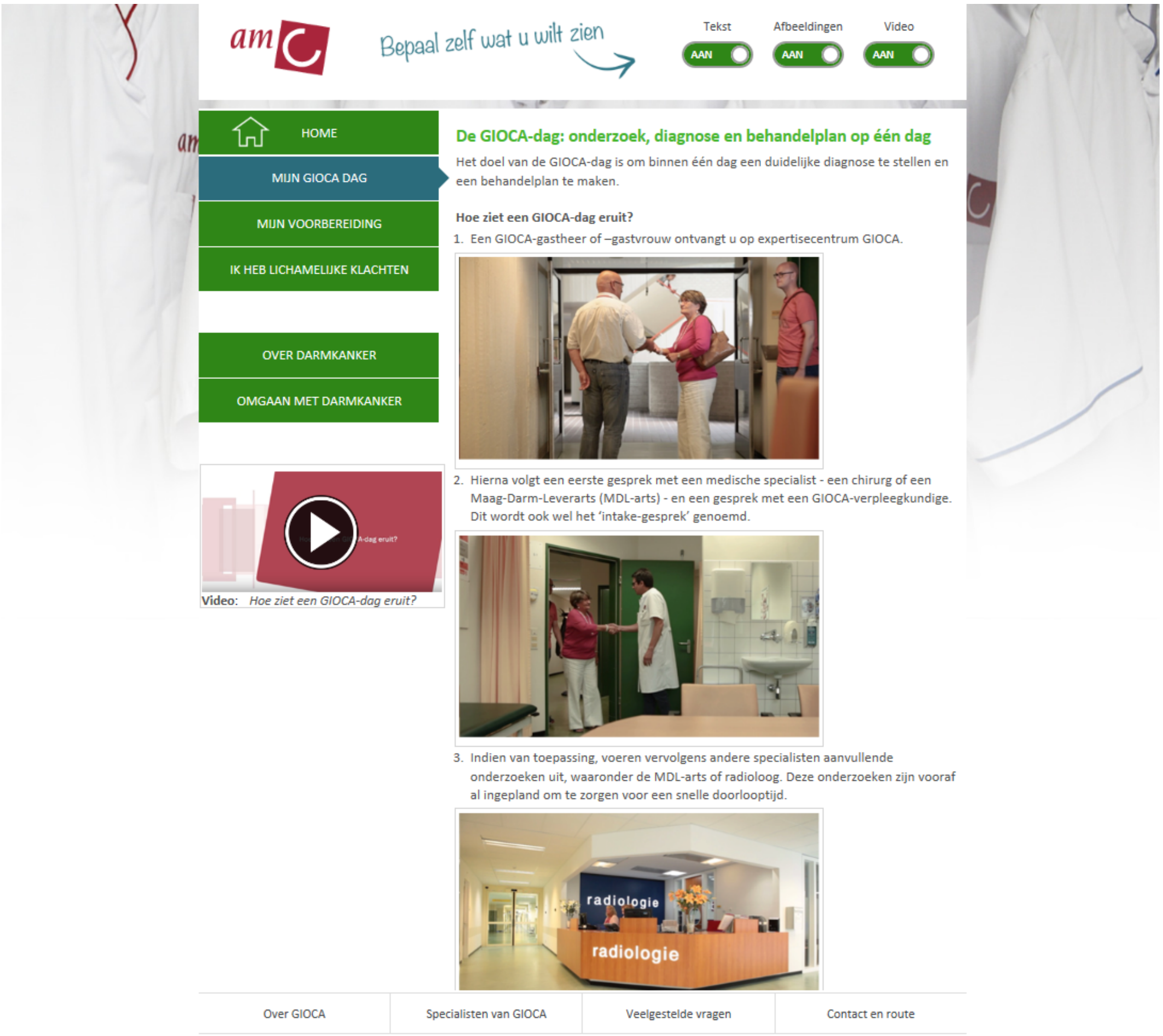
Note. Not all numbers add up to *N* = 232 because of missing data.

Study Procedure

Participants received a personal link to the hospital website by e-mail between one and five days before their visits, depending on when their appointments were scheduled. They were free to use the website as they wished. Before their visits, consenting patients completed an online questionnaire to record background variables. Their appointments took one full day. The day started with an intake consultation with a physician (i.e., gastroenterologist or oncological surgeon) to evaluate symptoms and medical history. At noon, a multidisciplinary team discussed the diagnosis and formulated a treatment plan. In the afternoon, diagnosis and treatment were discussed with the patient by the physician who conducted the intake. Depending on the treatment plan, patients also visited a surgeon, oncologist, or radiation oncologist on the same day to discuss their treatment plans. Patients had two to five consultations with different providers during this day. A research assistant was present to video record all consultations. All participants and providers gave written consent for the recordings.

The Hospital Website

The educational website intervention (see Figure 2) was designed to prepare patients for their visits. The website was explicitly developed for this study and not publicly available at that time. As part of a larger research project (Nguyen, Smet et al., 2019), four website versions were developed containing identical textual information but with different visual support (via images, illustrations, and/or patient videos). The present study focuses on the content, rather than how this content is conveyed, and therefore analyzes the website information participants have come across (see “Statistical Analyses” for how we control for this). The websites contained (a) medical information (i.e., the disease, diagnostics, treatment [options], complications, and side effects); (b) practical information, (i.e., about the clinic, appointment, and logistics of treatment and follow-up appointments); and (c) lifestyle information, (i.e., psychosocial topics and disease management in daily life, such as dealing with nutrition, diet, and fatigue). We developed the website in collaboration with health care professionals and patients (see Nguyen, Bol et al., 2019).



Tekst AAN

Afbeeldingen AAN

Video AAN

De GIOCA-dag: onderzoek, diagnose en behandelplan op één dag

Het doel van de GIOCA-dag is om binnen één dag een duidelijke diagnose te stellen en een behandelplan te maken.

Hoe ziet een GIOCA-dag eruit?

1. Een GIOCA-gastheer of –gastvrouw ontvangt u op expertisecentrum GIOCA.
2. Hierna volgt een eerste gesprek met een medische specialist - een chirurg of een Maag-Darm-Leverarts (MDL-arts) - en een gesprek met een GIOCA-verpleegkundige. Dit wordt ook wel het 'intake-gesprek' genoemd.
3. Indien van toepassing, voeren vervolgens andere specialisten aanvullende onderzoeken uit, waaronder de MDL-arts of radioloog. Deze onderzoeken zijn vooraf al ingepland om te zorgen voor een snelle doorlooptijd.

Video: *Hoe ziet een GIOCA-dag eruit?*

Figure 2. Example screenshot of the preparatory hospital website.

Main Variables

Website Use Behavior

All user activities on the website were logged with a participant ID, date, and timestamp. We calculated two measures reflecting their website use, namely the total number of Web pages visited, and the total time spent in minutes on each Web page. We categorized each measure of website use corresponding to the website content: (a) medical information, (b) practical information, and (c) lifestyle information (see Table 2), meaning that we had six variables in total reflecting website use.

Patient Participation

We developed a codebook before scoring patient participation from the videotaped consultations (based on work from Street & Millay, 2001; Zandbelt, Smets, Oort, Godfried, & Haes, 2007). We coded the number of verbal expressions in the form of (a) questions and (b) emotional concerns and cues that came from the patients' side, which includes verbal expressions by their companion—if applicable—as well. We defined questions as verbal expressions that have the goal to obtain or clarify information (e.g., "What are the side effects of the medication?"). Concerns reflect the explicit verbal expression of negative emotions (e.g., "I am afraid of the radiation"), while cues refer to the indirect disclosure of such negative emotions (e.g., "I just want to know what is going on; that is most important"). Emotional concerns and cues could, for instance, relate to worry, anxiety, disappointment, insecurity, frustration, and more. Because the number of emotional concerns and cues expressed was overall low, we collapsed these into one score reflecting the total number of emotional concerns and cues (referred to as concerns from now on). In line with the website content, we categorized patient participation into expressions about (a) medical topics (e.g., expressions about the disease, diagnostic test results, treatment and options, side effects), (b) practical topics (e.g., treatment planning and logistics), and (c) lifestyle topics (e.g., psychosocial care, daily life recommendations). Two coders were involved in the coding process (MHN & MB). Sixteen consultations were double coded, showing good intercoder reliability (Krippendorff's α = .95 and .85 for questions and concerns, respectively).

Control Variables

Sociodemographics

We measured age, gender, and education level. Education level was dichotomized to reflect higher education level (i.e., higher vocational education and university) versus all lower categories.

Medical Background Information

We recorded cancer type (colorectal = 0 and esophageal/stomach = 1) and whether patients came for a second opinion (yes/no). We assessed whether patients knew their preliminary diagnosis before consultation (yes/no). The treatment goal (palliative or unclear = 0; curative = 1) was derived from the medical file after the consultation.

Information Seeking Characteristics

We measured information coping styles with three items (Miller, 1987), which is the degree to which patients seek information in a threatening medical situation (e.g., "I intend to get as much information as possible about my treatment"; 5-point scale; Cronbach α = .83). We measured information preferences by asking whether patients prefer to receive (a) "as much information as possible, both positive and negative," (b) "as much information as possible, both positive and negative, but bit by bit," (c) "not much information," and (d) "only positive information" (Thomas, Kaminski, Stanton, & Williams, 2004). We merged the last three categories into "not all information (at once)" (0) versus the first category "as much information as possible, both positive and negative" (1; van Weert et al., 2009). Finally, we asked whether patients had searched for health information on the Internet in addition to the website provided for this study (yes/no), and whether patients had received information about the clinic from other sources (e.g., brochures, interpersonal communication; yes/no).

Consultation Characteristics

We calculated the duration of all consultations with doctors into one variable reflecting total consultation time. A consultation started with the first verbal expression and finished with the last. Interruptions during a consultation (e.g., a phone call) were not counted toward the total consultation time, as verbal expressions by the patient or companion directed at the provider were not possible at that time. We also recorded how many companions participants brought to their consultations and which providers participants consulted with (for each, yes/no).

Statistical Analyses

We conducted the analyses in R (version 3.6.2), using packages car (version 3.0-3; Fox et al., 2019) and QuantPsyc (version 1.5; Fletcher, 2012). To answer RQ1, we first describe how patients used the website and how they participated during their medical consultations. To answer RQ2, we used multivariate analyses of variance (MANOVA) to test whether the OHI-use variables influenced the outcome variables jointly, thereby accounting for Type I errors. If multivariate tests are significant, we report the univariate regression weights to show which outcomes are relevant. We estimated regression models to examine whether (a) the number of Web pages viewed and (b) the time spent on these Web pages influence (i) the questions asked and (ii) concerns expressed during consultation about the three information topics. We repeated all analyses without covariates as a robustness check. Controlling for which website version patients viewed did also not change the results. We omitted one severe outlier based on the Cook's distance method (deviation of five to nine standard deviations from the sample mean on all website use variables). Assumptions of linearity, normality, homoscedasticity, independent errors were met. The zero-order correlations are published in an appendix (https://osf.io/p8k7j). As the website use variables were highly correlated, we estimated separate models for the breadth and depth of OHI use. There were no issues of multicollinearity (VIFs ≤ 2.5).

Results

Patients' Online Health Information Use

Table 2 provides a summary of participants' OHI use. Most (62.1%) viewed the website twice or more often before their visits. Participants showed a large variability in their website usage (RQ1). Patients visited 34 Web pages on average (*SD* = 39.72) and spent an average of 35 minutes on the website (*SD* = 32:56). Web pages containing practical information were visited most often, with an average of 19 pages visited (*SD* = 20.59) and a duration of 20 minutes (*SD* = 20:03). This was followed by medical information, with an average of 10 pages visited (*SD* = 17.04) and 10 minutes (*SD* = 13:55).

Lifestyle information were least frequently consulted, with an average of 5 page visits (*SD* = 6.04) and 5 minutes visit duration (*SD* = 06:42).

Table 2. Website Use Characteristics.

	Mean (*SD*)	Median	Range
Total website visits	2.78 (2.28)	2.00	1–22
Number of Web pages viewed	34.01 (39.72)	23.00	1–384
Medical Web pages	9.95 (17.04)	5.00	0–168
Practical Web pages	18.91 (20.59)	12.50	1–175
Lifestyle Web pages	5.16 (6.04)	4.00	0–42
Time spent on Web pages	34:45 (32:56)	26:41	00:34–3:51:17
Medical information	10:21 (13:55)	04:59	00:00–1:11:05
Practical information	19:50 (20:03)	14:17	00:18–2:18:38
Lifestyle information	04:33 (06:42)	06:42	00:00–40:55
Website information consulted	Frequency (%)		
Medical topics			
Disease and treatment	187 (80.6)		
Diagnostic tests	94 (40.5)		
Practical topics			
The fast-track procedure	211 (90.9)		
Preparing for consultations	201 (86.6)		
Contact information	63 (27.2)		
Medical specialists	46 (19.8)		
Lifestyle topics			
Daily life recommendations	156 (67.2)		
When to contact the hospital	151 (65.1)		
Additional websites	58 (25.0)		

Note. *N* = 232. Time spent online is displayed in hh:mm:ss.

Patient Participation During Consultation

The average total length of the recorded consultations was 50 minutes (*SD* = 28:39), spread over an average of 2.52 consultations (*SD* = 0.76). The average time per consultation was 19 minutes (*SD* = 08:10). Patient participation varied widely across participants: On average, patients asked 30.74 questions (*SD* = 21.40) and expressed 6.11 concerns (*SD* = 5.93) during their meetings with physicians. Most questions and concerns were about medical topics (*M* = 20.37, *SD* = 15.19 and *M* = 3.30, *SD* = 3.75, respectively). For the number of questions, this was followed by practical topics (*M* = 9.18, *SD* = 7.17) and then lifestyle topics (*M* = 1.41, *SD* = 1.79). For the number of concerns expressed, this was followed by lifestyle topics (*M* = 2.23, *SD* = 3.05) and then practical topics (*M* = 0.63, *SD* = 1.09).

How Does Online Health Information Use Relate to Patient Participation?

About question asking (Table 3), multivariate tests revealed significant effects of the *number of Web pages visited* about medical information (V = .05, *F*(3, 187) = 3.29, *p* = .022), practical information (V = .07, *F*(3, 187) = 4.78, *p* = .003), but not for lifestyle information (V = .01, *F*(3, 187) = 0.86, *p* = .464). When considering the specific topics patients asked questions about, the univariate regression models show that the amount of Web pages visited about medical information related to more questions asked about lifestyle topics (β = .20), while viewing more practical information related to fewer questions about lifestyle topics (β = −.22). Viewing more Web pages about practical information related to more questions about medical topics (β = .17). The *time spent on Web pages* about medical (V = .01, *F*(3, 187) = 0.45, *p* = .718), practical (V = .03, *F*(3, 187) = 2.20, *p* = .089), and lifestyle information (V = .00, *F*(3, 187) = 0.25, *p* = .860) did not relate to question asking overall.

For concern expression (Table 4), multivariate tests revealed a significant relationship with the *number of Web pages visited* about practical information (V = .05, *F*(3, 187) = 3.24, *p* = .023), but not with Web pages visited about medical (V = .01, *F*(3, 187) = 0.62, *p* = .605) and lifestyle information (V = .01, *F*(3, 187) = 0.53, *p* = .660). Specifically, viewing Web pages about practical information related to more concerns being expressed about medical topics (β = .25). The *time spent on Web pages* about medical (V = .01, *F*(3, 187) = 0.35, *p* = .792), practical (V = .03, *F*(3, 187) = 2.23, *p* = .086), and lifestyle information (V = .03, *F*(3, 187) = 1.95, *p* = .122) did not relate to concern expression overall.

The results remained largely the same when repeating the models without covariates. Given space constraints, we report only the standardized regression coefficients of the models with covariates in Tables 3 and 4 and provide a complete overview in an online appendix (https://osf.io/p8k7j/).

Table 3. Effects of Online Health Information Use on Question Asking.

	Model 1			Model 2		
	β_{Medical}	$\beta_{\text{Practical}}$	$\beta_{\text{Lifestyle}}$	β_{Medical}	$\beta_{\text{Practical}}$	$\beta_{\text{Lifestyle}}$
Breadth: Number of Web pages						
Medical information	−.10	−.06	.20 *			
Practical information	.17 *	.12	−.22 *			
Lifestyle information	−.05	.04	.09			
Depth: Time spent on Web pages						
Medical information				−.03	.00	.07
Practical information				.05	.02	−.16 *
Lifestyle information				.02	.04	−.02
Sociodemographics						
Age	−.08	.06	.00	−.07	.06	.00
Female	−.04	−.03	.01	−.03	−.03	.00
Education level (high)	.16 **	.05	.03	.15 **	.04	.03
Medical background information						
Cancer type (esophageal/stomach)	−.10	.02	.19 **	−.09	.01	.18 **
Second opinion	−.14 *	−.19 ***	−.09	−.12 *	−.19 ***	−.12
Preliminary diagnosis known	.06	.00	−.08	.07	.01	−.09
Prognosis (curative)	.03	−.02	−.01	.04	−.02	−.01
Information seeking characteristics						
Monitoring coping style	−.02	.09	.00	−.02	.08	−.01
Information preference	.06	.05	.09	.06	.06	.11
Received other information	−.08	−.11 *	.05	−.08	−.11 *	.06
Searched online	.05	.04	.10	.06	.06	.09
Consultation characteristics						
Companion(s) at visit	−.02	−.02	−.05	−.01	−.02	−.06
Consultation time	.72 ***	.49 ***	.48 ***	.72 ***	.50 ***	.51 ***
Gastroenterologist	−.05	.12	−.15	−.04	.12 *	−.17 *
Surgeon	−.06	.06	−.13	−.05	.05	−.16
Medical oncologist	.00	.26 ***	−.08	−.01	.25 ***	−.09
Radiation oncologist	−.11	.09	−.12	−.11	.09	−.14
Adjusted R^2	.50	.54	.21	.49	.53	.20

Note. N = 210 because of missing data. We report standardized regression coefficients for the regression models. A full overview of results can be found in the online appendix.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 4. Effects of Online Health Information Use on Concern Expression.

	Model 3			Model 4		
	$\beta_{Medical}$	$\beta_{Practical}$	$\beta_{Lifestyle}$	$\beta_{Medical}$	$\beta_{Practical}$	$\beta_{Lifestyle}$
Breadth: Number of Web pages						
Medical information	−.09	.05	.02			
Practical information	.25 **	−.11	.00			
Lifestyle information	−.03	−.07	.07			
Depth: Time spent on Web pages						
Medical information				.02	−.05	−.05
Practical information				.19 *	−.01	.05
Lifestyle information				−.03	−.15 *	.06
Sociodemographics						
Age	−.06	−.10	−.18 **	−.08	−.12	−.18 **
Female	−.01	.08	−.02	−.01	.06	−.02
Education level (high)	−.03	−.12	.01	−.03	−.10	.01
Medical background information						
Cancer type (esophageal/stomach)	−.12	.04	.15 *	−.13	.05	.15 *
Second opinion	.02	−.13	−.01	.03	−.15	−.03
Preliminary diagnosis known	−.06	−.02	.00	−.07	−.03	.00
Prognosis (curative)	−.04	.08	−.04	−.04	.08	−.04
Information seeking characteristics						
Monitoring coping style	.10	−.09	.17 *	.10	−.09	.17 *
Information preference	.01	.03	−.06	.00	.01	−.07
Received other information	.06	−.07	.11	.04	−.07	.11
Searched online	−.07	.07	−.09	−.05	.06	−.08
Consultation characteristics						
Companion(s) at visit	.05	−.13	.00	.05	−.15 *	.00
Consultation time	.36 ***	.18 *	.27 **	.35 ***	.20 *	.27 **
Gastroenterologist	−.08	.11	.01	−.05	.10	.02
Surgeon	−.03	−.01	.04	−.02	−.03	.04
Medical oncologist	.24 **	.13	.12	.23 **	.14	.13
Radiation oncologist	−.13	.02	.13	−.11	.00	.13
Adjusted R^2	.20	.08	.22	.20	.09	.22

Note. $N = 210$ because of missing data. We report standardized regression coefficients for the regression models. A full overview of results can be found in the online appendix.
* $p < .05$. ** $p < .01$. *** $p < .001$.

The Role of Contextual Background Factors in Explaining Patient Participation

A great portion of variance in patient participation was explained by background variables. Overall, longer consultations contained more questions and concerns about all topics. Higher-educated patients asked more questions (mostly about medical topics) compared with lower-educated ones, whereas older age was associated with more concerns (mostly about lifestyle topics). The number of questions and concerns also differed by disease: patients with esophageal/stomach cancer talked more about lifestyle topics than those with colorectal cancer. Those coming for a second opinion asked fewer questions overall. Patient participation also varied by the type of physician people spoke with: those who consulted a gastroenterologist or medical oncologist asked more questions and expressed more concerns.

Discussion

This study aimed to investigate how people's use of OHI relates to offline communication with their doctors, by drawing on unique observational data—that is, online trace data and video observations of medical consultations. As a case study, we used data from patients who were newly diagnosed with cancer and received a preparatory website before their hospital visits. It is remarkable that many patients used the website intensively (*M* = 34 Web pages and 35 minutes). Overall, we find great variation in how people use a preparatory website before their hospital visits. Several people used the website only briefly, others visited multiple times, explored a wide range of Web pages, and spent time viewing information for up to several hours. About patient participation, our data show the number of Web pages consulted were associated with a lower or higher number of questions asked or concerns expressed about various topics (i.e., medical or lifestyle) depending on what information patients consulted (i.e., medical or practical information). Interestingly, the time spent on viewing OHI was not related to offline communication during consultations in the form of patient participation (i.e., question asking and concern expression). This corresponds with work by Han and colleagues (2009), suggesting that measures that go beyond time spent online are more predictive of health outcomes. In summary, our findings suggests that it is not *how long* people spend consulting OHI but rather the *various information* they are exposed to that relates to offline communicative behaviors during medical consultations.

Our study provides pioneering empirical evidence based on behavioral data (i.e., website trace data and videotaped observations) showing that what people do online relates to the offline communication in the consultation room. One possible explanation as to why people ask more questions to their providers when having viewed a greater number of Web pages could be that exposure to various topics primes them about subjects they would like to know more about. For instance, it could be that viewing mostly medical Web pages covered people's knowledge about this, leading to asking more questions about topics such as lifestyle. Similarly, viewing practical information could have meant that medical knowledge was missing, thus explaining why more questions and concerns were expressed around this topic. This suggests that the content of OHI that patients consume makes a difference to what patients talk about during consultation.

Another explanation for our findings is that when various OHI topics are explored (i.e., breadth), but this is not done in-depth (i.e., the amount of time), this can make patients uncertain about the information they find online. In contrast, the greater amount of time spent on OHI, suggesting that people consult information more thoroughly, might not trigger such responses and therefore have a different impact or have no impact on patient participation. In light of advancing theory, a next step is to explore the underlying mechanisms that explain different effects of OHI use on offline communication processes. Theory on communication, information, and uncertainty management (Brashers, 2001; Kuang & Wilson, 2017) could be a useful starting point to differentiate between various patterns of OHI use and its effects on uncertainty and information seeking online and offline in health contexts and beyond. For instance, greater relative “breadth” (i.e., the number of information topics consulted) versus “depth” (i.e., the time spent consulting specific information) of OHI use might increase feelings of uncertainty and lead to offline information seeking during consultations (e.g., more questions or concerns expressed). Overall, making a theoretical distinction between such different Internet usage patterns may help illuminate the interaction between online and offline communication processes and outcomes and contribute to computer-mediated communication theory more broadly.

We find no relationships between the time spent on OHI use and patient participation during consultations, which somewhat contradicts previous work in this domain (Bass et al., 2006; Iverson et al., 2008). This discrepancy might be explained by differences in measurement instruments. Previous studies have mainly used self-report measures for OHI use and patient participation, such as surveys (Bass et al., 2006; Iverson et al., 2008; Lee, Gray, & Lewis, 2010), and qualitative interviews (Kivits, 2006; Sillence et al., 2007), which could be sensitive to self-report bias. Although we find that the time spent online does not relate to the objective *number* of questions asked and concerns expressed, it may be that patients did feel more prepared and were better able to answer questions from the provider. Future research could explore how OHI use affects patient participation beyond question asking and the expression of concerns, for instance, by focusing on their sense of self-efficacy or by including alternative measures of participation such as relative speech time (Zandbelt et al., 2007).

Health communication designers and clinical practitioners could strategically use OHI to stimulate participation (e.g., by offering certain topics, or a broad variety). This is important for several reasons. First, providing OHI as part of the care trajectory fits well with the current trend in which people desire and are encouraged to play a more active role in their own health care (Castro et al., 2016; Tan & Goonawardene, 2017). Second, many people do not know which online information to trust and worry about being exposed to irrelevant information (Lee, Hoti, Hughes, & Emmerton, 2014). Recommended websites that come from a reliable source (i.e., the hospital) are more likely to be trusted than websites found through Google searches, where people must wade through a bulk of information (Sbaffi & Rowley, 2017). Finally, as most participants in our study used the website for a good amount of time, this indicates a high need for additional information at the early stage of diagnosis and treatment planning. Providing OHI at this stage might help people cope with their illnesses and facilitate patient participation, thereby contributing to a good start of their care trajectory.

Strengths, Limitations, and Future Research

A strength of this study is the use of purely behavioral, observational data of OHI use and offline communication in the form of participation during medical encounters. By using these methods, real-world behavior is accurately represented, and self-report bias is minimized. In our study, we quantified patient participation by counting the number of questions asked and emotional cues and concerns expressed. Alternatively, OHI use before consultations may not necessarily influence the frequency of such verbal expressions during consultation but rather the *quality* of such verbal expressions (e.g., more in-depth or specific questions, which in turn improves communication with their provider; Sillence et al., 2007). Future research could look at the nature of the questions asked or concerns expressed. Furthermore, exploring other measures of offline communication or patient participation, such as the relative time the patient is speaking or whether patients make assertive remarks (e.g., requests; Street & Millay, 2001; Zandbelt et al., 2007) is needed to gain a more comprehensive understanding of how OHI use influences patient participation.

Two side notes must be made when considering the results from this study. First, although we measured OHI use before consultation, it could be that those who viewed certain information (i.e., medical, practical, lifestyle) already had more questions or concerns about this topic to begin with. Thus, an increase in active patient participation may not primarily be explained by viewing more practical information pages but rather by the extent to which people were interested in this type of information before their hospital visits. Similarly, it could be those who seek health information online are also likely to do so during consultations by asking questions to their doctors, indicating a mere correlation between OHI use and participation (Cowan & Hoskins, 2007). Although a causal relationship cannot be concluded from our data, we do note that there is a temporal order in our data where participants viewed a website first, and met with their health care providers later. Moreover, we controlled for information needs and seeking characteristics at baseline and found relationships between OHI use and patient participation nonetheless, demonstrating the robustness of our results.

Second, the pages with practical information included instructions on how to prepare for a hospital visit, including the suggestion of making a list of questions. Such question-prompt lists can increase question asking during consultations (Brandes, Linn, Butow, & van Weert, 2015). Therefore, it could be that this practical advice activated people to ask more questions. Nevertheless, the content of the practical information pages encompassed a great deal of other information on practical matters, and so the results are not likely to result from the practical advice of preparing questions alone. Future work could consider the role of specific preparatory activities (i.e., behavioral responses) that people take in response to OHI use (e.g., preparing questions, listing concerns or treatment options) to better understand how it affects offline communication patterns.

In our analyses, we tried to account for possible confounding variables that are expected to have an influence on OHI use and/or patient participation during consultations. As our project focused on cancer patients at the time of diagnosis—a highly stressful time, it was important not to overburden patients with questionnaires. To this end, we only asked questions that were of direct relevance to online information seeking in a medical context and patient participation, which included essential control variables based on prior research, such as patients' monitoring coping style and information preferences (Looper et al., 2021; van Weert et al., 2009). Nonetheless, it could be that other, unobserved variables would influence OHI use and/or the questions asked or concerns expressed during consultation, such as people's trust in health care and doctors (DeWalt, Boone, & Pignone, 2007), fatalism (Paige, Alpert, & Bylund, 2021), anxiety (Looper et al., 2021) or uncertainty tolerance (Hillen, Gutheil, Strout, Smets, & Han, 2017). Exploring how such factors influence OHI use and patient participation outcomes continues to be an important avenue for future research.

In terms of external validity, it is important to consider the context in which this study took place. First, the Netherlands is characterized by many Internet users for health information. This made this study scene highly suitable for answering our research question but also raises the question about whether our results could be generalized to other country contexts. Although our study population is quite comparable to other Western countries about adoption of the Internet (Eurostat, 2024), it is important to consider that the results might be different in other cultural contexts. Second, participants consented to take part in a study about information provision. Despite that a quarter of our sample reported to be low-information seekers, it may be possible that high-information seekers were more interested to participate in the study. However, it is also known that newly diagnosed cancer patients generally have high information needs (Rutten, Arora, Bakos, Aziz, & Rowland, 2005), which could explain why the website was well-used by many participants.

Finally, this study was embedded in a larger project where participants received a website with the same information but with different visual aids (i.e., images and/or patient videos). As patients may be more attracted to view pages with visuals or videos, this might have influenced the way they used the website. Although we controlled for this in the analyses, it would be valuable to obtain such data from a website with a similar layout in future work. Furthermore, tracing general OHI use (outside the context of one website) to explain online and offline communication patterns would be a unique addition to the literature, although this comes with specific methodological and ethical challenges that have been addressed by previous computational communication scholars (Freelon, 2014; Van Atteveldt & Peng, 2018).

Conclusion

This study gives important insight into the interaction between online media use and offline communication in the health context. We analyzed unique website trace data from cancer patients who consulted a preparatory website before their hospital visit and linked this to their verbal participation (i.e., question asking, concern expression) during medical consultations derived from video recordings. Although the *time spent* on OHI use did not relate to patient participation, the *number of Web pages consulted* about certain topics (i.e., medical practical information) was significantly associated with the number of questions asked and concerns expressed. This suggest that it is important to consider not only if and how intensively patients use OHI but also *the various information* as well as *what specific information* they are exposed to, as this may shape offline communication processes differently. This study is novel in that it solely relies on observational data to measure OHI use and offline patient-provider communication, thus making an important methodological contribution to current scholarship on the implications of Internet use in the health context and beyond. Furthermore, our findings give unique insight into the interaction between online and offline communication processes and can guide future work in theorizing the effects of computer-mediated communication in today’s information age.

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