UNIVERSITY OF TWENTE.

MASTER'S THESIS

Improving physician–patient communication: Opportunities for augmented reality

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4 July 2018

Abstract

In medical situations, communication and trust between physician and patient are key to a smooth diagnosis and treatment process. In this research, traditional supporting communication methods (a brochure and a video), as well as the new technology of augmented reality (AR) are examined in how they influence patient experience during a consultation that confronts them with an invasive medical procedure. The purpose of this research is to improve communication between physician and patient and improve patient experience by looking at information provision and the opportunities for AR in this context. This was done through an exploratory case study, divided into two parts. In study 1a, the communication methods were compared quantitatively, through a questionnaire, which provided statistical evidence for the positive function of AR and audiovisuals in physician–patient communication. In study 1b, the reasons people had for the positive reaction to AR were examined through interviews. The results give clear directions for future research and possible guidelines on the opportunities and pitfalls of AR in the context of physician–patient communication.

Key words

Augmented reality, media richness, physician–patient communication, spoken communication, textual communication, audiovisual communication

Acknowledgments

I would like to express my great appreciation to Dr. B. Santerse of the MST hospital, and to Aryzon 3D B.V., specifically ir. L.E. Schipper, H.S. Salim BSc, and M.L. van der Werf. Dr. Santerse provided the initial research question and his involvement in this study's inception was undeniably valuable. Aryzon 3D B.V. was closely involved with the augmented reality aspect and their help and input was essential to the successful execution of the entire project. Furthermore, I would like to offer my thanks to Dr. R. Meijer of the UMC academic hospital for his input, and the Albert Schweitzer hospital for allowing me to use their informational video in my research. And last, but certainly not least, I would naturally like to thank my supervisors at the university, Dr. M. Galetzka and Dr. H. A. van Vuuren for their invaluable pointers and constructive feedback from the very start of the project all throughout to the end. You all made this research project achievable and an overall great experience for me.

Table of Contents

List of Figures and Tables

Figures

Tables

1. Introduction

In medical situations, communication and trust between physician and patient are key to a smooth diagnosis and treatment process. Particularly in situations where serious illnesses or invasive procedures are discussed, physician–patient communication needs to handled with care, since these patients may experience much emotional distress. Anxiety, anger, sadness, worry, fear, and uncertainty are among the emotions experienced by patients (Annunziata & Muzzatti, 2013; Dean & Street, 2014; Denberg, Melhado, & Steiner, 2006). If not handled with care, these feelings of distress may lead to emotional and physical trauma (Dean & Street, 2014). Therefore, it is imperative that all aspects, from diagnosis to treatment, are optimized to provide comfort and satisfy patient needs as much as possible.

Information provision is a continuous part of the communication process that could have a large impact on the patient. Patients' demands and expectations for health-related information are increasing (Guo, 2015), meaning the method through which the patient is informed needs to meet patient needs. Lack of meeting patients' information needs could affect the extent to which patients accept the given information or diagnosis, and could cause an increase in distress and confusion experienced by the patient (Fallowfield & Jenkins, 1999; Mendick, Young, Holcombe, & Salmon, 2013). There is a great variety of communication methods at peoples' disposal that can be used to help adequately inform patients. In addition to that, the development of new technologies, such as virtual reality and augmented reality, provides new opportunities to improve communication. Since several studies have identified an opportunity to use augmented reality in medical education (e.g., Barsom, Graafland, & Schijven, 2016; Billinghurst, Clark, & Lee, 2015; Kamphuis, Barsom, Schijven, & Christoph, 2014; Kang, & Wang, 2013), this particular new technology could prove useful in physician–patient communication as well.

Since augmented reality (AR) is a new technology and is still in the process of continuing development and finding where it can be useful in society, there is much need for research. Rather than a gap in the knowledge, it is more accurate to say there is opportunity for new knowledge. Aside from that, the research that has been done into the use of AR is not focused on the context of physician to patient communication. Available literature mostly focuses on education of medical professionals or is theoretical in nature. The current study is therefore relevant in that is addresses a new and scarcely researched situation and context, and in that it includes a specific case where empirical data can be gathered, which provides the opportunity to more closely examine real reactions to AR. This helps open up more opportunities and insights in the field of physician–patient communication.

2. Theoretical framework

2.1. Physician–patient communication

The communication between physician and patient is an integral part of the diagnosis and treatment process. It occurs in a variety of forms and methods, all of which are meant to inform and educate the patient. Well received information provision, and *quality* thereof, can positively affect patient recovery. This is supported by multiple studies (Sitzia & Wood, 1997; Walker, 2007), including one where preoperative education (part of which was information provision) was found to reduce time spent by patients in ICU and general and postoperative hospital stay (Arthur, Daniels, McKelvie, Hirsh & Rush, 2000). Walker (2007) found clear indications that the provision of good-quality information facilitates patients' active involvement in their care, and may contribute to an increase in satisfaction. However, they also stated that it is not apparent which is the most effective method of delivering information. This raises questions on what factors the communication should focus on in order to optimally engage the patient. Taking into account the multitude of communication methods available, there are countless choices to make regarding the form and shape of information provision. In addition, new technological developments, including AR, bring the opportunity to revolutionize physician–patient communication. However, the question here is whether patients are receptive to the use of AR to support the information given to them or not. Thus, there is need for more knowledge regarding the benefits or pitfalls of using AR in physician–patient communication, and which other communication methods are most appreciated by patients.

2.1.1. Quality of information

As stated, good quality information facilitates patient involvement. This concept of *quality* of information is therefore an important aspect of information processing and as such an important factor in the current study. Quality of information includes several aspects. Mendick et al. (2013) described that adequate information can help patients feel confident in physicians' expertise, and make sense of what is happening. On top of that, Myles, Williams, Hendrata, Anderson and Weeks (2000) posed that factors that are related to postoperative recovery and patient satisfaction include individualized preoperative education, adequate communication, and interpersonal skills of hospital staff. This 'adequate' information can be classified as *completeness* or as *credibility*, as it addresses that all the necessary information should be present and should be believable. These are therefore indicators of quality. Furthermore, Street,

Makoul, Arora, and Epstein (2009) found that communication, part of which is greater patient knowledge and understanding, can positively affect health, which includes greater well-being, pain control, and vitality. Additionally, several studies stated that reducing feelings of fear and providing clear information can improve information retention and patient experience (Doyle, Lennox, & Bell, 2013; Sep, Van Osch, Van Vliet, Smets, & Bensing, 2014). Summarizing, these studies address *comprehensibility* of the information, another component and indicator of quality. Thus, quality of information constitutes completeness, credibility, and comprehensibility, and can be seen as an integral part of physician–patient communication.

2.1.2. Salience

In order to better understand the way AR can impact physician–patient communication, the routes through which information is processed may be important. There is more than one process at work when digesting information. In section 2.1.1, one of the processes at work was described, namely perceived *quality* of the information. Another process, which is especially important when using AR in communication, concerns the *salience* of the communication method. This concept is more abstract and therefore requires clear explanation. Salience constitutes the effect of using AR (or another unfamiliar or impressive communication method), and how the impressiveness of this technology and the positive reactions thereto transfers to positive reactions to the communication process. It concerns the *captivating qualities* the medium carries. There have been various terms used that describe the concept, including *memorability* (Guzel & Dortyol, 2016), the '*wow-effect*' (Chandler, 2017), and, indeed, *salience* (Romaniuk & Sharp, 2004). In an article by Coultier (2017) was stated that 'wow' was the most common reaction from first time users of an AR application. Additionally, various studies mention and acknowledge the 'wow-factor', and confirm that AR has it (Boletsis & McCallum, 2013; Bulearca & Tamarjan, 2010; Burns, 2016; Chandler, 2017; O'Shea & Elliott, 2016). However, since in the current study this effect also concerns the *memorability* and *remarkable qualities* of the communication that captivate attention and incite positive reactions in patients, a different, broader term was chosen instead of '*wow-effect*' to address it. In order to adequately conceptualize this effect, the term *salience* is used in the current research to describe the ability of the communication to captivate attention and 'wow' the receiver.

In order to explicate the difference between the two mentioned processes, the conceptualization given by Petty and Cacioppo (1986a; 1986b) in their Elaboration Likelihood Model may best provide clarification. They describe two routes – *central*, meaning with thoughtful consideration, and *peripheral*, meaning through other factors – through which information is processed, and although they focus on how these routes work for persuasion,

their core conceptualization can also be applied in a broader context. In the context of the current research, the perceived quality of information that is discussed in section 2.1.1 can be taken as the central route of processing information, meaning the content of the communication is central to the way the message is received and the effect it has. Salience can be seen as the peripheral route, as other cues (e.g., memorability, remarkability) that take less conscious and thoughtful consideration help the receiver process and interpret the message.

2.2. Communication methods

Information on diagnoses can be provided to patients using textual, auditory, or visual communication, or a combination of these. When it comes to medical information provision to patients and potential patients, the means of communication can be particularly important for the effectiveness of the information transfer, since medical information can be complicated and in relatively large quantities, while being vital to the patients (Pinto et al., 2014). If patients are left feeling uncertain on the disease or treatment in question, they may experience more anxiety. It is therefore necessary to offer adequate information at the level of comprehension and vocabulary of the patient (Baile et al., 2000; Ferrario & Cremona, 2013). This might be difficult due to the large variety of educational backgrounds and reading ability of (potential) patients (Graber, Roller, & Kaeble, 1999). Thus, in order to make sure information is comprehensible to most patients, it should be presented at a basic level. Additionally, the medium used for physician–patient communication can affect how the patient receives and perceives the given information. According to Media Richness Theory (Daft & Lengel, 1986), richer mediums are more effective means of communication. Richer mediums are more personal and can include visuals, such as body language and gestures. This implies that a medium that incorporates visuals, interaction, and personal contact would be the most effective form of communication. As such, audiovisual communication is richer than textual communication (Liu, Liao, & Pratt, 2009). In the current study, taking spoken communication as a basis, this would mean that the addition of textual material would be less positively received when compared to an addition of audiovisual material. Furthermore, it would mean the use of AR to support communication would be most positively received compared to the use textual or audiovisual material. This would imply that, in general, solely spoken communication would be least positively received, spoken communication supported by textual communication would be better received than solely spoken communication, spoken and audiovisually supported communication would be better received than spoken plus textual communication, and spoken communication supported by AR would be better received than spoken plus audiovisual communication. Figure 1 illustrates this notion.

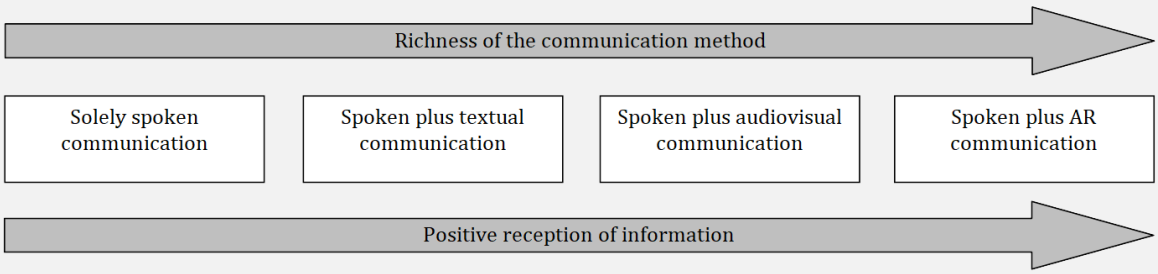


Figure 1. Representation of richness of the communication methods in the current study.

In this theorization, 'positive reception' covers several factors that constitute the patient's experience. Well received communication and proper information provision, as previously stated in section 2.1 and also as found by Radin (2006), can help reduce feelings of *distress*, including fear, anxiety and uncertainty. Similarly, if the communication is perceived as solid, it can strengthen feelings *trust* between the physician and patient (Radin, 2006; Zeffane, Tipu, & Ryan, 2011). Furthermore, patient *satisfaction* is also an important factor, both for the hospital (i.e., good image and reputation) and for the patient (i.e., improved comfort and positive feelings). As stated by Sitzia and Wood (1997), satisfaction is also linked to higher comprehension, which further solidifies its importance. Lastly, *compliance* is a factor, since it embodies the patient's willingness to follow the physician's course of treatment, which is ultimately a goal of a consultation between physician and patient.

With the established communication methods addressed in the current study, the posed importance of quality and salience in the physician–patient communication process, and the identification of the above factors as aspects of patient experience, hypotheses were formed.

H1: *Quality of information positively mediates the relationship between the method of communication (i.e., solely spoken, spoken plus textual, spoken plus audiovisual, spoken plus AR) and how well it is received (i.e., distress, trust, satisfaction, compliance).*

H2: *Salience of the communication method positively mediates the relationship between the method of communication (i.e., solely spoken, spoken plus textual, spoken plus audiovisual, spoken plus AR) and how well it is received (i.e., distress, trust, satisfaction, compliance).*

Each communication method is addressed in more detail in sections 2.2.2 to 2.2.4, inclusive, before further hypotheses can be formed.

2.2.1. Spoken communication

Spoken communication can be and is used throughout the communication process between physician and patient. This form of communication is the main method during consultations and when giving medical advice (Kessels, 2003). Face-to-face interaction with the physician is also perceived as one of the most trusted source of information (De Boer, Versteegen, & Van Wijhe, 2007; Hesse et al., 2005; McCree, Sharpe, Brandt, & Robertson, 2006). This means spoken communication is a fundamental part of physician–patient communication, and cannot be disregarded. However, when taking into account what was posed about the richness of the communication method, it is possible that solely spoken communication could not sufficiently address patients' informational demands, and an addition (i.e., textual, audiovisual, AR) would be beneficial.

2.2.2. Textual communication

Currently, much of the information presented from physician to patient in a hospital is textual. This makes it possible to disclose a large amount of information at once, and gives patients the time and opportunity to (re)read at their own pace. Spoken messages are not remembered well by patients, and also lead to less compliance than written messages (Kessels, 2003). Hamrosi et al. (2013) found that patients appreciate and want textual information, and Hamrosi, Raynor, and Aslani (2014) state that written medicine information has a positive impact on knowledge, satisfaction and health literacy. This implies that textual information satisfies patient informational needs, and improves compliance..

In order to be perceived positively by patients, textual communication needs to be of high enough quality, and ultimately be a positive influence on the feelings of distress and the trust felt by the patient. Written health communication materials can only be effective if they can be read, understood, and remembered (Hoffmann & Worrall, 2004). Proper understanding can reduce distress and anxiety (Ming & Kelly-Campbell, 2017). Comprehensibility can be enhanced by using common or familiar words in an active and conversational style (Hoffmann & Worrall, 2004). However, the content should balance this conversational style well with a more professional tone in order to retain credibility. Furthermore, content should be perceived as complete, since patients should feel that the communication they receive covers what they need to know. This all refers to the quality of the particular communication materials. Adequate quality of information might reduce feelings of distress (fear, anxiety, worry). This is corroborated by Hoffmann, McKenna, Worral, and Read (2007), who found that different formulations of textual information elicited different amounts of anxiety in patients.

However, textual information may present difficulties for patients with low literacy or education. Furthermore, textual information is processed far slower than visual information (Trafton, 2014), and the majority of information transmitted to the brain is visual (Shi, Cao, Chen, Zhuang, & Qiu, 2017). Visual representations may substantially improve information comprehension (Gigerenzer & Edwards, 2003; Lipkus & Hollands, 1999). Thus, visual aspects could improve textual messages. Taking into account the qualities of textual information and the richness of this method, it is likely that textual communication would add to positive patient experience, thus leading to the following hypothesis (with the bracketed letters representing sub-components of the hypothesis):

H3: If patient communication consists of spoken plus textual communication, patient experience (i.e., (a) distress, (b) trust, (c) satisfaction, (d), compliance) is more positive than if patient communication consists of solely spoken communication.

2.2.3. Audiovisual communication

Using visual representations in communication is most easily achieved by employing audiovisual methods, such as a video. Felder and Silverman (1988) state that information retention is lower with textual information than visual information. Moreover, a combination of auditory and visual information leads to even higher information retention and faster learning (Felder & Silverman, 1988; Seitz, Kim, & Shams, 2006). This supports the possibility that audiovisual information may be more beneficial to patients than textual information or solely spoken messages.

Similar to textual communication, audiovisual communication should be of high enough quality in order to be perceived positively by patients. The advantage of a video is that visual representations can be utilized easily, which can positively affect processing and comprehensibility of the information (Gigerenzer & Edwards, 2003; Trafton, 2014). Studies have also shown that patients that watched a video that provides information can lead to higher satisfaction (Dunn, Steginga, Rose, Scott, & Allison, 2004; Karahalios et al., 2007; Thomas, Daly, Perryman, & Stockton, 2000), and lower levels of anxiety and perceived anxiety (Karahalios et al., 2007; McGregor, 2003; Thomas, Daly, Perryman, & Stockton, 2000). This requires more use of technology, which is in line with current developments in society, where technology and digital media have become an integral part of human interaction (Gordon et al., 2015). Aside from the effects of adding additional communication methods to aid spoken communication, there is likely a difference in effectiveness of textual communication as opposed to audiovisual communication. That might be partially attributed to personal preference (O'Callaghan et al.,

2016), but is also determined by the qualities and richness of each communication method. The following hypotheses are posed:

H4: *If patient communication consists of spoken plus audiovisual communication, patient experience (i.e., (a) distress, (b) trust, (c) satisfaction, (d), compliance) is more positive than if patient communication consists of solely spoken communication.*

H5: *If patient communication consists of spoken plus audiovisual communication, patient experience (i.e., (a) distress, (b) trust, (c) satisfaction, (d), compliance) is more positive than if patient communication consists of spoken plus textual communication.*

2.2.4. Augmented reality

Recent technological developments focused on virtual reality (VR) and augmented reality (AR) applications. These are starting to affect and integrate into daily life, and may have applications within the field of medical information provision as well. In the current study, AR was chosen as a suitable support in physician–patient communication over VR, since AR does not fully separate the user from the actual surroundings.

AR is a new technology for superimposing information onto the real world. This technology allows users to present and interact with 3D visuals and animations, which could enhance communication and information presentation (Billinghurst et al., 2015). Figure 2 gives a clear representation of how AR works. Although this example shows 2D AR, as opposed to 3D AR which was used in the current study Whereas Figure 2 provides a general explanation, Figure 3 delves into the specifics of 3D AR that was used in the current study.

Applications for AR have been identified in the fields of medicine, entertainment, design, and education (Billinghurst et al., 2015; Chi, Kang, & Wang, 2013). The full scope of possibilities with AR is likely to broaden as its developments further advances. In the current study, AR is included in order to find whether these new visualization technologies are welcomed by patients in need of information on the procedure they are scheduled to undergo. For this, Aryzon software was used, as represented in Figure 3. Previous research showed that visual elements are appreciated and positively affect information absorption (Felder & Silverman, 1988; Seitz, et al., 2006; Shi et al., 2017). This could mean that this advancement in visualization also positively affects information absorption and retention. Relating this to media richness, by including AR in a personal communication environment, another interactive element is added, making the communication richer, which should be an indicator of higher effectiveness.

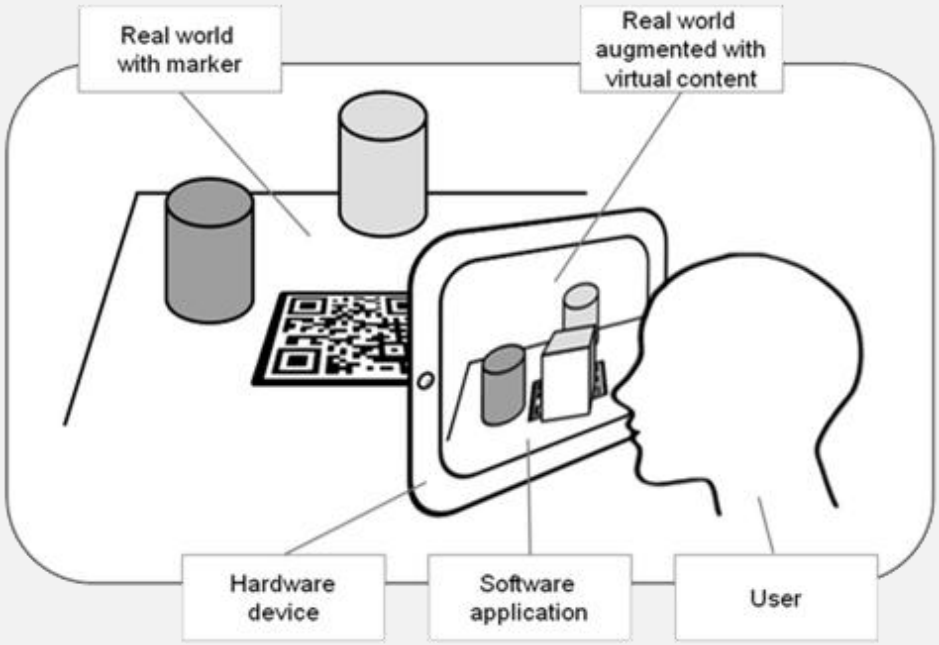


Figure 2. How AR works: Virtual content (*block*) is added to the real world (*table*). A hardware device (*tablet*) including software is used to make the content visible for users. Reprinted from "Augmented reality in medical education?", by C. Kamphuis et al., 2016, *Perspectives on Medical Education, 3*(4), p. 304.

However, there has not been much research relating to this subject. Although there are multiple articles researching the use of AR in education of medical professionals (Barsom et al., 2016; Kamphuis et al., 2014), which show the potential of AR as means of education in the field of medicine, there is no research on how patients could benefit from such means of information provision. On top of that, these studies are mostly theoretical as opposed to empirical or experiential (Bulearca, & Tamarjan, 2010), meaning practical application of AR may yield new and interesting results. The way information in AR is received by (potential) patients can go two ways. Patients could appreciate the visualization, and the clarity it gives them regarding their fear and uncertainty ruled situation. On the other hand, patients could experience more fear if they do not want such visualizations or are having trouble accepting the new technology. However, since this new technology is being accepted and integrating into society, and medical professional users report that AR visualization provides a more realistic representation of anatomy (Courtier, 2017), it is expected that patients will react positively to AR.

Additionally, the use of new technology could have a pure effect in itself due to its salience, or 'wow-factor', as described in section 2.1.2, meaning patients could react purely to the use of a high tech information provision method. As described, it is expected that this salience would provoke positive reactions in patients due to the positive responses to the impressiveness of the high tech communication being carried over to other aspects within the

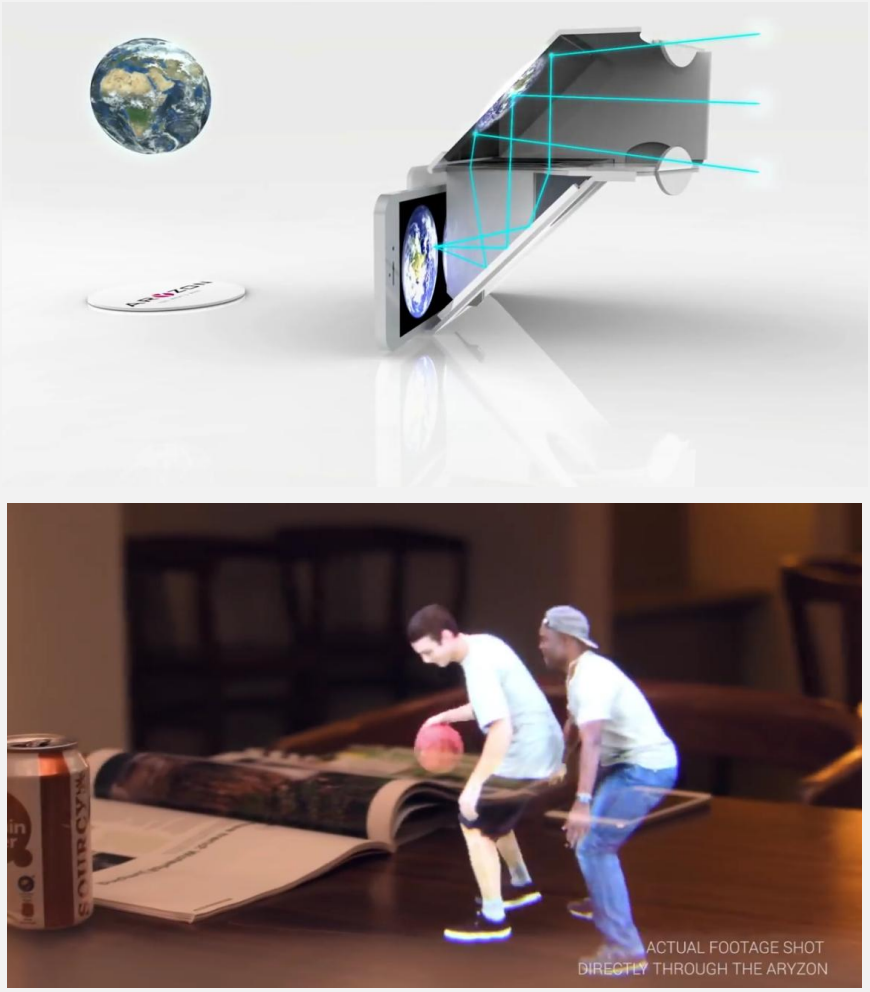


Figure 3. AR in the current research: (a) the Aryzon device and software used in this research, and (b) what the visuals look like, as seen in these figures visible on a table through the Aryzon headset.

situational context. Concisely put, patients may feel more comfortable with the entire procedure if the method of communication is impressive. The communication about the medical procedure they would undergo is, after all, the first impression they get of the procedure. However, the possibility that the impressiveness of the AR communication can distract patients from processing the information cannot be neglected. As such, this was taken into consideration and is further elaborated on in section 2.2.5. This role of salience of AR in medical communication is a subject that, in its entirety, has not been researched much. The following hypotheses were formed:

H6: *If patient communication consists of spoken plus AR communication, patient experience (i.e., (a) distress, (b) trust, (c) satisfaction, (d), compliance) is more positive than if patient communication consists of solely spoken communication.*

H7: *If patient communication consists of spoken plus AR communication, patient experience (i.e., (a) distress, (b) trust, (c) satisfaction, (d), compliance) is more positive than if patient communication consists of spoken plus textual communication.*

H8: *If patient communication consists of spoken plus AR communication, patient experience (i.e., (a) distress, (b) trust, (c) satisfaction, (d), compliance) is more positive than if patient communication consists of spoken plus audiovisual communication.*

2.2.5. The role of familiarity and distraction

In addition to the variables discussed in the previous sections of chapter 2, there are additional factors that could influence the strength of the relationship between the established variables. These moderating factors are *distraction* and *familiarity*.

Familiarity comprises the extent to which a patient is familiar with the illness or condition they are facing and how familiar they are with the treatment or medical procedure that is proposed to them. Familiarity is involved in intuitive judgments of risk, and people often associate familiarity with safety (Song & Schwarz, 2009). Coulter (2002) also stated that "familiarity tends to breed contentment, not contempt" (p. 668). Furthermore, Shuaib et al. (2014) linked high compliance to familiarity. As such, familiarity may result in pre-existing trust in the physician, might reduce distress (i.e., fear, worry, anxiety) by reducing uncertainty, and may improve patient satisfaction and compliance.

Distraction comprises the extent to which the method of communication distracts from the information given. Irrelevant stimuli or animation during communication can distract attention (Hong, Thong, & Tam, 2004) and too many details in a (visual) communication method may also distract from the message (Voinov, Çöltekin, Chen, & Beydoun, 2018). Firstly, this could mean solely spoken communication can be distracting, since there are only the spoken words to focus on and any other stimulus present during this communication is a distracting stimulus. Additional supporting communication methods could help patients focus on the information. Secondly, this may also mean that a communication method using new or unfamiliar technology, such as AR, may distract from the information since receivers may pay more attention to the novelty and possibly impressive qualities of the technology. There are no clear indications of whether AR is a distracting factor or not, but Voinov et al. (2018), although their study focuses on VR as opposed to AR, do warn for the possibility of the new technology working as a distraction. Therefore, it is included in the current research to find out how AR functions in the

context of information provision. The combination of these two and the aforementioned factors form the current study, which is represented in a conceptual model in Figure 4.

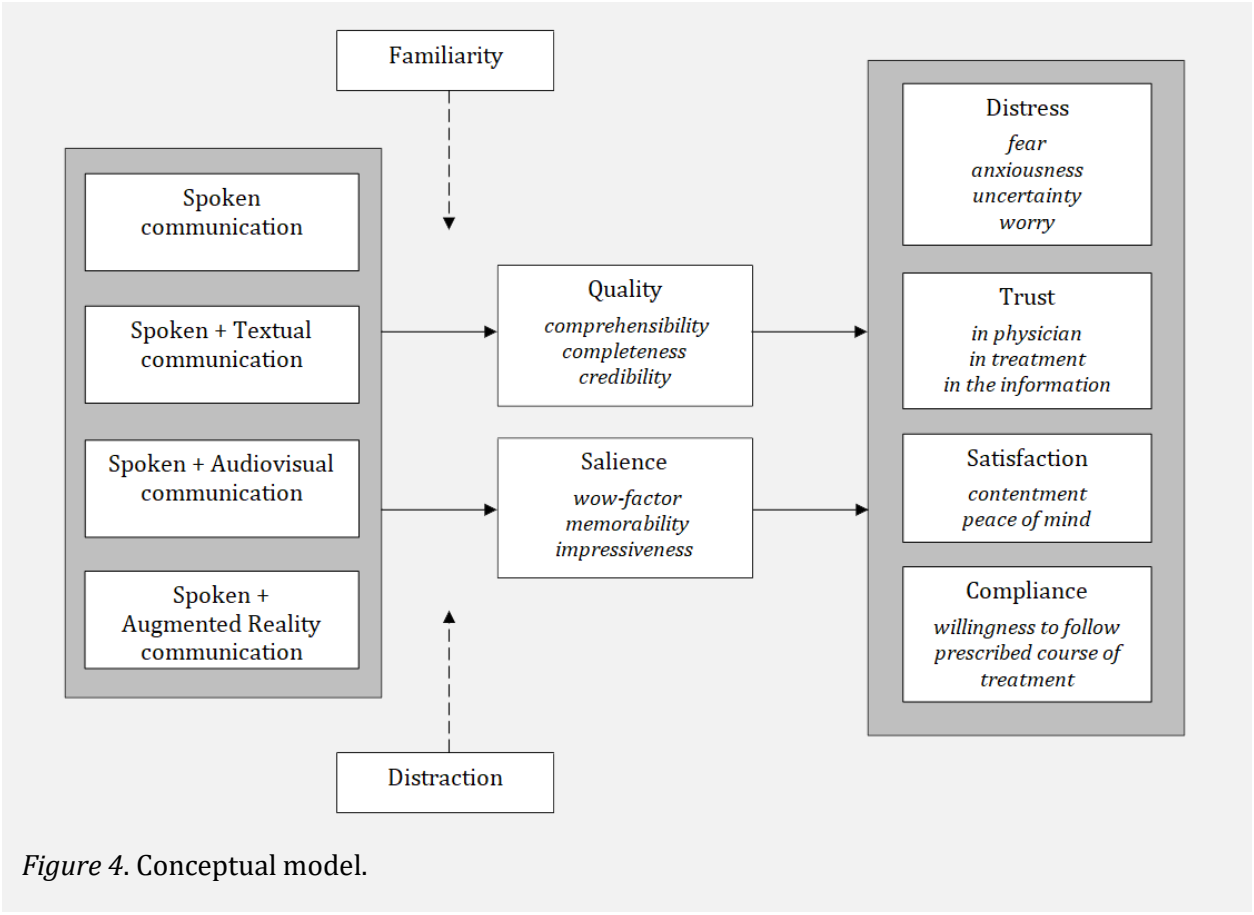


Figure 4. Conceptual model.

3. Method

3.1. Research design

In this study, there were two parts in which one case, namely a consultation regarding a urological diagnosis, was examined. In study 1a, a quantitative experimental approach was taken. In this part, the four introduced consultation situations (i.e., solely spoken, textually supported, audiovisually supported, AR supported communication) were compared. This was done through an online questionnaire, to gain statistical insights. It should be noted that, since the AR had to be physically held and used by the participants, the AR condition was measured in a face to face setting. The first three conditions were measured online in a video-recorded setting. The AR condition was measured at a different time, collecting answers using the same questionnaire, but in an altered set-up due to the face to face component, after data for the other conditions was collected. Implications of the effect of this variation in data collection are addressed in more detail in chapter 5. In study 1b, interviews were conducted on the AR condition to gain more in depth insights regarding reactions to this new technology. This was done immediately after data collection of the AR condition for study 1a, thus combining the quantitative and qualitative methods.

3.1.1. Medical procedure

For the whole study, one particular medical procedure was chosen to be the subject of this case. In association with two practicing urologists, a transurethral resection of the bladder (TURT) was determined to be a suitable procedure. This surgical procedure is used to diagnose cancer in the bladder or remove polyps from the bladder. It is a common procedure that both males and females of a wide variety of ages can undergo, although it is more common for older males. Since the procedure is so common and applicable in a variety of patients in terms of gender and age, yet is still invasive, it has the potential to provide valuable insights. Also, since a TURT is a procedure used to *diagnose* possible cancer, it is used on patients who have not officially been diagnosed with cancer yet. This is easier to empathize with, since the participants had to envision themselves in a situation where they could have cancer, as opposed to a situation where they would have had to envision themselves as having (progressed) cancer. Thus, with these factors of commonness of procedure, applicability to a variety of ages and both genders, the ease of empathizing, and two professional opinions, the TURT procedure was considered suitable.

3.1.2. Pretest

The video of the consultation was pre-tested (*n=5*) to establish that participants felt able to emphasize with the material. The factors of commonness of the procedure and the ease of empathizing mentioned in section 3.1.1 were addressed in this pretest. Using this pretest, it was established that participants would be enabled to adequately put themselves in the situation of the patient. Additionally, the prototypes of the textual and audiovisual communication that were designed for this study were pretested (*n=5* each) to ensure credibility and comprehensibility. The questionnaire used to gather the quantitative data was also subjected to pretesting and reliability and factor analyses, which is explained in further detail in section 3.2.3 and 3.2.4, in order to ensure its dependability.

3.2. Study 1a

3.2.1. Design

In study 1a, the four methods of communication were compared using fictional consultations. In the first three conditions (i.e., solely spoken, spoken plus textual, spoken plus audiovisual), participants were shown a filmed consultation and asked to empathize with the patient in the video, as if they were the ones in the consultation, and answered questions based on that. This approach was taken so as to avoid ethical issues due to the sensitive nature of medical consultations. However, this did mean the participants in this study needed to have the ability to empathize. To better facilitate participants' ability to empathize, it was decided upon to film from a first person perspective. This way, the physician in the video looked directly at the camera, thus providing a more direct way of addressing the participant and enhancing involvement. In the fourth condition (i.e., AR), which was in a face to face setting, the participants directly interacted with the physician, which meant there was less pressure on their ability to empathize, since they were physically in the consultation. The information given in all four conditions was similar and consistent. This was stressed and carefully taken into consideration particularly because of the different setting for the AR condition and to avoid any unnecessary variations between conditions.

3.2.2. Sample

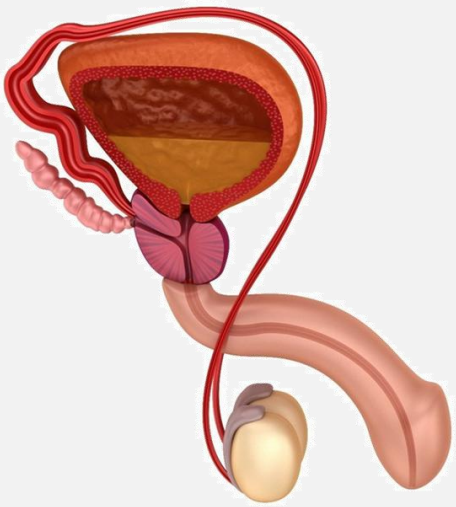
Participants for study 1a were people between the ages of 18 and 80, both male and female. This group did not necessarily consist of actual patients, however it did consist of potential patients.

Anyone in this group could be confronted with the situation of facing the possibility of cancer and having to undergo a procedure to locate or rule out a cancerous affliction. The medical procedure included in this study facilitates this, and was chosen because both genders and a variety of ages can undergo the TURT procedure. Due to the differences between the spoken, textual, and audiovisual communication methods and the AR supported communication method, there were variations in how the participants were recruited. For the first three conditions (i.e., solely spoken, spoken plus textual, spoken plus audiovisual), participants were recruited online through convenience sampling, by sharing the questionnaire through networking websites. For the AR condition participants were recruited through stratified sampling to ensure that both youth and older age groups were represented as well as both genders and people from different educational and professional backgrounds. However, since these participants had to be available for the study at the right time, opportunity sampling also played a slight part in the sampling method. Implications of using these sampling methods are discussed in chapter 5. For the first three conditions, participant group sizes were equal (*n=40* each), however for the AR condition, group size was lower (*n*=15) due to the more time consuming nature. This resulted in a total of *n=135* participants, with 42 males and 93 females.

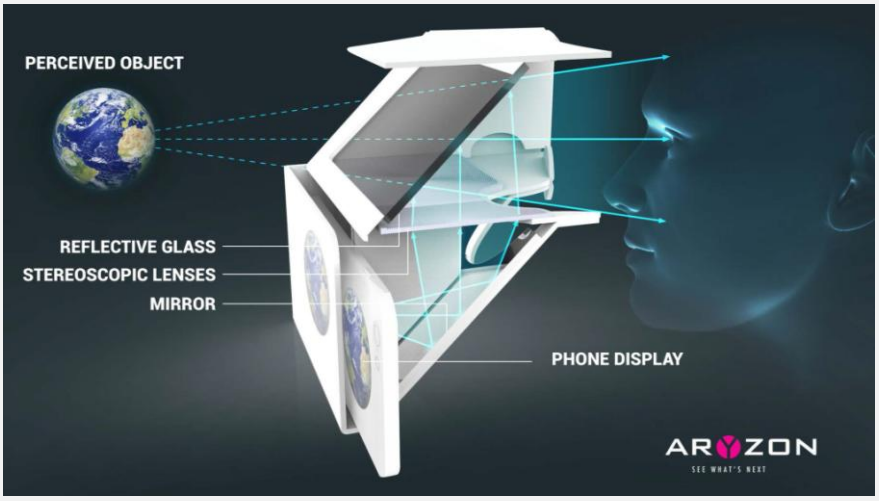
3.2.3. Stimulus material

The video with the physician to patient consultation, used for the *solely spoken*, *spoken plus textual*, and *spoken plus audiovisual* conditions, was shot using first person perspective to enhance involvement and facilitate empathy. The location for this was an examination room at the urology department at MST hospital in Enschede, the Netherlands. The physician in the recorded consultation was a licensed and practicing urologist. This video was then shown to participants, either with no accompanying communication methods (therefore solely *spoken communication*), a brochure (*textual communication*), or an information video (*audiovisual communication*). The information video was acquired, with permission, from the Albert Schweitzer hospital in the Netherlands, and adjusted to remove any logos. The brochure prototype was produced using a textual version of the audio from the information video, and images that were screenshots from this video, so as to ensure the content between conditions remained the same. Participants were then asked to answer a survey to test the effect of the independent, mediating and moderating variables on the dependent variables.

For the *AR* condition, a real life face to face consultation was simulated. This was done in a simulated doctor's examination and consultation room. This way, participants would be facilitated in imagining themselves in the same situation. Participants were informed of the situation and context before the start of the study and were given the same information as what



(a)



(b)

Figure 5. The stimulus material for the AR condition: (a) the model for the AR animation, and (b) the Aryzon AR headset used to project this animation.

was recorded for the other three conditions. An AR animation was developed using the images from the audiovisual condition as a modeling example. The AR was developed in collaboration with Aryzon, using their technology, and projected through an Aryzon headset in which a phone was placed to act as the medium through which the animation became visible in the 'real world', as illustrated in Figure 5. The spoken explanation that was paired with the animation shown in the AR animation was derived from the information video used in the audiovisual condition, but slightly adjusted in order to keep to the timing of the AR animation. Also, slight adjustments were made to the explanation in order to facilitate interaction with the participant (i.e., asking them if they are seeing what is being described and directing them to significant details in the animation), which served to involve the patient and differentiate this communication method from a video where no interaction in the explanation is possible. Participants were then asked to answer the same questionnaire.

3.2.4. Questionnaire

The questionnaire consisted partly of existing and validated scales where possible, as listed in Appendix I. All items were on a 5 point Likert scale, with the exception of the construct of *quality*, which was on a 5 point semantic differential scale. The initial survey was formed as described in section 3.2.4.1 which illustrates how items were decided on. However, the survey was adjusted as a result of reliability and factor analysis, which lead to a revised and final questionnaire as described in detail in section 3.2.4.2.

3.2.4.1. Initial questionnaire

To measure perceived *quality*, items were derived and adapted from key concepts mentioned by Bahia and Nantel (2000), such as 'credibility' and 'understanding'. Similar newly formed items were also added and together formed a semantic differential scale of 5 items, including, for example 'complete [five point choice options] incomplete'.

In order to measure *salience*, items were loosely adapted from other scales as well as newly developed for this research. Some items as mentioned by Bulearca and Tamarjan (2010) were loosely adapted. To complete this scale, terms that adequately described the concept, such as 'this communication method looks impressiveness', were formed into newly developed items.

Testing participants' *familiarity* with the situation they were in, meaning with bladder afflictions and TURT as a procedure, was done by adapting items from different familiarity scales (Gefen, 2000; Kent & Allen, 1994; Malär, Krohmer, Hoyer, & Nyffenegger, 2011). These scales were originally used for brand familiarity, but are generally applicable to any situation, since the items themselves do not include specific wording, like 'I am familiar...'.

Feelings of *distress* were measured by adapting items from the Amsterdam Preoperative Anxiety and Information Scale (APAIS) (Moerman, van Dam, Muller, & Oosting, 1996). In this study, an anxiety scale was tested, as well as an information scale. Participants who had high information requirement were found to score higher on the anxiety scale, meaning there is a correlation between need for information and fear experienced. Additionally, items were derived from the Breast Cancer Fear Scale (Champion et al., 2004), leading to items such as 'I am worried about the procedure' and 'the thought of the procedure scares me'.

In order to measure *patient satisfaction*, items were adapted from the Client Satisfaction Questionnaire (Larsen, Attkisson, Hargreaves, & Nguyen, 1979). Since their focus was on a more general program, items needed to be adjusted in terms of wording, shifting the focus of the items to specifically the information provision, leading to items such as 'if a friend needed similar help, I would recommend this program'. Since there are two identifiable aspects to the satisfaction

experienced by patients, it was decided to create two sub-parts, namely satisfaction with the information received, and satisfaction with the general process , the 'service', so to speak.

Trust was divided into three sub-parts to be examined. Firstly, there was the trust a patient has in the physician and institution (α=0.76), which influences their treatment process and can affect the trust they put in the information given prior to the procedure. Secondly, there was the trust a patient has in the procedure that is being proposed to them (α=0.50). Lastly, trust in the communication and information given was measured (α=0.75). To measure this construct, items were adapted from the Trust in Physician scale (Anderson & Dedrick, 1990). In order to specifically address trust put in the different forms of communication, new and specific items were generated, since there was no validated scale that covered this subject. However, other patient to physician trust scales were taken into account when formulating the items (Anderson & Dedrick, 1999; Gefen, 2000; Kao, Green, Zaslavsky, Koplan, & Cleary, 1998).

Similarly, *compliance* was measured through newly developed items. The items measuring this construct were derived from the definition of compliance as used and represented in the conceptual model in Figure 4. They were then thoroughly discussed for wording and relevance before adding them to the survey.

In addition, items were added that would measure the extent to which the method of communication distracted from the information. Also, as an additional measure to quantify the extent to which participants felt able to put themselves in the situation outlined in this study, items were added that would measure their perceived ability to empathize. The survey that resulted was discussed before it was pretested by a total of n=5. Remarks that resulted from the pretest were processed and resulted in the final questionnaire. This questionnaire was then distributed online.

3.2.4.2. Revised questionnaire

After the data collection, an exploratory factor analysis was conducted in order to assess whether the posed constructs expounded in 3.3.1 were in actuality the constructs measured with the questionnaire. For this, extraction using principal component analysis with varimax rotation was used. Based on these results, the setup of the study and questionnaire was reevaluated as seen necessary.

There were multiple constructs that did not need change. *Quality* (α=0.82) yielded one factor and thus remained unchanged. However, one item was removed from this scale. Similarly, the items measuring feelings of *distress* (α=0.89) and the items measuring *compliance* (α=0.86) yielded one factor and high reliability. Therefore, no adjustments were necessary to this component in the initial questionnaire. Similarly, the items on *distraction* (α=0.81) and the

control items on *empathy* (α=0.83) also posed also posed no issues, and as such, remained unchanged. Although *salience* (α=0.87) did yield two factors in initial analysis, this component also stayed the same. After further consideration of each item and reliability analysis of the two calculated factors, which resulted in insufficient reliability when split, it was decided that this construct remain as it is.

However, there were also several construct that needed to be adjusted. In the initial formation of the questionnaire, it was decided that there was to be distinguished between sub-groups when measuring *trust* and *satisfaction*. Based on initial analyses, it was decided that these were better as one construct without sub-groups. Factor analysis showed only one factor for *satisfaction* (α=0.90), thus, it was decided to group its items into one. The analysis on the *trust* (α=0.84) items revealed that while there were two identified factors, the second factor appeared incoherent, which lead to the decision to form one construct that generally measures trust, only including the items that formed one factor, instead of dividing it into sub-groups. Furthermore, the reliability analysis for *familiarity* showed that this measure had insufficient reliability (α=0.54). Further testing and eliminating items did not improve reliability. Therefore, it was decided that, due to the undeniably low reliability, this construct could not be included in this form in further statistical analysis.

3.3. Study 1b

3.3.1. Design

In study 1b, a qualitative approach was taken, focused solely on the AR condition. Immediately after the data collection in study 1a for the AR condition was concluded, there was a follow up interview that comprised study 1b. This interview was designed to gain more in depth insights and reasonings behind the reactions to AR. As with study 1a, empathy was important here, since the participants had to imagine they were in an actual consultation. Whether participants felt able to empathize with the situation was addressed and confirmed (i.e., 15 participants felt able, 0 participants felt unable) during the interview.

3.3.2. Sample

The participants for study 1b were the same as the participants for the AR condition for study 1a, meaning sample size for this study was *n=15*. As stated in 3.2.2, participants were gathered through stratified sampling to ensure that both youth and older age groups as well as both genders and people of different educational and professional backgrounds were represented.

Also, participants who were familiar with either hospital situations or specifically bladder afflictions were included, because they could reflect on a similar situation they had already encountered. One participant had experienced a bladder affliction a year before this study, which was reflected on in the interview.

3.3.3. Stimulus material

The stimulus material was exactly the same as the material for the AR condition of study 1a, which was explained in detail in section 3.2.3, since the interview was conducted immediately after.

3.3.4. Interview

The questions for this interview were formed by specifically addressing each of the defined constructs with a standard question. These questions were listed in Appendix IV. The interview was recorded using audio recording. The content was then transcribed concisely to document the main points said by each participant on each construct. The data was analyzed and coded in two stages. Firstly, per construct in order to systematically go through all the study components. Secondly, themes were identified and grouped. Table 1 shows the codebook used for the analysis.

Additionally, a table was constructed during transcription of the interviews which kept track of whether participants expressed positive or negative or non-existent effects of AR (Table 3). In this, participants could have one positive and one negative remark concerning each construct, since some participants had both a positive and negative point of view. This way, a clear overview and representation of participant responses was made. The themes are further elaborated on in the results, and translated into specific guidelines for the opportunities and pitfalls for AR were extracted.

Table 1

Codebook for study 1b

	Description	Example
Per construct		
Distress	Comments on AR having a positive or negative effect on feelings of distress	" I'd feel less fear, because the information is so clear"
Trust	Comments on AR having a positive or negative effect on feelings of trust	"[AR] gives the impression that the hospital is [...] using the newest technologies. That makes them look more competent"
Quality	Comments on AR having a positive or negative effect on the quality of the communication process	"The quality was high, because I saw exactly what would happen during the procedure, [the explanation] was very clear"
Salience	Comments positively or negatively on AR having salience	"It [AR] is innovative. I'm impressed, that's a good thing"
Distraction	Comments on AR having a positive or negative effect on how distracted they are from the information	"The AR keeps you focused on the information being given"
Satisfaction	Comments on AR having a positive or negative effect on feelings of satisfaction	"I would be more satisfied, because I felt I got more information than I would have in a regular consultation"
Compliance	Comments on AR having a positive or negative effect on intent to comply with the prescribed procedure	"I would comply. [AR contributed] because I better understand what is happening"
Per theme		
Appropriateness	Comments on when or for whom the use of AR in physician–patient communication is appropriate	"The elderly might not be very receptive [to the AR], but for someone like me, who is young, I think this is innovative and good"
Presentation + implementation	Comment on how AR should be presented or what aspects to take into account in to have a positive effect	"Next to this [AR] explanation, the professional and personal conversation [should also] be there"
Effect on the patient	Comments on what positive or negative effect AR had on the participant's experience	"You can look at it your own way [...], and look where you want to look. It makes me feel like I have more control"
Familiarity with AR	Comments on how familiar the participant is with AR and how that affects their judgment of AR	"It's not impressive anymore if it's become the standard"

4. Results

4.1. Study 1a

A one-way analysis of variance (ANOVA) was conducted to investigate the impact that the communication method (i.e., spoken, spoken plus textual, spoken plus audiovisual, spoken plus AR) had on patient experience. The ANOVA yielded statistically significant effects of communication method for all constructs, as seen in Table 2. Therefore, post hoc analyses were done with Hochberg's GT2 (using an α of .05). These revealed AR had significantly different scores than the other communication methods on all dependent variables and that audiovisual communication had significantly different scores on two of the variables. These results are elaborated on in section 4.1.1 and 4.1.2.

Possible differences between genders in scores on the dependent variables were also measured. Of the 135 participants that completed this study, 42 participants were male (31%) and 93 were female (69%). Notably, there were no statistical differences between male and female participant scores, despite the visual example being a model of the male anatomy.

4.1.2. Augmented reality supported communication

4.1.2.1. Feelings of the patient: distress and trust

As can be seen in Table 2, the effect of communication method on level of distress was significant. Post hoc analyses with Hochberg's GT2 showed that, *AR supported communication* scored significantly lower on distress than solely *spoken communication* (p<.001), *spoken plus textual communication* (p<.001), and *spoken plus audiovisual communication* (p<.001). This indicates that participants who had AR supported communication presented to them experienced less distress than participants who had other communication methods presented to them.

Similarly, *AR supported communication* also scored significantly higher on trust than solely *spoken communication* (p<.001), *spoken plus textual communication* (p=.001), and *spoken plus audiovisual communication* (p=.028). This, in line with expectations, gives indications that communication supported by AR elicited more trustful feelings than the other communication methods.

Table 2

Descriptives and general significance in means between groups (i.e., communication method).

		Mean	Std. deviation	Sig. effect comm. method
Distress	Spoken	3.66	.78	(F (3, 131)=9.84, p<.001)
	Spoken plus brochure	3.50	.77	
	Spoken plus audiovisual	3.52	.73	
	Spoken plus AR	2.43	.86	
Trust	Spoken	3.49	.58	(F (3, 131)=6.69, p<.001)
	Spoken plus brochure	3.59	.80	
	Spoken plus audiovisual	3.78	.69	
	Spoken plus AR	4.36	.44	
Quality	Spoken	3.33	.81	(F (3, 131)=9.28, p<.001)
	Spoken plus brochure	3.71	.83	
	Spoken plus audiovisual	3.51	.91	
	Spoken plus AR	4.60	.47	
Salience	Spoken	2.47	.68	(F (3, 131)=42.11, p<.001)
	Spoken plus brochure	2.71	.60	
	Spoken plus audiovisual	3.17	.74	
	Spoken plus AR	4.59	.41	
Distraction	Spoken	3.11	.84	(F (3, 131)=19.55, p<.001)
	Spoken plus brochure	2.68	.87	
	Spoken plus audiovisual	2.32	.82	
	Spoken plus AR	1.31	.43	
Satisfaction	Spoken	2.99	.75	(F (3, 131)=12.38, p<.001)
	Spoken plus brochure	3.33	.80	
	Spoken plus audiovisual	3.42	.79	
	Spoken plus AR	4.38	.52	
Compliance	Spoken	3.58	.72	(F (3, 131)=7.89, p<.001)
	Spoken plus brochure	3.83	.49	
	Spoken plus audiovisual	3.91	.80	
	Spoken plus AR	4.56	.53	

Note. The mean difference is significant at the 0.05 level, all scores were on a 5 point scale.

4.1.2.2. Attributes of the communication method: quality, salience, and distraction

Table 2 also shows that *AR supported communication* scored significantly higher on quality than solely *spoken communication* (p<.001), *spoken plus textual communication* (p=.003), and *spoken plus audiovisual communication* (p<.001), which indicates, in accordance with expectations, that participants who encountered AR supported communication perceived the quality of the communication to be higher than the participants who experienced the other communication methods.

Moreover, *AR supported communication* scored significantly higher on salience than solely *spoken communication* (p<.001), *spoken plus textual communication* (p<.001), and *spoken plus audiovisual communication* (p<.001), showing that, as expected, AR supported communication was perceived to be more salient and impressive than the other communication methods.

Furthermore, *AR supported communication* scored significantly lower on distraction than solely *spoken communication* (p<.001), *spoken plus textual communication* (p<.001), and *spoken plus audiovisual communication* (p<.001), which means that, contrary to the present concerns, AR supported communication did not distract from the information, or distracted significantly less than the other communication methods.

4.1.2.3. Patients' appraisal: satisfaction and compliance

In line with the previously discussed variables, *AR supported communication* also scored significantly higher on satisfaction than solely *spoken communication* (p<.001), *spoken plus textual communication* (p<.001), and *spoken plus audiovisual communication* (p<.001), indicating that AR supported communication could facilitate higher satisfaction with the communication process in patients than the other communication methods.

Lastly, *AR supported communication* (M=4.56, SD=.53) scored significantly higher on compliance than solely *spoken communication* (p<.001), *spoken plus textual communication* (p=.003), and *spoken plus audiovisual communication* (p=.011). This gives indications that AR supported communication could facilitate more compliance than the other communication methods.

4.1.3. Audiovisually supported communication

In addition to the significant differences found with regard to the AR condition, the post hoc analyses with Hochberg's GT2 also showed that the audiovisually supported condition yielded

significant results for two variables. Firstly, the difference in scores on salience between *spoken plus audiovisual communication* and the solely *spoken* (p<.001) and *spoken plus textual communication* (p=.013) conditions was statistically significant. This gives indications that, while not as high on salience as AR supported communication, audiovisually supported communication does have more salient and impressive qualities than the textually supported and solely spoken communication conditions.

Additionally, *spoken plus audiovisual communication* scored significantly lower on distraction than solely *spoken communication* (p<.001), indicating that audiovisually supported communication distracts less from the information than solely spoken communication. In all remaining comparisons, no statistically significant differences were found. The effects of the communication methods are also visually represented in Figure 6, which most clearly shows the difference between AR and the other communication methods, but also shows an apparent upward (and downward in the case of the distress and distraction) movement from least rich to richest medium for the variables.

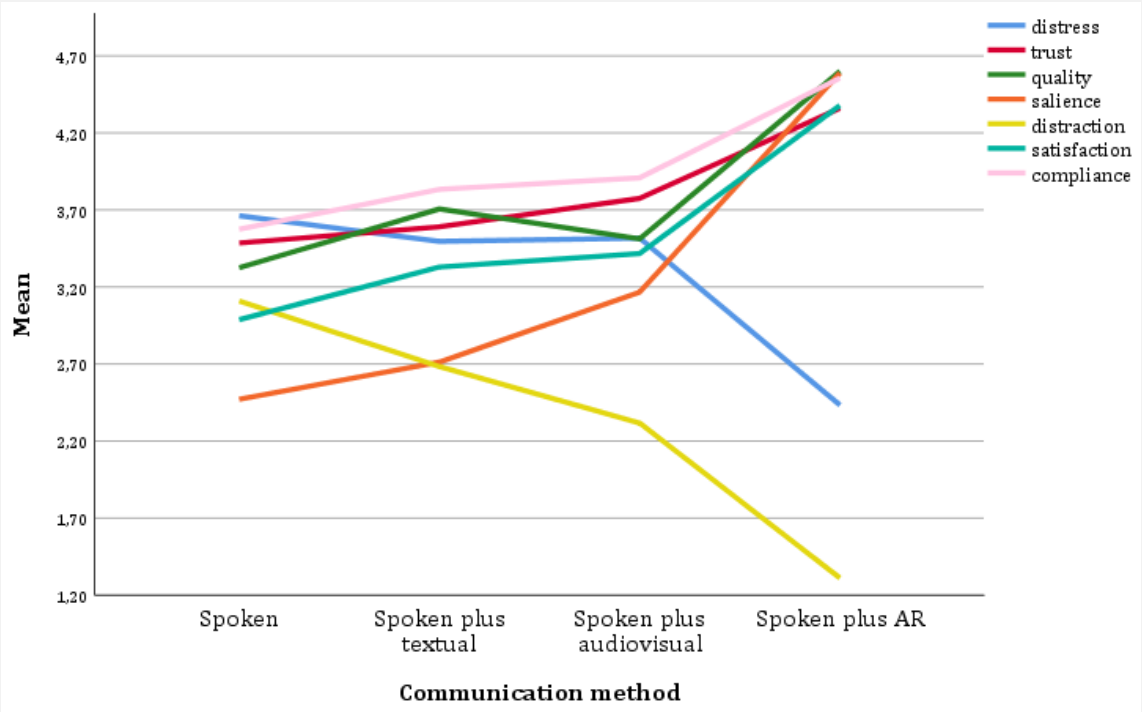


Figure 6. Means plot for the variables with significant p values. All variables were measured on a 5 point scale.

4.2. Study 1b

4.2.1. Participant traits

Of the 15 participants that completed this study, 6 participants were male (40%) and 9 were female (60%). There were 8 participants (53%) between the ages of 40 and 60, and 7 participants (47%) between the ages of 18 and 25 years old. Participants had a variety of backgrounds, including one person working in the pharmaceutical industry and one working as a communications adviser, but also participants with careers unrelated to this study's case, such as a mortgage consultant, a police officer, and students, thus providing a variety of points of views. There was one participant who had had a bladder affliction and was therefore able to reflect on a previous similar experience and provide comparative insights. Furthermore, there were 6 participants who indicated they were familiar with AR, 8 participants who indicated they were not familiar with AR, and 1 participant who was somewhat familiar. Appendix V details what gender, age, and AR familiarity each participant had (per number).

4.2.2. Analysis of interview responses

Firstly, participant responses were documented per construct and described in sections 4.2.2.1 through 4.2.2.4. All participants (P) gave predominantly positive answers and explanations regarding the application of AR in physician–patient communication in their interviews. Table 3 provides a general overview of all their responses, including several short quotes that illustrate the things the participants said about each construct and overall. The table is separated into two components, the first one showing the remarks per construct, and the second showing more broad an overall remarks, such as comparing AR to other visual communication methods. All quotes were paraphrased since they had to be translated from their original Dutch. Table 3 shows that for all constructs, the positive remarks outnumber the negative remarks, with *positive remarks* being 'when the participant reported perceiving AR to have a positive effect on a construct' and *negative remarks* being 'when the participant did not perceive AR to have any useful or a negative effect on a construct'. These results are consisted with the questionnaire findings in study 1a. Then, after initial analysis per construct, general themes were extracted from these findings. These themes (T) were elaborated on in section 4.2.2.5.

Table 3

Overview of interview responses

	Nr. of positive comments	Example	Nr. of negative comments	Example
Per construct				
Distress	14	"I'd feel less fear, because the visualization is [a model and] not too realistic"(P5, P13)	5	"Confrontation with an illness always brings fear, a good explanation of it won't remove these feelings" (P1)
Trust	14	"Using AR shows that the hospital is keeping up with the newest innovations" (P1)	3	"[I think] trust is more connected to the reputation of the hospital [than the AR]" (P3)
Quality	15	"Since there interaction with the physician during the use of AR, I got a positive impression of the experience (P10)	1	"I think the high quality is due to the clear visuals, but that could also be achieved through another medium" (P14)
Salience	15	"[Impressiveness and innovativeness] is good, because it carries over to the professionalism of the medical procedure" (P7)	2	"It's innovative, but not impressive to me anymore, because I've seen supermarkets use the same kind of technology" (P3)
Distraction	15	"You're looking through these glasses, and that becomes your sole focus" (P7)	4	"It took some getting used to in the beginning, which was a bit distracting, but once I had it, it actually improved the information I got from it" (P5)
Satisfaction	15	"I prefer getting visuals with explanations, otherwise I'd have a hard time imagining it in my head, so I appreciate this" (P2)	2	"[Satisfaction] also hinges for a great part on the qualities of the physician" (P1)
Compliance	15	"AR wasn't the main convincing factor, but did aid in the ease and speed of deciding" (P3, P5)	3	"I would comply, but AR did not contribute to that. It's more about what the doctor prescribed, they've studied for ten years for this" (P10)

	Nr. of positive comments	Example	Nr. of negative comments	Example
Overall				
AR versus other visualization methods	13	"With a video, you have the option not to watch, but with this AR you have to, which helps you concentrate and focus on the information" (P3, P7) "With AR, you can look at the visuals from different angles, which gives it something extra" (P3, P4) "With AR, there is personal contact with a physician, which is favorable for trust and trustworthiness, compared to a video" (P13)	3	"Video would work as well, but AR is more innovative" (P2) "I think a regular anatomical model would work as well, although it is static, as opposed to AR which is more dynamic" (P10) "A PowerPoint or video would work just as well, it's the fact that there is visualization at all that helps" (P14)
Overall judgment of AR	14	"Everybody should use this" (P15) "I would wish for every patient to be able to have this, if only to improve their peace of mind" (P4) "I'm enthusiastic and I hope this will be used more in medical environments" (P8)	5	"It may not work for the elderly and for heavy medical procedures" (P6, P8, P13)

Note. Survey maximum score was 5 and minimum score was 1. Positive comments were positive reactions to the use of AR. Negative comments were either criticisms on AR or lack of effect of AR. Participants can have both a positive and a negative remark concerning the function of AR.

4.2.2.1. Feelings of the patient: distress and trust

Regarding *distress*, there was a divide in responses. The majority of the participants (i.e., P2, P3, P4, P5, P7, P8, P9, P11, P14, P15) reported feeling less distress due to the addition of AR. Explanations for that included the AR giving "more clarity" (P4, P8, P11) which made participants feel like they had a "better grip on the situation" (P8, P11). The words "clarity" and "peace of mind" or variations thereof were mentioned by nearly all participants. Also, it was reported that distress was more controlled because the AR animation "was not too realistic" (P5, P12, P13). On the other hand, there were participants that felt that AR helped lessen the fear for the procedure but did not lessen the fear and discomfort of the overall situation of facing an illness (P1, P6, P12, P13). Participant 10 reported no positive or negative effect of AR. However, P9 and P10 did mention that they could "imagine there being people who really don't want to see what is happening during a medical procedure, who'd get squeamish" (P9).

Participants said generally positive things about the effect of AR on *trust* felt. P1 reported that the use of AR "gives more trust, because it gives the impression that the hospital is modernizing, innovating, is using the newest technologies. That makes [them] look more competent". However, although all participants were positive about the effect AR could have on trust, there were those that stressed that that would only happen "if next to this [AR] explanation, the professional and personal conversation is also there. If I was only given a video, I'd find it impersonal and that would make me doubt the physician. But I really appreciate the combination of the two" (P5).

4.2.2.2. Attributes of the communication method: quality, salience, and distraction

All participants were also positive about the *quality* of the communication, they all reported the quality being high. Many participants explained that the quality was high due to the AR "visualizing" the explanation (P1, P5, P8,) and providing a "clearer image" of the procedure (P2). However, P6, P8 and P10 stressed that the quality is high not only because of the AR, but also the "personal conversation with the physician". P8 added "I am enthusiastic about [AR], and I can imagine, if I'd be a patient, that like this, I would get more peace of mind". Furthermore, P3 explained "it's good that you can see and move with the image [...] and if the doctor says 'now you see this, now you'll see that', it shows that the doctor knows what they are talking about and knows what you are seeing. That gives strength to their story".

Many of the comments on quality overlapped with what participants reported about *salience*, as they described features of AR that they thought were positive. Although P3 did point out that "it's not impressive anymore if it's become the standard", most participants indicated

that, at this moment, they thought the AR was impressive and innovative, and that that was a positive thing in the context of a hospital consultation. P7 illustrated "I think it is good, because it carries over to the professionalism of the medical procedure". P8 added "you can look at it your own way, like zooming in, and looking where you want to look at your own tempo. It makes me feel like I have more control".

The interaction with, and control over, the AR visualization was also mentioned by multiple participants as helping them focus on the information. All participants had similar opinions regarding *distraction*, namely that AR did not distract from the information, but rather helped concentrate on the information. P3 illustrated "I think that if you're only informed through spoken conversation, there is 'white noise' that makes you lose some of the information. Because you will try to visualize their words in your head. With AR, you don't need to [...]. You're listening to the words, but watching the animation, with no other interacting [variables], which makes you concentrate more on both", to which P7 added "it's like you're really in it [the animation], and since you watch through the glasses, that image has to become your focus". Although P6 did state that she "had to get used to it first, how does this work, but when that was done, got more out of the explanation". P13 also added that the timing does need to be right, because "sometimes I thought 'am I at the right part of the animation?', but that could maybe be improved with [separating the animation into] steps, that you can activate yourself".

4.2.2.3. Patients' appraisal: satisfaction and compliance

Regarding *satisfaction*, the results were, again similar. Multiple respondents indicated that they think in images, or are very visually oriented people. Consequently, they reported that they appreciated the visuals, and that the AR "helped put [their] mind at ease" (P8). Although a significant majority of the participants was positive about the use of AR, there were several respondents that did stress that other aspects, mainly the face-to-face and personal contact with the physician, was just as important in creating a positive experience. P1 stated "[satisfaction] also hinges for a great part on the qualities of the physician, but I think that, especially if the physician is not very good at explaining clearly, this [AR] could be a really effective supporting method to help the physician transfer the information". P7, P10, P12 and P13 talked about the importance of good timing to help create a satisfying experience.

Concerning *compliance*, participants reported a less significant effect of AR. Most participants indicated that they felt the procedure would have to be done either way, so AR was not a deciding factor. However, it became clear that AR did help with the clarity of the explanation and, because of that, indirectly with the speed and ease of deciding.

4.2.2.4. AR versus other visualization methods

It was noted, though, that many of the participants (e.g., P2, P6) referred to "visualization" in general, instead of AR specifically. When asked about the difference between AR and other visualization methods, such as a video, most did provide a positive distinction between them, such as "if you'd watch the animation on a laptop, you can get distracted more easily, and with AR you can move the image [in different angles] which sets AR apart [from video]" (P3), and "[the physician] did the talking and I could react to that by zooming in on the image where [the physician] indicated, which made [AR] more personal" (P8). However, there were two participants that indicated other methods could work as well, namely P10, who mentioned a "physical anatomical model", but did add that that would be "static, as opposed to an animation", and P14 who did not see a significant distinction between AR and other video visualizations. However, the majority preferred AR. There were participants who referred to a recent previous experience with undergoing a medical procedure and compared this simulation to their experience. P12 said "I've been operated on before, and I think that if they explained the procedure to me beforehand [like this], that I would have had a better idea of the procedure and more peace of mind". P5 had undergone bladder examinations, which provided a specific comparison: "A year ago I had my bladder examined, and if I'd had those [AR] glasses, I think I might have had clearer insights beforehand. After the examinations, it turned out it wasn't that bad, but I went to the examination with a lot of fear at the time".

When asked about possible drawbacks or pitfalls of using AR, P5 and P8 speculated that AR might not be appropriate for very heavy diagnoses or procedures, and P5, P8, P11 and P12 speculated that the elderly and children might not react well to the AR, but did mention that they did feel AR was appropriate for themselves.

4.2.2.5. Recurring themes regarding the opportunities and pitfalls of AR

From the previous paragraphs that discussed participants' reactions to the variables established for this study, several recurring themes could be extracted. These themes could provide several clear opportunities and pitfalls for using AR physician–patient communication, and could give a clear representation of who to use AR with, how to present the AR, the most impacting feelings the AR evoked, and the role familiarity if AR is more widely implemented. The content of the themes is explained below and summarized in Table 4. This table also serves to give an overview of the guidelines that detail the opportunities and pitfalls for using AR in physician–patient communication.

Table 4

Themes that compose guidelines for use of AR in physician–patient communication

Theme number	Theme	Summary of theme content
1	Appropriateness (when and for whom)	Appropriate for: young adults and middle aged patients Inappropriate for: elderly patients Most appropriate situations: not too severe or heavy
2	Presentation + implementation	Present as a model, not too realistic Combine AR with personal spoken contact with physician Proper timing and alignment of AR and spoken explanation Facilitate timing by separating animation into smaller parts
3	Effect on the patient	AR provides clarity and peace of mind AR communicates competence of physician/hospital AR provides sense of control for patient AR facilitates feeling of personalization of communication AR helps patients focus on the information
4	Familiarity with AR	Novelty leads to feeling of innovativeness Innovativeness /impressiveness is perceived as positive feature Familiarity leads to waning impressiveness Familiarity could facilitate efficient use of AR

The first theme (T1) presents the when and to whom, meaning which patients and which contexts would likely react positively or negatively to the use of AR during a hospital consultation. Almost all participants expressed positive feelings, with one exception being P14, who was 59 years old. Other participants indicated they thought the elderly would not react well, and P15, being the oldest participant, could have an illustrative function for that notion. It was also stated that the context should not be too hard on the patient. Therefore T1 describes that AR could be used for young adults as well as middle aged patient groups, in situations that could be mildly to moderately severe.

The second theme (T2) summarizes the things participants said concerning what features improve their impression or what features should be considered to improve the experience, or put differently, how to present and implement AR. This included the AR being a representation of a model, and not a 'too realistic' image. Also, what several participants said about the AR being used as a well coordinated combination with a qualified physician talking applied here. This, in turn, also concerns the timing of the AR, which should be just right for the

AR to have a more positive effect. This proper timing could be facilitated by separating the AR animation into different parts. As can be observed, several clear recommendations on the implementation of AR could be derived from this theme.

The third theme (T3) concerns the feelings and reactions evoked by the AR. The terms "clarity" and "peace of mind" were mentioned multiple times and are clear distinguishing features of the AR animation. Also important here was the sense of control the AR gave the participants, meaning that participants felt they could control where and how to look at the animation. This facilitates a personalized approach to communication. Additionally, T3 includes the focusing function of AR. All participants stated that the AR helped them focus on the information, as opposed to distract them. This illustrates the clear function AR could have in facilitating positive patient experience.

The fourth theme (T4) constituted the familiarity participants had with AR. This notion is something that emerged during the interviews and was not considered beforehand. It turned out people that were unfamiliar with AR felt that the technology was innovative and impressive. However, participants that were had encountered AR before were less impressed by the technology, which could mean that familiarity dictates how innovative patients perceive the use of AR to be. Therefore, the innovativeness wanes if the AR becomes more widely used. However, this could also mean efficiency in use is improved, since the AR would not need to be explained. As such, reduction in perceived innovativeness could correlate with an increase in efficiency of the use of AR. This theme could, therefore, provide implications for possible effects of further implementation of AR in physician–patient communication.

5. Discussion

5.1. Discussion

This study investigated how physician–patient communication could be improved, and the possible role of augmented reality in the communication process. Overall, the results from both studies led to useful conclusions and interpretations. Whereas study 1a provided a clear overall statistical overview of how patients reacted to AR in relation to other communication methods, study 2b provided specific insights and recommendations.

The main findings of study 1a show a clear preference for AR in physician–patient communication when compared to solely spoken communication, textually supported communication, and audiovisually supported communication. Also, audiovisually supported communication was preferred over solely spoken communication and textually supported communication in relation to salience and distraction, meaning that the visualization in both the audiovisual and AR communication methods looked impressive and helped focus on the information, although the reactions to AR were more positive than the reactions to audiovisuals. The main findings for study 1b support these findings and provided detailed underlying reasoning for these results. Thus, the findings for study 1a provide a general statement through statistical evidence *that* AR is better received (and audiovisuals somewhat better received). The findings for study 1b delve into *why* reactions to AR were positive (and indirectly why visualization in general was preferred). Table 3 and Table 4 summarize what participants said during their interview. Overall judgments were positive, and several specific opportunities and pitfalls were identified and summarized in Table 4, which could give clear guidelines on how to start utilizing AR in physician–patient communications, and what pitfalls to look out for and take into account.

The general positive reaction to AR the audiovisual communication was expected and in line with Media Richness Theory's notion that the richer the medium, the more positive the reactions. However, this immediately also poses questions on the original theory, and whether its original premise still holds. The results show the importance of interaction, which was already a core dimension of a medium's richness. However, this current study found that interaction is not only important in face to face or person to person communication, but also in the technology or visualization method used in the communication. If spoken communication is supported by another communication method, such as a video or AR animation, interaction and a sense of control in this supporting communication is also appreciated, as suggested in the current study. This subsequently relates to the impact on richness if, in general, a combination of

communication methods is used. In the original theory, richness was considered per single communication method. However, with modern technology, more often than not there is a combination of methods when communicating, often including some sort of technology to facilitate visualization. And this visualization has already been identified as being preferable to the general populace, both in the current study and by previous studies, such as Dunn et al. (2004) and Karahalios et al. (2007), who reported an increase in satisfaction if video material was shown to patients. As such, should Media Richness Theory be reconsidered to include a dimension of combined communication methods and a dimension of the technology that facilitates the communication support? The current study provides implications that this might be beneficial, since the results yielded such clear statements regarding interaction and control as positive features of AR, yet also stressed that the personal and spoken contact remains essential. Much more room for future research therefore remains.

With regard to the other communication methods incorporated in the current study, the differences between them did not reach significance. However, Figure 6 did show that in general, for every dependent variable on every communication method, there was an upward trend that coincided with the richness of the medium. The reason the value differences were not significant could be due to the method, which did rely heavily on participants imagining themselves in a situation they were not physically in. Concerning textually supported communication, other authors, such as Kessels (2003), did report that solely spoken communication lead to less compliance than when written communication was added. However, they put more focus on information retention or memory, which was not the focus of the current study. This, along with the chosen method, might explain the lack of significant results. Concerning audiovisual communication, some effect was found, but not all variable values reached significance. Several previous studies did find a positive effect of video use on patient satisfaction (e.g., Dunn et al., 2004; Karahalios et al., 2007) and a decrease in distress (e.g., Karahalios et al., 2007; McGregor, 2003) , contrary to the current study. However, these studies were solely focused on video use to educate patients, all of the examples evaluating long and more detailed videos (the Dunn et al. and Karahalios et al. studies reporting that their videos were over twenty minutes long), as opposed to a short video to support spoken information given by the physician. Thus, they focused on only the video instead of the combination of spoken plus video which was the case in the current study. Also, all of these three studies involved actual patients, who were therefore more involved and invested in the material. It is possible that in the current study, being online and without actual patient, yielded more nuanced results because of this gap in involvement. Moreover, there were also studies (Gigerenzer and Edwards (2003) and Lipkus and Hollands (1999) that did find significant improvement in comprehension due to visual representations, yet in the current study, quality (which includes comprehensibility) of audiovisually supported

communication was not significantly higher than solely spoken or textually supported communication. However, they gathered their statement from literature research, as opposed to an experiment that provided empirical data, and their focus was on risk communication in general as opposed to hospital communication specifically. Kessels (2003) did report that multimedia (i.e., audiovisuals) use in communication yielded only slightly better results than written communication, but, again, that was focused on information retention. However, Kessels (2003) also reported that cancer patients preferred direct communication with a clinician over a video. This coincides with what participants in study 1b reported about the importance of personal contact in the communication process. Arguably, this might also explain why the values on the non-significant variables were nuanced, since the method resulted in an execution where the spoken consultation was being displayed before the video, thus not including any interaction between the physician and the use of the video, which may have separated the two communication methods in the participants' experience rather than experiencing them as a combined whole. Circling back to what Figure 6 showed about the upward trend, though it was not significant, it was in line with the significant findings of previous study (as opposed to contradicting their findings), and as such possible correlation with regard to the non-significant variables cannot be confirmed in this study, but should not be dismissed either.

Aside from these speculations on lack of significance in some of the relations in the current study, there were also results that did reach significance, but were unexpected. Notably, there were clear and unambiguous indications that AR did not distract from the information, disproving that the new technology could be distraction as warned for by Voinov et al. (2018). The reasoning for this could be that with AR, the patient is looking through a headset and *has to* look at the animation, thereby eliminating irrelevant additional stimuli, which, as stated by Hong et al. (2004) can be distracting. Additionally, the notion that the spoken explanation that went with the AR was also easy to focus on could be explained by this same lack of other stimuli, or could be due to the physician interacting with the patient and animation or directing them to parts of the animation, thus directing their focus.

Another unexpected result involved the familiarity with AR. At the inception of this research, familiarity was considered a possible factor, but with focus on familiarity with hospital situation. However, for study 1a this construct had to be eliminated due to lacking reliability for statistical analysis (which is further discussed in section 5.2). However, during study 1b, it became apparent that familiarity in relation to AR could be an important factor and could give clear implications for the future, if AR is to be more widely integrated into society. The results implied that AR was considered impressive and innovative, but only as long as it was not 'the standard'. Familiarity with AR reduces the feeling of impressiveness, which was also stated in Table 4, in theme 4, but could possibly improve the efficiency of using AR. It is likely inevitable

that the innovativeness of AR wanes the more the technology integrates and diffuses into society. However, this could, in turn, mean that the use of AR becomes more simple and efficient, since no prior explanation or introduction would need to be given and the technology would be widely available. This, in addition to the other positive results and the function of AR in focusing attention, could give implications for AR that suggest its longevity does not hinge on its innovativeness and 'newness', but also on the lasting attributes (e.g., theme 3 described in section 4.2). This was also addressed by O'Shea and Elliot (2016), who stated that the usefulness of AR could be sustained by its 'wow-factor' as long as it is novel, but should not rely on that alone. The current research touches upon that.

Lastly, there was a lack of differences in reactions between genders. Although this was not a main focus of this research, in hindsight, it might be a something notable. Since the case material, meaning the visualizations of the medical procedure, was in all cases displayed on a male example model, it would seem that it would have been easier for men to put themselves in the situation than women. Also, the discomfort associated with the anatomical region involved in this case is generally more discomforting to males than females, yet the gender were not reportedly differently affected. This may have been due to the fictional nature and distance with reality due to the online data collection. Nevertheless, gender differences could still be important, for example when concerning the gender of the acting physician. This is addressed and acknowledged in the second paragraph of section 5.2 of this study.

5.2. Limitations

With the novelty of this subject, the use of AR in patient oriented communication, interesting insights could be gathered in the current study. However, that is also where difficulties arose. Because there was not much previous research to be gathered as foundation for the setting of this current research, some speculation had to be done and concessions had to be made. In actuality, the subject of physician–patient communication is excessively broad. There are so many possible variables to take into account, that it is impossible to adequately include them all in one study. Looking at study 1 alone, it would have been better to conduct multiple studies, such as one to determine how patients respond to different types and formats of textual information and one to determine the same for visual information so that both could be more thoroughly and optimally represented. Additionally, the doctor's office contains many variables as well, such as where physician and patient are sitting, the gender, attitude and communication style of the physician, the (lack of) presence of medical equipment, and the presence of a computer monitor which the physician may show or turn away from the patient. That alone

could have constituted several other studies. However, due to time and resource constraints, not all possible variables could be addressed and study 1a and 1b were framed as they were.

Concerning study 1a, there were some concessions that had to be made within the study. Having respondents watch an online video and imagine themselves in the situation asks a lot of empathic ability, and can never fully simulate a real conversation, no matter how enabled to empathize participants reported themselves to be. Therefore, this method could not fully reflect a real experience. However, due to time and resource constraints, this is the method that was chosen in order to get a decent sized sample group. Additionally, the AR condition had to be measured in a different setting than the other three conditions were measured. This was, again, due to time and resource constraints and the more time consuming nature of the measurement of this condition, as well as the AR needing to be physically held and experienced. There were some other differences with the other three conditions in study 1a that could have influenced the outcome. Though this condition consisted of a real face-to-face consultation the physician in this study was not a real physician. Also, the physician in study 1a was a different person in both age and gender than the physician in study 1b, which could have influenced results and may have impaired comparability. Since medical information and examination can be particularly personal and a sensitive subject, especially in the urological or gynecological area, gender of the physician could have a large impact on patient experience, which is something that has been addressed and acknowledged in previous studies (e.g., Armitage & Cahill, 2018; Bignell, 1999; Dubé, Fuller, Rosen, Fagan, & O'Donnell, 2005). Again, this choice was due to time and resource constraints, as conducting the AR condition of study 1a and the entirety of study 1b took up considerably more time for the acting physician than the online measured conditions in study 1a, which resulted in the study 1a physician, who was a real physician, being unable to return for study 1b. Therefore, comparative results and the influence of physician gender should be further addressed in future research and should be taken into account in the outcome of the current study.

Moreover, there was also one issue that arose with the construct of familiarity in study 1a, which had to be dropped due to low reliability. The reason for this low reliability was unclear. The items used were derived from verified measures. However, the translation to this case may have resulted in less correlation between the subject of the items. They may have combined too general as well as too specific wording. However, factor analysis revealed only one factor, and reliability analysis showed there was no clear item that stood out as badly worded, since any item removal did not significantly improve reliability. It is also possible participants were confused by these items, although the pretest did give indications for this. Thus, since there were no indicators that supported these possible reasons, a clear explanation could not be formed. This lack of clarity concerning the reason for the low reliability contributed to the

decision to not include the construct in analysis. Perhaps, if familiarity were included in future research, more focus should be put on this concept and more thorough definitions of what the participants are familiar with should be considered. Alternatively, instead of focusing on familiarity with hospital situations, possibly focus should have been on familiarity with AR.

Furthermore, the sampling method also left implications for the limitations in this study. The sampling method was mainly convenience sampling, which can lead to under- or over-representation of groups within the populations. In the current study, this was most apparent in the genders of the participants, since there were far more female than male participants. As such, representativeness of the sample and therefore generalizability of the results could have suffered. As for study 1b, the participants were gathered through stratified sampling, which gave more room to influence the division of genders and involve a variety of backgrounds, thus providing a more balanced distribution of participant traits. However, these participants had to be available and willing to cooperate, which means there may still be under-representation of the type of people unable to find the time to cooperate, only less apparent than with the convenience sampling part. Additionally, For both studies, no real patients were asked to participate, meaning the samples consisted of potential patients. This was due to ethical concerns that would have arisen if real patients information had to be used. On top of that, the subject matter could be perceived as confrontational, and since the study is exploratory, it can hardly be justified to confront them with a situation that can be heavy for them without having proven and probable cause to do so. Perhaps, once the indications of effect are strengthened more, it could be done. In the current research, a solution was found in creating the research context around a situation where a possible ailment is being diagnosed. This is something that could happen to anyone at any time, thus making it plausible to include participants that were not actual patients. Nevertheless, there could still be issues concerning the participants. In study 1a, there was an unequal divide between male and female. This could be due to the sampling method, namely convenience sampling, which can lead to under- or over-representation of groups within the populations. In the current study, this was most apparent in the genders of the participants, since there were far more female than male participants. As such, representativeness of the sample and therefore generalizability of the results could have suffered. Although no differences were found between these groups, the different sizes may have had an influence on that. As for study 1b, the participants were gathered through stratified sampling, which gave more room to influence the diversity of genders and involve a variety of backgrounds, thus providing a more balanced distribution of participant traits. However, these participants had to be available and willing to cooperate, which means there may still be under-representation of the type of people unable or unwilling to find the time to cooperate, only less apparent than with the convenience sampling part. Also, since these people engaged in a face-to-

face interview afterwards, they may have given socially biased answers. Therefore, it is again stressed that the results could not fully reflect a real situation. Nevertheless, the distinct and unambiguous direction visible in the results, mainly in relation to AR, should not be disregarded and can provide clear insights and orientations for further research. The current study can therefore be regarded as exploratory, and touches upon a broad and novel subject that requires more research to further explore.

5.3. Future research

Although the study yielded clear indicative results, due to the exploratory nature of this study, much room for further research remains. One of the most pertinent aspects in need of further research concerns the role of *familiarity with AR* in the technology's usefulness. The current research touched upon this, but in the wider integration of AR, research focus should be put on how familiarity with AR, and thus its waning innovativeness, could affect perceived usefulness and therefore longevity. Additionally, it became apparent that in the consulted previous research into supporting communication methods (i.e., text and video), the focus was mainly put on this communication method, as opposed to a combination of spoken consultation and additional supporting communication. Since the current research revealed the importance of interaction, and the appreciation of personal contact, it would be beneficial to further research the combination of spoken consultation with other supporting communication methods, be it textual, audiovisual, or AR.

Due to the positive outcomes of both studies regarding AR, it is also recommended to further research the best ways to optimize and implement this technology in the communication directed at patients. Additionally, further insights could be gained by designing a study that directly compares traditional audiovisual information (video) with AR visualization to give more conclusive comparative data. On that note, it is also recommended to more thoroughly research the effect of textual versus visual information on patient experience and further address variables present in a doctor's examination room, preferably all in comparable settings. If possible, including real patients to better reflect the reality of emotions experience would be preferable, but that should only be considered after considerable strengthening of the ideas posed (which is something the current research serves for), as well as after careful consideration of ethics. Thus, the current study gives clear implications for opportunities to improve physician–patient communication using AR, however it is apparent that much more and larger scale research could be done into this subject in order to strengthen any of the findings here.

6. Conclusion

6.1. Conclusion and interpretation of results

This study researched physician–patient communication and whether augmented reality could play a role in improving this communication. The results revealed clear positive reaction to the use of AR in physician–patient communication, and a moderate positive reaction to audiovisually supported communication. Overall, participants reported that the use of AR was impressive and made the information given very clear. This clarity led to more peace of mind with regard to the medical procedure. Reported reduction in feelings of distress and increase in trust could be due to the innovativeness of the technology, however, could also be attributed to the perceived control the participants had over the information. If they moved, the animation moved with them, which might have given an impression of being in control of the situation. Furthermore, if the physician conveys that they know what they are talking about, in general and in relation to the AR animation, the feelings of trust could be enhanced, since it communicates competence and confidence.

The increase in perceived quality could be due to the addition of visuals in general, but the results revealed most participants did prefer the AR over other visualization methods. This could be due to the interactive qualities as well as the impressive qualities (salience) the AR holds. However, the interviews did reveal that the AR and spoken communication should be aligned and timed properly in order to ensure this high quality. A good alignment would also further improve focus on the information. There was a clear favor for AR in terms of being able to focus on the information and not feeling distracted. This could be due the participants being forced to watch the AR, not being able to look at anything else, which kept them from being distracted. The only stimuli they could perceive were the visuals and the physician's spoken explanation. However, it should be noted that this could be further enhanced by the physician interacting with the animation by pointing the patient to parts, for instance by saying "at the top you can see...." or "right now the animation is showing...". And this relates to proper timing, which could be an asset if done right and a detriment and distracting factor if lacking. If all the factors are coinciding properly, satisfaction could be improved.

Since the interviews revealed participants were explicitly enthusiastic about the AR, it can be concluded that the use of AR in explaining the medical procedure could improve patient experience. Compliance is the only factor that was not as explicitly supported by participants in the interview. Most participants said that they would comply with the proposed procedure, but that the AR was not a direct deciding factor in it. This could be due to there not being an

alternative option, making the participants feel like having it removed should 'just be done'. This means AR could be a factor if there were multiple options, but that has not been verified or falsified in this study. Overall, all participants had positive remarks regarding AR, regardless of the criticisms they might have also expressed, which lead to the conclusion that there is use for AR in physician–patient communication, but that it should be considered carefully.

6.2. Recommendations and implications

6.2.1. Recommendations for improving physician–patient communication

Overall, there does seem to be room for improvement in physician–patient communication. Any additional communication method to support the orally communicated information given by the physician could improve patient experience, as supporting communication methods serve to help the patient focus on the message more than when there is only spoken communication, but there is a clear preference for visuals. Video animation and AR both improved overall patient experience. AR yielded the highest results, therefore it is recommended to look into ways to best implement this technology in patient oriented hospital communications. Practical guidelines are outlined in the results and represented in Table 4.

At this moment, since AR is not widely used yet, early adapters could profit from AR when it is still unusual in daily practice, since the impressiveness wanes when the technology is more widely used. However, AR should be used after careful consideration, as uncoordinated use could confuse patients and be a detriment to the communication. This confusion is more likely to occur in older patients, therefore it is not recommended to utilize it with elderly patients (age 60 and up). It is important for the AR to be coordinated well, and interactive to give both patient and physician more control, as it is imperative that the physician is at all times in control of the situation and communication in order to keep the patient more at ease. This could be done, for example, by develop a pause button in the animation to create room for asking questions during the explanation, or by separating the full animation into smaller parts that each have their own start button.

Furthermore, the AR should always be a support and cannot replace, but can enhance, the necessary professional and competent attitude the physician should convey to patients. As such, AR supported communication is recommended to physicians who feel they can work with this technology, and with patients that are young or middle aged. The overall guidelines for opportunities and pitfalls that resulted from this study are concisely represented and summarized in Table 4, which the author refers to for the main recommendations on implementing AR. However, as stated, both physician and patient should feel able and

comfortable with this technology, and if that is not the case, other more traditional methods that contain clear visual material (e.g., information video) are recommended.

6.2.2. Practical and academic implications

This research has touched upon a rather broad and novel subject, providing exploratory results. As such, there are several clear directions for further research that give this research academic relevance. Particularly the research into broader implementation of AR and how that would affect AR's function and usefulness, and the combination of spoken consultation with visuals to support the communication, could be important directions for further research. In terms of practical relevance, this research provided clear results regarding people's reaction to the use of AR, as illustrated in Table 3, and gave several specific recommendations, as summarized in Table 4, regarding when and how to implement AR. If thoroughly considered, using these guidelines, implementing AR could help improve physician–patient communication.

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Appendix I: Measurement scales

Table 5

Existing measurement scales adapted for the questionnaire for study 1a

Construct	Scale	Example Items
Quality	Bahia, K., & Nantel, J. (2000)	• credibility • understanding • good quality - bad quality
Salience	Bulearca, M., & Tamarjan, D. (2010)	• Do you find the use of this AR application enjoyable? In what ways? (Prompting: absorbing activity/active engagement)
Familiarity	Familiarity scales (e.g., Gefen, 2000; Kent & Allen, 1994; Malär et al., 2011)	• I am familiar with ... • I know what ... is • experience - inexperience
Distress	Amsterdam Preoperative Anxiety and Information Scale (APAIS) (Moerman et al, 1996) Breast Cancer Fear Scale (Champion et al., 2004)	• I am worried about the procedure • The procedure is on my mind continually • The thought of the procedure scares me • When I think about the procedure, I feel nervous • When I think about the procedure, I get upset
Trust	Trust in Physician Scale (Anderson & Dedrick, 1990)	• I doubt that my doctor really cares about me as a person • My doctor is a real expert in taking care of medical problems like mine
Satisfaction	Client Satisfaction Questionnaire (CSQ) (Larsen et al., 1979)	• If a friend were in need of similar help, would you recommend this program to him/her • If you were to seek help again, would you come back to this program

Note. Items in the actual questionnaire were translated to Dutch to accommodate participants' mother language.

Appendix II: Study 1a questionnaire

Wat is uw geslacht?

- Man
- Vrouw

Wat is uw leeftijd?

_____

Wat is uw hoogst genoten of huidige opleiding?

- vmbo
- havo
- vwo
- mbo
- hbo
- wo

Ik heb minstens één persoon in mijn omgeving die mij kan ondersteunen bij een artsbezoek

- Ja
- Nee

U krijgt nu een kort filmpje te zien met een doktersgesprek waarin de patiënt een serieuze diagnose krijgt. Het is de bedoeling dat u zich inleeft in deze situatie. Lees daarom de onderstaande tekst goed door, en kijk aandachtig naar het filmpje:

Stel, u heeft last van buikpijn en onlangs vond u een beetje bloed in uw urine. Daarom heeft u besloten om naar de huisarts te gaan. Deze heeft u verwezen naar het ziekenhuis. Hier heeft u urine en bloed afgegeven, en de specialist in het ziekenhuis heeft uw blaas onderzocht. Direct na dit onderzoek, krijgt u in de behandelkamer de diagnose die hieruit gevonden werd te horen en de voorgestelde behandeling om u te helpen.

Als u klaar bent met het inlezen, kunt u het filmpje starten. Zorg alstublieft dat het volume hard genoeg staat. Als u het filmpje helemaal gekeken heeft, kunt u naar de volgende pagina gaan.

[filmpje]

OPTIONEEL: In aanvulling op het gesprek krijgt u van de arts een brochure. Lees deze ook goed door. Als u dat gedaan heeft, kunt u naar de volgende pagina.

[brochure]

OPTIONEEL: In aanvulling op het gesprek krijgt u van de arts een informatiefilmpje om te kijken. Bekijk deze ook goed. Als u dat gedaan heeft, kunt u naar de volgende pagina.

[audiovisueel]

Hieronder vind u een aantal stellingen over het gesprek dat u net gehad heeft. Geeft u alstublieft aan in hoeverre u het eens bent met de stellingen. Er zijn geen foute antwoorden.

	Helemaal mee oneens	Mee oneens	Niet mee oneens, niet mee eens	Mee eens	Helemaal mee eens
Ik maak me zorgen over deze procedure	0	0	0	0	0
Als ik denk aan deze procedure, voel ik angst	0	0	0	0	0
Ik voel me ongemakkelijk bij deze procedure	0	0	0	0	0
Als ik aan deze procedure denk, word ik onrustig	0	0	0	0	0
Ik ben bang om deze procedure te ondergaan	0	0	0	0	0
Ik voel me onzeker over het ondergaan van deze procedure	0	0	0	0	0

Hieronder vind u een aantal stellingen over het gesprek dat u net gehad heeft. Geeft u alstublieft aan in hoeverre u het eens bent met de stellingen. Er zijn geen foute antwoorden.

	Helemaal mee oneens	Mee oneens	Niet mee oneens, niet mee eens	Mee eens	Helemaal mee eens
Ik heb vertrouwen in de expertise van de dokter	0	0	0	0	0
Deze dokter stelt mijn welzijn voorop	0	0	0	0	0
Na dit gesprek zou ik zeker een second opinion willen	0	0	0	0	0
Ik vertrouw dat de procedure goed uitgevoerd gaat worden	0	0	0	0	0
Na het krijgen van deze informatie, voel ik me beter voorbereid op de procedure	0	0	0	0	0
Deze manier van communicatie versterkt mijn vertrouwen in de arts	0	0	0	0	0

Hieronder vind u een aantal stellingen over het gesprek dat u net gehad heeft. Geeft u alstublieft aan wat in uw mening het meest overeenkomt met uw ervaring. Er zijn geen foute antwoorden.

Ik vind de inhoud en manier van communiceren...

compleet	0	0	0	0	0	niet compleet
onbegrijpelijk	0	0	0	0	0	begrijpelijk
geloofwaardig	0	0	0	0	0	ongeloofwaardig
hoge kwaliteit	0	0	0	0	0	lage kwaliteit
te weinig	0	0	0	0	0	te veel

Hieronder vind u een aantal stellingen over het gesprek dat u net gehad heeft. Geeft u alstublieft aan in hoeverre u het eens bent met de stellingen. Er zijn geen foute antwoorden.

	Helemaal mee oneens	Mee oneens	Niet mee oneens, niet mee eens	Mee eens	Helemaal mee eens
Ik heb vaker een artsgesprek gehad naar aanleiding van serieuze klachten	0	0	0	0	0
Ik ben bekend met blaasaandoeningen	0	0	0	0	0
Ik heb vaker in een soortgelijke kamer een artsgesprek gehad	0	0	0	0	0
Ik weet niet wat een blaasaandoening in zou houden	0	0	0	0	0
Ik wist voor dit gesprek al wat voor soort ingreep een transurethrale resectie is	0	0	0	0	0

Hieronder vind u een aantal stellingen over het gesprek dat u net gehad heeft. Geeft u alstublieft aan in hoeverre u het eens bent met de stellingen. Er zijn geen foute antwoorden.

	Helemaal mee oneens	Mee oneens	Niet mee oneens, niet mee eens	Mee eens	Helemaal mee eens
Deze manier van communiceren ziet er indrukwekkend uit	0	0	0	0	0
Deze manier van communiceren is saai	0	0	0	0	0
Deze manier van communiceren is vernieuwend	0	0	0	0	0
Deze communicatiemethode geeft de indruk dat de arts weet waarover hij het heeft	0	0	0	0	0
Deze manier van communiceren is opvallend	0	0	0	0	0
Deze manier van communiceren is stimulerend	0	0	0	0	0

Hieronder vind u een aantal stellingen over het gesprek dat u net gehad heeft. Geeft u alstublieft aan in hoeverre u het eens bent met de stellingen. Er zijn geen foute antwoorden.

	Helemaal mee oneens	Mee oneens	Niet mee oneens, niet mee eens	Mee eens	Helemaal mee eens
Ik voel me prettig bij deze manier van communiceren	0	0	0	0	0
Ik kan me goed inleven in deze situatie	0	0	0	0	0
Ik vond deze manier van communiceren realistisch	0	0	0	0	0
Ik voel me ongemakkelijk bij deze manier van communiceren	0	0	0	0	0
Deze manier van communiceren helpt mij de informatie goed te verwerken	0	0	0	0	0
Deze manier van communiceren leidt me af van de informatie	0	0	0	0	0
Door deze manier van communiceren kan ik me niet goed concentreren op de informatie	0	0	0	0	0

Hieronder vind u een aantal stellingen over het gesprek dat u net gehad heeft. Geeft u alstublieft aan in hoeverre u het eens bent met de stellingen. Er zijn geen foute antwoorden.

	Helemaal mee oneens	Mee oneens	Niet mee oneens, niet mee eens	Mee eens	Helemaal mee eens
Ik ben tevreden met de informatie die me gegeven is	0	0	0	0	0
Ik voel me niet voldoende geïnformeerd	0	0	0	0	0
De informatie die ik zou willen krijgen, heb ik gekregen	0	0	0	0	0
Als een vriend dezelfde hulp nodig zou hebben, zou ik hem/haar deze instelling aanbevelen	0	0	0	0	0
Ik ben tevreden over de professionele uitstraling van de arts	0	0	0	0	0
Als ik nog een keer een consultatie nodig heb, zou ik naar een andere instelling gaan	0	0	0	0	0

Hieronder vind u een aantal stellingen over het gesprek dat u net gehad heeft. Geeft u alstublieft aan in hoeverre u het eens bent met de stellingen. Er zijn geen foute antwoorden.

	Helemaal mee oneens	Mee oneens	Niet mee oneens, niet mee eens	Mee eens	Helemaal mee eens
De voorgestelde procedure lijkt mij een goede aanpak	0	0	0	0	0
Ik zou de gegeven adviezen niet opvolgen	0	0	0	0	0
Ik zou akkoord gaan met de voorgestelde procedure	0	0	0	0	0

Appendix III: Participant distribution across conditions for study 1a

Table 6

Participant traits and distribution across groups in study 1a

Condition	Nr. of males	Nr. of females
Spoken communication	11	29
Spoken + textual communication	16	24
Spoken + audiovisual communication	9	31
Spoken + AR communication	6	9

Appendix IV: Interview questions

Table 7

Structured interview questions for study 1b

Construct	Question
AR general	• Are you familiar with augmented reality / do you know what AR is ? • How do you think AR differs from a 'regular' video?
Distress	• An medical procedure can illicit feelings of distress. Do you think the use of AR to support the explanation of the procedure eased or enhanced your feelings of distress or discomfort?
Trust	• If this technology was utilized by a physician or hospital, would you feel more or less trust for them than if it wasn't used? • Does this new technology make the physician or hospital look more competent?
Perceived quality	• What do you think of the quality of the communication you just experienced (as a whole)? • Is the quality higher or lower due to the addition of AR?
Salience	• Do you think the use of AR here is impressive / innovative? • Do you think this is a good or a bad thing / necessary or not?
Empathy	• Did you feel able to empathize with this situation?
Distraction	• Did the AR help you process the information or did it distract from the information?
Satisfaction	• If this is how you are being informed at a hospital, would you be satisfied? • Do you think you are more or less satisfied because of the AR?
Compliance	• Would you follow the prescribed course of action? • (How) do you think the AR contributed to this intention?

Note. The actual interview questions were formulated in Dutch, then translated to English for this report. All questions had the standard follow up question of "why" or "please elaborate" if answers were judged as insufficient.

Appendix V: Participant details and distribution across conditions for study 1b

Table 8

General participant traits for study 1b participants

Participant nr.	Gender	Age	Familiar with AR
1	Female	51	No
2	Male	56	No
3	Female	41	Yes
4	Female	50	No
5	Female	23	No
6	Female	20	No
7	Male	57	Somewhat
8	Female	50	Yes
9	Female	22	Yes
10	Male	23	Yes
11	Female	19	No
12	Male	19	Yes
13	Male	25	Yes
14	Male	59	No
15	Female	50	No