REDUCING UNCERTAINTIES IN VIRTUAL CONSULTATION: THE IMPACT OF MEDIA NATURALNESS AND MENTAL MODEL ALIGNMENT ON PATIENT SATISFACTION IN DOCTOR-PATIENT COMMUNICATION

by

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ABSTRACT

Virtual consultation (VC) can be simply referred to as a telemedicine service that enables patients to access doctors remotely. It has been largely used by patients with many potential benefits. Nevertheless, many patients still have uncertainties regarding the consultation processes and results, which mostly concern communication with doctors. This thesis aims to answer the following two questions:

1) What **uncertainties** do patients have during VC, and how do these uncertainties affect patients' satisfaction towards the consultation?
2) How does the medium affect patients' perceived **uncertainties** and their satisfaction with VC?

Two studies were conducted to examine the impact of media on perceived uncertainty and patients' attitudes in doctor-patient computer-mediated communication (CMC), based on uncertainty reduction theory, media naturalness theory, and mental model theory.

The first study is a content analysis to analyze why patients are willing to visit doctors virtually and what uncertainties patients have about VC. Patients' online reviews on five famous virtual consultation systems were collected to do content analysis. The results show that the uncertainties patients have during patient-doctor communication in VC are mainly on doctors' behaviour, describing symptoms, understanding doctors, doctors' feelings and emotions, doctors' attitudes, and VC process. This study helps to understand patients' concerns about using healthcare systems to do VC and reconceptualizes uncertainty in the context of patient-doctor CMC.

The second study is a field experiment to explore how media naturalness (selection of media) and mental model alignment (media content) influence the patients' perceived uncertainties which then impact on the patients' satisfaction with the VC experience. After three rounds of pre-tests, 327 valid questionnaires were obtained in the main test and used to do data analysis. The results support the following hypotheses: a) Higher levels of media naturalness reduce patients' perceived uncertainty level. b) Higher levels of mental model alignment (i.e., the alignment of VC design with patients' mental models) decrease patients' perceived uncertainty level. c) Patients' lower level of perceived uncertainty increases their level of satisfaction.

This thesis contributes by revealing the meaning of uncertainties in VC and improving our understanding of how to reduce the patients' perceived uncertainties by better designing VC system. It provides empirical evidence on how media naturalness and mental model alignment increase patients' satisfaction on VC by reducing their uncertainties. The results can serve as a basis for further research on how to enhance the design of VC systems to fit patients' psychological and cognitive processes when they use these systems to visit doctors online. The thesis contributes practically by facilitating healthcare providers to understand patients' concerns and uncertainties while partaking in VC, and by guiding the design of VC systems to enhance communication between patients and doctors, and thus increase patient satisfaction.

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LIST OF ABBREVIATION

Abbreviation	Full Meaning
CMC	Computer-Mediated Communication
VC	Virtual Consultation
FTF	Face-to-Face
URT	Uncertainty Reduction Theory
UC	Uncertainty
MMA	Mental Model Alignment
NA	Naturalness
SF	Satisfaction
ECG	Electrocardiograms
WHO	World Health Organization
PLS-SEM.	Partial Least Squares Structural Equation Modeling
DA	Doctor’s Attitudes
UD	Understanding Doctors
DF	Doctor’s Feelings and Emotions

DS.	Describing Symptoms
DB.	Doctor’s Behaviour
VP	VC Process

1 Introduction

This chapter introduces the motivation and objectives of the thesis. By providing a review on the growth and benefits of VC, this chapter addresses the challenges of VC, which leads to the two research questions on how to better understand these challenges and how to conquer them by studying the role of media. This chapter ends with an introduction to the thesis organization.

1.1 Background and Motivation

VC is an important telemedicine service that enables patients to access healthcare remotely. It has drawn much attention in academia and practice. It has many advantages compared to a traditional face-to-face consultation, including convenience, efficiency and more. This section introduces the dramatical expansion of VC along with the development of telemedicine technology, as well as the benefits VC brings to patients, doctors, and healthcare organizations.

1.1.1 Growth of Virtual Consultation

Healthcare communications have changed along with our ability to send digital content. Telemedicine technology is used extensively between patients and doctors even across country borders. For example, telephone telemedicine is common and is estimated to be used in up to 25% of doctor-patient encounters (Haimi, Brammli-Greenberg, Waisman, & Baron-Epel, 2018; Street, Gordon, & Haidet, 2007). The idea of telemedicine is to allow better distribution of healthcare services to patients, especially underserved patient populations, and is not new. The first recorded use of telemedicine was by Wilhelm Einthoven, inventor of the Electrocardiography (ECG). He experimented with transmitting early ECG recordings by telephone in 1906 (Stowe & Harding, 2010). One of the earliest published uses of this technology was in the 1970s (Brooks, 2016; Glazer, Marshall, & Cunningham, 1978). However, in the 1970s, this tool was extremely costly and not easily scalable. In modern times, the most recent iteration of telemedicine is supported by the wide availability of the wireless Internet infrastructure to transport digital data quickly and easily from device to device at an affordable cost (Brooks, 2016).

Telemedicine is defined by the World Health Organization (WHO) as:

> *the practice of medical care using interactive audiovisual and data communications. This includes the delivery of medical care, diagnosis, consultation, and treatment, as well as health education and the transfer of medical care.* (Stowe & Harding, 2010).

It can also be simply defined as the delivery of healthcare services at a distance using information and communication technologies (Saliba et al., 2012).

Telemedicine often can be differentiated into three modalities: 1) consultation, 2) remote monitoring, and 3) remotely supervised treatment or training (Klaassen, Van Beijnum, & Hermens, 2016). Through these differing modalities, telemedicine can increase access to healthcare by limiting geographic dispersion and health disparities, especially in developing countries (Segato & Masella, 2017). It also provides a chance to keep the patients monitored, even at home or in primary care organizations (Segato & Masella, 2017).

Among the three modalities of telemedicine, VC is a critical one to deliver healthcare (Klaassen et al., 2016). VC (e-consultation or remote-consultation) between clinicians and patients is technically possible and increasingly acceptable (Greenhalgh et al., 2016). Such consultations offer potential advantages to patients (who are spared the cost and inconvenience of travel) and to the healthcare systems (e.g., they may be more cost-effective) (Barlow et al., 2007; Ekeland, Bowes, & Flottorp, 2010; McLean et al., 2013). VC can be practiced through email, telephone, and video, and has application in primary consultation, second opinion consultation, telediagnosis and administrative roles (e.g., e-referral) (Caffery & Smith, 2010).

The process of VC can be generally categorized into three steps to patients: making the appointment, communicating with selected doctors, and getting diagnosed. Under most conditions, patients can select a doctor from many options. After booking an appointment online from a doctor's available times, patients communicate with the doctor in different ways, including videos, messages, and phone calls.

1.1.2 Benefits of VC

It is widely accepted that VC has many benefits in delivering healthcare compared to face-to-face (FTF) doctor's visits. Traditionally, the patient may make a phone call to book an appointment, then the doctor or specialist discusses the patient's medical problem in person and begins the process of a treatment plan. The entire consultation process is face-to-face communication. This scenario is looking more and more obsolete, making the traditional doctor visit yet another procedure transformed by the age of online healthcare (Rosenzweig & Baum, 2013). The rapid proliferation of VCs is challenging the norm, with the benefits of eliminating the need for patients to leave the comfort of their office or home, accessibility of the same quality healthcare services in large cities and rural areas, and reduced charges for both patients and caregivers. Some researchers attested that up to 70% of all patients who seek care do not even need face-to-face interaction (Palen, Ross, Powers, & Xu, 2012).

VC benefits patients in many formats. One of the best-known and freely available internet video applications to conduct VC is Skype. Previous reviews of the clinical uses of Skype provided evidence to support it clinically (Armfield, Bradford, & Bradford, 2015; Armfield, Gray, & Smith, 2012). Armfield et al. (2015) reviewed twenty-seven articles and concluded that Skype was reported to be feasible and beneficial (Armfield et al., 2015), especially in the management of chronic diseases such as cardiovascular diseases and diabetes. Their results showed that Skype allowed excellent communication between individuals and health professionals and was mostly used in developed countries. While not many studies considered the economic effects associated with using Skype and similar free or inexpensive tools to do VC, those that agreed that Skype was more economical than face-to-face appointments with savings from avoided travel and waiting (Armfield et al., 2015;

Daniel.W., Darren.F., Michael., Seamus., & John. P., 2012; Travers & Murphy, 2014).

The feasibility of clinical use of these tools, including Skype, telephone, message, and others, motives the development of various VC systems. One popular commercial type is systems that enable patients to select certified doctors from a list of options, regardless of whether they are familiar with the doctors, to do VCs online (Greenhalgh et al., 2016; Tejera Segura & Bustabad, 2016; Zilliacus et al., 2010). With these systems, patients can access professional healthcare anytime and anywhere, without the risk of getting infected by other patients in the hospital (Ellenby & Marcin, 2015; Greenhalgh et al., 2016; Klaassen et al., 2016).

Besides the benefits of VC for patients, other parties, including physicians, nurses, and healthcare institutes, also receive massive conveniences and benefits. VC improves the efficiency of physicians, and largely reduces the rate of no-show appointments (Hanna, May, & Fairhurst, 2012). VC can complement nursing in cost-effective ways and increase the intimacy between patients and nurses (Reed, 2005; Stern, 2017). It can also benefit hospitals and other healthcare providers with more accessible doctor-physicians-specialists-hospitals connections. For example, Patterson and Wootton (2013) carried out a questionnaire survey of referrers and specialists over a six-month period and found that the patient management and diagnosis efficiency improved due to the use of telemedicine technology (Patterson & Wootton, 2013).

1.2 Challenges of Virtual Consultation

Despite its undeniable potential, fears have been expressed about VC that it may be clinically risky and less acceptable to patients or staff, and it brings significant technical, logistical, and regulatory challenges (Greenhalgh et al., 2016). Also, the influence of VC varies greatly depending on where and how the technology is applied (Porter & Lee, 2015). Thus, there are many challenges to the adoption of VC and make full use of VC.

The challenges of VC can come from the consultation process, technology, and consultation outcomes (e.g., Botrugno, 2018; Rogers et al., 2017). First, while saving patients' time and reducing the cost and inconvenience of traveling to hospitals, remote consultation may have drawbacks including a significant impact on patients' relationships with the doctor (Hailey, Roine, & Ohinmaa, 2002; Stowe & Harding, 2010). Some people may find it challenging to communicate freely in the presence of video and other equipment, especially if they have concerns about confidentiality and uncertainties (Rosenzweig & Baum, 2013; Stowe & Harding, 2010). It is important that both patient and clinician are aware of who is present at "the other end" of the conversation and whether he/she can be trusted.

Second, when it comes to VC technology, some clinicians may object to such new working models, and some patients are afraid to change the traditional consultation mode, especially when evidence supporting their safety and efficacy is lacking. Professional resistance to change and doctor training difficulties in utilizing the technology must be overcome if telemedicine is to reach its full potential (Porter & Lee, 2015).

Third, there are enduring concerns about the effectiveness and cost-effectiveness of VC. Despite the afore-mentioned theoretical benefits, the actual data to date is far from convincing (Porter & Lee, 2015). Additionally, there is no evidence that VCs will reduce hospital follow-up appointments or be cost-saving (Stowe & Harding, 2010). Most telemedicine studies focused on feasibility and acceptability for patients, instead of examining patient-centered outcomes (Adler-Milstein, Kvedar, & Bates, 2014). Although these aspects are important, they are not the same as – and may not correlate with patient-centered outcomes such as mortality and functional status (Porter & Lee, 2015). Thus, the results of such studies are not convincing enough. Given these limitations, the existing literature does not settle the issue of whether telemedicine delivers the same outcome as face-to-face encounters at either the same or lower costs (Ferrigno et al., 2018; Kaplan & Litewka, 2019; Porter & Lee, 2015).

Furthermore, the legal and regulatory infrastructure for VC has yet to catch up with the technology. The current regulatory environment erects multiple barriers to informal, distance-based care, and is poorly equipped to keep pace with rapid technology changes (Kaplan & Litewka, 2019).

There is currently little theoretical guidance to address the emerging challenges of VC. Although how to boost patients' attitudes has been studied extensively in VC area, traditional approaches to studying VC solely focused on outcomes and were from a positive perspective (Alrubaiee & Alkaa'ida, 2011; Lazar, Fleischut, & Regan, 2013; Meesala, Paul, & Ambedkar, 2017). In these traditional healthcare research, it is considered important to connect patient satisfaction with VC benefits and advantages. This becomes problematic as the patients' negative feelings play a comparably important role to form their perceptions on the consultation experience, despite all the benefits of VC.

1.3 Objectives of the Thesis

Given the limitations of traditional approaches to boost patients' attitudes towards VC, novel approaches that focused on other aspects except outcomes from negative perspective are needed. This thesis examined the effect of a largely ignored, but important, factor influencing patients' satisfaction in VC – *uncertainty*, and how the intervention of media would affect this factor during patient-doctor communication, with in-depth qualitative methods. Uncertainty refers to "an interactant's subjective sense of the number of alternative predictions available when thinking about a partner's future behaviour, or the number of alternative explanations available when thinking about a partner's past behaviour" (Bradac, 2001).

Despite the benefits, it is not surprising that not many patients are using VC as they claimed to be. One significant reason may be the negative perceptions (i.e., trust) patients have surrounding VC since most of the time they virtually visit unfamiliar doctors. One reason to cause patients' trust issues on doctors and diagnosis is their uncertainties in a traditional clinic environment (Ong, De Haes, Hoos, & Lammes, 1995). In the context of VC, to many patients, doing things online is like 'magic' because they do not precisely know how the results are generated electronically at the back end, especially when they communicate with persons they never met in real life. This 'magic' feeling comes from patients' uncertainties and causes their trust problems on online consultation. Consequently, patients are not satisfied with the consultation experience which could prevent them from continuously adopting the VC systems. To improve patients' satisfaction, trust and other attitudes towards VC, it is critical to understand and reduce patients' uncertainties. The first research question of this thesis is, therefore:

> **Research Question 1:** What uncertainties do patients have during VC and how do these uncertainties affect patients' satisfaction towards the consultation?

This thesis explored the answers using content analysis of user reviews on five commercial VC systems. The study revealed patients' concerns and uncertainties during VC consultation, the connection of uncertainties and patient satisfaction, as well as the benefits of patients doing VC.

This research then aimed to explore strategies to reduce patient's uncertainty during communication with doctors in the context of VC, specifically the role of media in reducing uncertainty. Patients communicate with doctors using computers or other electronic devices as mediated media. No matter how astute the doctor is on the other side of the mediated media in VC, there is always a diagnostic risk in some circumstances compared with a face-to-face consultation. For example, the poor lighting in a patient's home might obscure precancerous signs of a skin lesion, while this vision issue is not a problem in a doctor's visit in person. Therefore, patients have hesitations on the communication results with doctors in VC. As a result, the second research question in this thesis is:

Research Question 2: How does the medium affect patients' perceived uncertainties and their satisfaction with VC?

This thesis investigated the answers from both the selection of media/system and the content design of the system. It proposed that media naturalness and mental model alignment were inversely related to patients' uncertainties during doctor-patient communication. In particular, selecting a medium which has a high level of naturalness enables patients to communicate naturally with doctors during consultations, and consequently reduces patients' uncertainty levels toward both doctors and quality of consultation. Also, systems designed to match patients' mental models give them more confidence in communicating with doctors during VC and reduce their uncertainties.

By answering these questions, the thesis aims to make some key contributions to our knowledge of VC, as listed in Figure 1, in addition to the objectives of each aim.

Overall objective: Reducing uncertainty in VC

	Research Question 1: What uncertainties do patients have during VC and how do these uncertainties affect patients' satisfaction towards the consultation?
Chapter 1, 2	• The problems of accepting VC • Definition of VC • Limitations and gaps to existing VC approaches • Identification of uncertainty as a key factor • Exposition of the gap in understanding how to improve patient satisfaction toward VC
Chapter 3	Theoretical foundation of reducing uncertainty: • Uncertainty reduction theory (URT) • Media naturalness theory • Mental model theory
Chapter 4	A content analysis to understand: • Patients' uncertainties • The association between uncertainty and patient satisfaction • Benefits and advantages of VC Summary of findings: • The majority of patients' uncertainties are in the six key elements, including doctors' behaviour, describing symptoms, understanding doctors, doctors' emotions, doctor's attitudes, and VC process • Patient-centered uncertainty is tightly associated with patient satisfaction. • Virtual Consultation has many benefits including convenience, saving time and money, obtaining prescription fast, and others.

	Research Question 2: How does the medium affect patients' perceived uncertainties and their satisfaction with VC?
Chapter 5	Research framework to reduce uncertainty during patient-doctor communication including independent variables: • Media selection: naturalness • Media content: mental model alignment A field experiment to evaluate the impact of naturalness and mental model alignment on: • Patient uncertainty • Patient satisfaction Summary of findings: • Naturalness and mental model alignment are negatively related to patient uncertainty • Uncertainty is negatively related to patient satisfaction
Chapter 6	Thesis contributions Thesis limitations Directions for future research

Figure 1. The Roadmap and Key Contributions of the Research

1.4 Thesis Organization

The remainder of the thesis is organized as follows (see Figure 1). The next chapter provides background and review of the current literature on VC, including patient-doctor communication, uncertainty and patient satisfaction.

Chapter 3 provides a theoretical foundation for uncertainty reduction, including uncertainty reduction theory (URT), media naturalness theory, and mental model theory. This chapter also introduces a conceptual framework on reducing uncertainty and uses the theories listed above to derive propositions about the impact of media on patient uncertainty during patient-doctor CMC.

Chapter 4 presents a content analysis that seeks to understand patients' uncertainties on both doctors and systems, and how the uncertainty level affects patient satisfaction on VC experience.

Chapter 5 develops a research model from the conceptual framework in Chapter 3 and proposes the hypothesis. A field experiment is presented in this chapter to test the impact of naturalness and mental model alignment on uncertainty during patient-doctor CMC in VC.

The thesis concludes by summarizing how the cited research primarily contributes to theory and practice. It also recommends several areas for future research.

2 Review of Relevant Literature on Virtual Consultation

There is no universal definition of VC in current research. This chapter introduces some definitions from micro and macro perspectives and definitions in different contexts. It also reveals three main shortages in current VC research, including lackings of patient-doctor interaction, in-depth qualitative, and studies on negative effects of VC. Then this chapter reviews relevant literature on the patient-doctor CMC, uncertainty, and patients' satisfaction in the context of VC, with a goal of finding a novel approach to improve the above shortages. This goal motives the thesis to focus on using in-depth qualitative methods to study how to improve patient satisfaction during patient-doctor CMC by reducing patients' negative feelings.

2.1 Virtual Consultation Overview

Technology-supported consultation in healthcare is viewed by many as at least a partial solution to the complex challenges of delivering healthcare to diverse populations, especially rural people (Greenhalgh et al., 2016). Telemedicine (or telehealth), as one of these technologies, to send digital high-definition video and audio signals from one computer to another for direct patient care, can add an additional dimension to patient care by providing a logical extension of existing face-to-face physical doctor-patient consultation (Brooks, 2016; Jue, Spector, & Spector, 2017; Klaassen et al., 2016; Segato & Masella, 2017). As one important telemedicine modality, VC is broadly referred by some as a telemedicine service that enables patients to receive treatment in their daily living environment (Ellenby & Marcin, 2015; Epstein et al., 2005; Klaassen et al., 2016; H. Yu, Namboodiri, & Terashi, 2014). Some define VC explicitly as creating a virtual online doctor-patient consultation environment similar to physical consultation, with the added use of video-conferencing (telemedicine) technology (Brooks, 2016; Greenhalgh et al., 2016). Others define it from a conceptualization perspective. For example, Abbott et al. (2018) put it in the context of communication among doctors and defined it as a remote interaction between referring physician and specialist to investigate financial and temporal advantages in veterans requiring specialty care (Abbott et al., 2018). This thesis first focuses on video-based VC in which patients remotely visit doctors through video conferencing, and explores patients' uncertainties during VC, then investigates how the different types of VC influence patient satisfaction through the effect on uncertainty.

Studies on VC provided profound evidence on the effectiveness and efficiency of VC (e.g., Andreassen, Trondsen, Kummervold, Gammon, & Hjortdahl, 2006; Barlow et al., 2007; Ekeland et al., 2010; Hailey et al., 2002; Hillestad et al., 2005; McLean et al., 2013). Most of these studies were generally outcome-focused to investigate cost-effectiveness (Ferrigno et al., 2018; Hailey et al., 2002; Lee, Chan, Chua, & Chaiyakunapruk, 2017), healthcare access and quality (Doubova & Pã, 2018; Gallagher et al., 2017; Rosenzweig & Baum, 2013; Weinstein et al., 2014), and other advantages (Klaassen et al., 2016; McLean et al., 2013). The few studies conducted to date have shown great potential for the use of virtual online media tools, for communication between patients and clinicians. However, not many studies have been done to focus on improving the interactions between patients and clinicians (Greenhalgh et al., 2016; Verlinde et al., 2012).

The contribution of VC to healthcare has been studied mainly using experimental methods (especially randomized controlled trials) (Ellenby & Marcin, 2015; Greenhalgh et al., 2016; Reed, 2005). While the experimental method has its place to study the usability of VC, in-depth robust qualitative studies are needed to reveal not only before-after outcomes but also interactions among VC users (Greenhalgh et al., 2016).

Another shortage of current VC research is the lack of studies on negative effects of VC which investigate the usage of VC from a negative perspective. These could be studies about limitations and disadvantages of VC instead of benefits, negative attitudes toward VC, and about other challenges VC may face including governance, legal and technical difficulties (Greenhalgh et al., 2016). These studies could be on VC per se, or the VC participants including patients, doctors, nurses, healthcare providers and other parties that surrounding VC. The lack of studies on negative effects of VC raises the issue of publication bias and call into question on the conclusion that VC is effective and efficient (Greenhalgh et al., 2016; Jung & Padman, 2014; Ward, Jaana, & Natafgi, 2015). VC is often overestimated and may be deemed so important that it can potentially replace face-to-face physical consultation in the future (Van Velsen, Tabak, & Hermens, 2017). However, the desire to have a face-to-face interaction and not trusting VC quality are cited by many patients as reasons to not use VC services, despite additional time and money spent traveling to appointments (Gardner et al., 2015; Greenhalgh et al., 2016). Wilson et al. (2006) examined the development of trust in computer-mediated and face-to-face teams by having fifty-two, three-person groups work on a mixed-motive task over a 3-week period. The results suggested that electronically mediated teams do not develop comparable levels of trust to face-to-face ones (Wilson, Straus, & McEvily, 2006). In 2015, Gardner et al. conducted a phone survey of a random sample of patients and found that there are significant hurdles to effectively implement telehealthcare as part of mainstream practice, although many patients are likely to accept telehealthcare (Gardner et al., 2015). Besides the trust issue of patients on telemedicine or VC, literature also identified the concern of care quality in remote consultation environments including telephone, email, video, and internet consultation (Daniel.W. et al., 2012; Hewitt, Gafaranga, & McKinstry, 2010; McKinstry et al., 2010; Roter, Larson, Sands, Ford, & Houston, 2008). However, these negative aspects of VC were typically mentioned in passing but not elucidated further. While positive outcomes of VC are relatively well-established, the lack of studies on negative effects of VC prevents people from fully understanding the concept and accepting the technology (Greenhalgh et al., 2016). This thesis fills these gaps by studying patients' uncertainties via in-depth qualitative methods, with a focus on improving patient-doctor communication.

2.2 Patient-Doctor Computer-Mediated Communication (CMC) in Virtual Consultation

2.2.1 Patient-Doctor CMC

McQuail (2005) defined computer-mediated communication as: "any act of communication that takes place through the use of two or more electronic devices" (McQuail, 2005). This very broad definition encompasses all the approaches and experimental conditions deployed in the studies in this thesis.

The advent of CMC as a new mechanism for the formation and maintenance of interpersonal relationships poses interesting questions (Ramirez, Walther, Burgoon, & Sunnafrank, 2002). In the healthcare area, one of the important questions is: How does CMC affect traditional doctor-patient relationships? This question is barely answered by current CMC studies because few scholars have examined how CMC serves to fulfill the relational functions between doctors and patients (Lee & Zuercher, 2017).

In the context of patient-doctor communication, CMC is viewed mainly by academia as a method to seek and share information, build a 'good relationship', and others (Lee & Zuercher, 2017). While information seeking and sharing were suggested by many literatures as the main task of patients and doctors using CMC (Johnson & Ramaprasad, 2000; Lee & Zuercher, 2017; Ramirez et al., 2002; Swee-Lin Tan & Goonawardene, 2017; Ye, Rust, Fry-Johnson, & Strothers, 2010), few literature focused on the topic of using CMC to build and maintain a good relationship between patients and doctors (Andreassen et al., 2006; Lee & Zuercher, 2017; Nilsson, Skär, & Söderberg, 2010; White, Moyer, Stern, & Katz, 2004). Nevertheless, the very limited number of studies still gave a glance at the benefits of CMC on patient-doctor relationship. CMC plays a vital role in building a trusting relationship between patients and doctors and leads patients to communicate with doctors more comprehensively and thoroughly (Andreassen et al., 2006). It also empowers patients to express concerns and preferences (Verlinde et al., 2012) and improves patients' satisfaction (Butalid, Bensing, &

Verhaak, 2014; Fritzsche et al., 2014) in the VC environment. Physicians also believe that CMC can have a positive effect on doctor-patient relationships by establishing and maintaining rapport with the patient (Aelbrecht et al., 2015; Weng, Chen, Chen, Lu, & Hung, 2008). Acknowledging the convenience of CMC, both doctors and patients are willing to communicate via different types of communication systems (S. A. Lee & Zuercher, 2017).

Patient-doctor CMC has some barriers, along with the benefits (Lee & Zuercher, 2017). While it empowers patients on obtaining information and expressing concerns, physicians tend to complain about the heavy workload and reimbursement issues (Mcgeady, Kujala, & Ilvonen, 2008), especially for telephone and message communications. For example, when telephone consultation was first introduced, doctors concerned about more and more calls from anxious patients day and night (Bergmo, Egil Kummervold, Gammon, & Bredrup Dahl, 2005). Similar concerns were raised when messaging communication was introduced (S. A. Lee & Zuercher, 2017; Mcgeady et al., 2008). Doctors complained of wasting time on patients' irrelevant messages and questions (S. A. Lee & Zuercher, 2017). While the majority of doctors believe in the effectiveness of patient-doctor CMC and are willing to encourage their patients to use them, these complains somehow prevent the widespread use of CMC in patient-doctor communication (Bruyneel, Van Den Broecke, Libert, & Ninane, 2013; Ignatius & Nielsen, 2017).

On the one hand, new communication technologies make it easier for patients and doctors to connect. Patients can reach their doctors without physically visiting, and doctors can easily get feedback from patients and avoid unnecessary visits. On the other hand, easy communication mode makes patients more likely to contact their doctors with unnecessary calls and messages, which may result in an overwhelming number of messages on doctors. With limited time and effort, physicians may not be able to respond to all the patients and adequately answer their messages, which may result in a decrease on service quality (Liederman & Morefield, 2003). Many other concerns are put forward on doctor-patient CMC, including trust and privacy (Khan, 2013; Lee & Zuercher, 2017;

McKinstry et al., 2010; Ye et al., 2010). While the benefits of CMC on patient-doctor relationship await further studies, the concerns also need to be addressed. One concern of patients during their communication with doctors, especially unfamiliar doctors online, is their uncertainties on doctors and communication results (Ong et al., 1995). This thesis focuses on reducing patients' uncertainties during patient-doctor CMC.

Unlike face-to-face consultation where patients send and receive information in the presence of doctors, VC relies on the CMC between patient-doctor with the intervention of medium. The differences between the two communication modes are illustrated in Figure 2. The role of the medium is introduced in the following section.

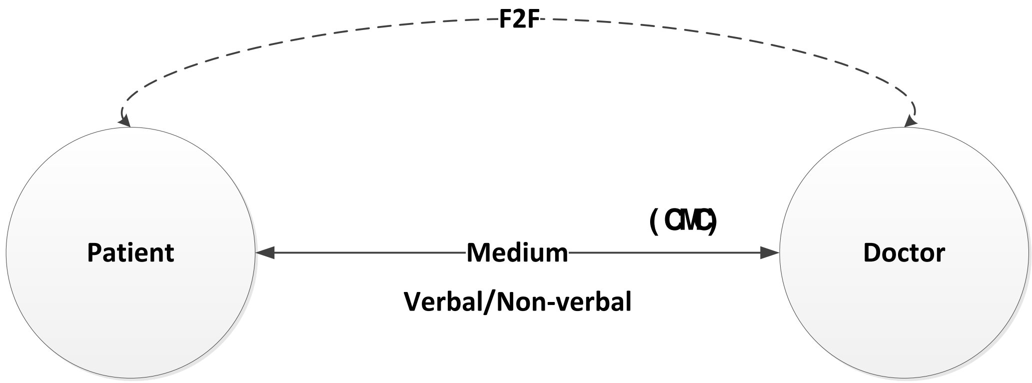

Figure 2. The process for face-to-face and computer-mediated communications

2.2.2 Media Selection and Content in Patient-Doctor CMC

Numerous studies have explored the complex effects and contradictory roles of the Web in altering healthcare delivery and the physician-patient relationship (Wald, Dube, & Anthony, 2007). Instead of direct communication between patients and doctors in a traditional face-to-face consultation, VC involves media during patient-doctor communication. Trevino et al. (1987) proposed that various media differ in their ability to accurately convey information cues (Trevino, Lengel, & Daft, 1987) and to provide communication functions (Huang, Yang, Baek, & Lee, 2016). Daft et al. (1987) suggested that correct media selection is expected to be related to communication effectiveness, and hence to communicators' performances (Daft, Lengel, & Trevino, 1987). Also, mass communication theorists have included orientation to the environment or uncertainty reduction as an important function played by the media (Berger, 1986; Katz, Blumler, & Gurevitch, 1974).

Media selection has long been studied in different areas for different purposes. For example, Kuang et al. (2017) conducted an experiment to study strategies to select social media for more effective promotion (Kuang, Jiang, Cui, Sun, & Yang, 2017). Lapointe (2018) studied the impact of media selection for better design of ballasted flocculation processes (a technology consisting of injecting ballast medium to increase floc specific gravity and size in the water industry) (Lapointe & Barbeau, 2018). Liu and Chang (2016) examined the role of media involvement in game addiction (Liu & Chang, 2016). Some research focused on the factors that influence people's media selection instead of the opposite. For example, Ambrose et al. (2008) explored factors on the choice of communication media and concluded that media selection is affected by the communication needs of the participants, the stage of relationship development, and the purchasing context (Ambrose, Marshall, Fynes, & Lynch, 2008). Though media selection is not new in the information system area, little research on media selection has been done on patient-doctor communication (Mao, 2015).

2.3 Uncertainty in Virtual Consultation

Unlike other negative aspects in VC, uncertainty is an critical factor that can affect communication results (Antheunis, Schouten, Valkenburg, & Peter, 2012; Duronto, Nishida, & Nakayama, 2005). Since the scope of this thesis is restrained to patient-doctor communication, it is naturally to focus on patient uncertainty instead of other similar concepts to investigate how to improve patient-doctor communication results. There are two types of uncertainty, including cognitive uncertainty and behavioural uncertainty (Berger & Bradac, 1982). Cognitive uncertainty refers to the level of uncertainty associated with the beliefs and attitudes of each other in the communication, while behavioural uncertainty refers to the extent to which behaviour is predictable in a given situation (Berger, 1986; Berger & Bradac, 1982). Research has shown that managing uncertainty is a central process that affects our communication with people, especially strangers (Duronto et al., 2005).

Another similar concept with uncertainty is perceived risk which is broadly defined by Dowling as representing an uncertain, probabilistic potential future outlay (Dowling, 1986). Knight proposes that risk has a known probability while uncertainty exists when knowledge of a precise probability is lacking (Knight, 2012). That is, uncertainty differ from perceived risk because it could be on both positive and negative issues, and also viewed as many researchers as the antecedents of people's perceptions such as trust and perceived risk (Knight, 2012; Mitchell, 2017).

In healthcare, uncertainty is everywhere in clinical practice (Danczak & Lea, 2017). Diagnosis, referral, arranging treatment and teamwork difficulties may all give rise to troubling uncertainties for doctors (Danczak & Lea, 2017). Clinical uncertainty can give patients stress, and mis- or over-use of medicines (Srivastava, 2011). Many studies have been done to reduce doctors' uncertainty during diagnosis. For example, Andre et al. (2016) interviewed 25 general practitioners to describe strategies of coping with uncertainty in patients (Andre, Gröndal, Strandberg, Brorsson, & Hedin, 2016). Their results showed that the use of guidelines as well as the use of more patient-centered tests associate to reduce uncertainty. Patient-centered care is the newest trend in medicine (Srivastava, 2011). It is suggested that adhering to patients can reduce either diagnosis uncertainty for doctors or patients' stress and prognosis uncertainty (Schapira, 2014; Stieglitz & Dang-Xuan, 2013).

In the traditional face-to-face consultation, patients have feelings of uncertainty, anxiety, depression, and other psychological difficulties because of patients' limited understanding of medical problems and treatment (Ong et al., 1995). In the context of VC, patients can be uncertain about many things both on doctors and systems (Panlaqui, Broadfield, Champion, Edington, & Kennedy, 2017). These uncertainties could stem from feelings of lacking information as traditional consultation, or from the selected communication media (Stefan Timmermans et al., 2018). These uncertainties can affect their cognitions, feelings, as well as decision makings (Schapira, 2014). Communicating uncertainty is the first and critical step in helping patients to manage uncertainty about the consultation quality in order to make a good quality decision (Politi & Street, 2011). Good patient-doctor CMC should give patients confidence that their doctor is an advocate who will not abandon them in order to reduce their uncertainty (Srivastava, 2011). In the face of uncertainties, healthcare organizations must be reprogrammed and renewed, repositioning themselves for the future (Cheng Lim & Tang, 2000). Therefore, understanding patients' uncertainties during communication with doctors would allow healthcare organizations to receive guidance to improve system design.

2.4 Satisfaction in Virtual Consultation

According to O'Connor et al., "It's the patient's perspective that increasingly is being viewed as a meaningful indicator of health services quality and may, in fact, represent the most important perspective"

(Andaleeb, 2001). Patient satisfaction is considered as one of the most important quality dimensions and key success indicators in healthcare (Pakdil & Harwood, 2005). Oliver (2014) defined satisfaction as "the consumer's fulfillment response", a post-consumption judgment by the consumer that a service provides a pleasing level of consumption-related fulfillment, including under- or over-fulfillment (Alrubaiee & Alkaa'ida, 2011; Oliver, 2014). Zineldin (2006) defined satisfaction as an emotional response (Alrubaiee & Alkaa'ida, 2011; Zineldin, 2006).

A comprehensive and critical review of the patient satisfaction literature was first done by Ware et al. (Ware, 1978). The conclusion revealed empirical studies of patient satisfaction dealt with many items which could be grouped into constructs which were implicitly intended to measure (Ware, 1978; Ware, Profile, & Hays, 2017). Linder-Pelz (1982) argued that while the result was informing us of the multidimensionality of the phenomenon, it still did not tell what is the nature of the phenomenon to begin with (Linder-Pelz, 1982), and this issue had never been confronted concerning patient satisfaction (Linder-Pelz, 1982). Patients make judgments about the care they received from healthcare providers. Their judgments are based largely on their perceptions of how care is administered (Pakdil & Harwood, 2005). That is, patient satisfaction is created through a combination of responsiveness to the patient's views and needs, and continuous improvement of the healthcare services, as well as continuous improvement of the overall doctor-patient relationship (Zineldin, 2006).

Determining the factors associated with patient satisfaction is an important topic for people to understand what is valued by patients, how the quality of care is perceived by patients, and to know where, when and how service change and improvement can be made (Mair & Whitten, 2000; S, J, & J, 1998; Zineldin, 2006). Much research has been done on the impact of characteristics of doctors and systems on patient satisfaction in the healthcare area. Studies have investigated how far the doctor's level of information provision, information seeking, and communication skills during consultations are related to patient satisfaction (Agha et al., 2009). This thesis suggested an impact of patient-centered uncertainty on patient satisfaction in the context of VC.

2.5 Chapter Conclusion

This chapter reviewed relevant literature on patient-doctor communication in the context of VC and revealed gaps and challenges in this area.

Studies on VC are sparse but begin to accumulate. While this handful of studies are broadly positive, studies on negative effects of VC are urged to reassure the unqualified conclusion that the consultation is effective and to waive publication bias caused by most of the current publication being positive (Greenhalgh et al., 2016). Additionally, in-depth qualitative research is needed to study not only VC outcomes but also on the patient-doctor interaction.

While the benefits of overall patient-doctor CMC for information seeking and sharing are relatively well-established, its roles in building patient-doctor relationships await further investigation. This situation is even more emergent in the context of VC than other contexts, where patient-doctor interaction decisively influences patients' attitudes toward the consultation.

This thesis introduces a concept-*Uncertainty*, which is important to communication results between patients and doctors, to fill the gap of lacking studies on negative effects in VC. Using in-depth qualitative methods, this thesis investigates how the intervention of medium influences patients' uncertainty and satisfaction, with a focus on the interaction between patients and doctors.

3 An Overall Framework and Theoretical Foundations

This chapter introduces an overall research framework outlining the impact of media in reducing patients' uncertainty and improving their satisfaction. This framework is the basis for the content analysis in study one and for developing the research model in study two. This chapter then introduces three theories as theoretical foundations: uncertainty reduction theory (URT), media naturalness theory, and mental model theory.

3.1 An Overall Research Framework

In the context of CMC, not only patients' and doctors' characteristics affect communication results. The selection of media and different communication process result from different media designs also have an impact on patients' uncertainties about doctors, and consequently, affect patients' satisfaction with the consultation experience. According to the discussions in Chapters 1 and 2, this thesis generated the overall conceptual framework presented in Figure 3.

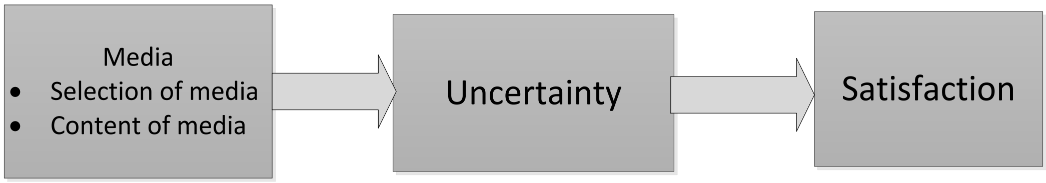

Figure 3. A conceptual framework of uncertainty in CMC

Three theories, including uncertainty reduction theory, media naturalness theory, and mental model theory, are used as the theoretical foundation for this overall framework and the research model for study two. The following sections will introduce the three theories in detail.

3.2 Uncertainty Reduction Theory

The uncertainty reduction theory (Berger & Calabrese, 1975) was first developed to deal with the initial stage of interpersonal interaction. Berger and Calabrese (1975) labeled three phases of communication including the entry phase, personal phase, and exit stage. By assuming the persons involved in the communication interactions are strangers, they defined the entry stage as the beginning of communication during which communication content is somewhat structured. That is, the information received and given by the interactants tends to be symmetric (Berger & Calabrese, 1975). For example, the message content tends to be demographic information about the interactants. By the end of this phase, the interactants have a confident estimate of whether or not they will develop the relationship to a more intimate level. In the context of VC, from a patient's perspective, the entry phase could be when the patient read the doctor's basic demographic information and make decisions on whether or not to consult the doctor. The personal phase refers to the second stage of the communication transaction which begins when the interactants engage in communication about central attitudinal issues, personal problems, and basic values (Berger & Calabrese, 1975). This phase in VC could be the consultation process when the patient describes symptoms and other information to the doctor. The exit phase is the final stage during which decisions are made concerning the desirability of future interaction. This stage in VC is the end of consultation where the patient has an evaluation of the consultation and make decisions on future usage of

VC. The three stages provide directions on where to reduce uncertainties during VC process. For example, to reduce patients' uncertainties, they should be able to communicate with doctors naturally and smoothly during the personal phase, while they should be given sufficient and accurate information on doctors during the entry phase.

According to Berger and Calabrese (1975), when strangers meet, their primary concern is one of uncertainty reduction or increasing predictability about the behaviour of both themselves and of others in the interaction. Uncertainty involves both prediction and explanation components. Prediction component refers to a proactive process of creating predictions. That is, an individual aim to predict how the other interactants will act during the communication. Explanation component refers to the retroactive process of explaining the other's behaviour (Berger & Calabrese, 1975). A high level of uncertainty in a relationship decreases the intimacy level of communication. And a low level of uncertainty produces a high level of intimacy.

According to URT, uncertainty reduction is the gathering of information that allows the information seeker to predict someone's attitude and behaviour. During the uncertainty reduction processes, the information seeker creates mental models that help him/her make sense of other people and their intentions, emotions, and behaviours (Antheunis et al., 2012; Berger & Calabrese, 1975; Srull & Wyer, 1989). The degree of one's perceived uncertainty can be lowered by three unique uncertainty reduction strategies: (1) passive, (2) active, and (3) interactive (Antheunis et al., 2012; Shin, Lee, & Yang, 2017). Passive strategies are those in which an informant unobtrusively observes the target person, for instance, by observing videos of the doctor's previous consultation for VC patients. Active strategies pertain to proactive efforts to get to know the target person, without confronting the person, for example, by reading other patients' reviews about the doctor before VC. Interactive strategies require direct interaction between the communication partners, for example, by asking questions or through reciprocal self-disclosure (Antheunis et al., 2012; Berger & Calabrese, 1975), which means actual video consultation with the doctor. Due to the ability of this theory to explain people's strategies to reduce uncertainties about other parties in a communication interaction, it can provide a theoretical perspective on how to better design VC systems. These systems will help patients reduce uncertainties during computer-facilitated communication with doctors, and consequently improve their experiential satisfaction.

3.3 Media Naturalness Theory

3.3.1 Media Naturalness

Media naturalness is an important concept to explain the differences between computer-mediated and face-to-face communication (Blau & Caspi, 2010). The degree of naturalness of a medium can be assessed based on the degree to which it incorporates five key elements of face-to-face communication: a) colocation, which would allow individuals engaged in a communication interaction to share the same context, as well as see and hear each other; b) synchronicity, which would allow the individuals to quickly exchange communicative stimuli; c) the ability to convey and observe facial expressions; d) the ability to convey and observe body language; and e) the ability to convey and listen to speech (Kock, 2005). According to Kock (2002, 2005), the naturalness of the communication medium created by an e-communication technology can be defined as the degree to which the technology selectively incorporates (or suppresses) those five elements. That is, other things being equal, the degree of incorporation of one of the media naturalness elements correlates with the degree of naturalness of an e-communication medium (Kock, 2002).

3.3.2 Media Naturalness Theory

Two theories were primarily used by previous research on media selection: social presence theory and media richness theory (Palvia, Pinjani, Cannoy, & Jacks, 2011). Both theories focus on the determinants of media choice and posit that the match between the medium and task results in effective communication (Palvia et al., 2011). The two theories emphasize how media differ in the extent to which they can deliver different cues of human communication and information (Rice, 1993). However, this thesis not only focuses on the information delivery during patient-doctor communication but also patients' naturalness feelings on VC comparing with traditional consultation. Media naturalness theory better serve this task as a theoretical foundation in this thesis by providing elements of naturalness which not only emphasizes on the communication information but also on a time-space perspective, including co-location and synchronicity.

From an evolutionary standpoint, synchronous face-to-face communication (using audible sounds and visual cues) has been the primary mode of communication in the evolutionary history of human beings (DeRosa, Hantula, Kock, & D'Arcy, 2004), which means that humans are optimized for FTF interaction (Kock, 2002). According to Kock (2002), all other things being equal, humans prefer FTF because it is the most natural form of communication. Furthermore, communication modes that are most like FTF interaction are more natural for humans.

Ned Kock (2002) developed the media naturalness hypothesis to answer the question: What happens when we selectively suppress face-to-face communication elements (e.g., colocation,) through e-communication technologies? The hypothesis argued that, other things being equal, a decrease in the degree of naturalness of a communication medium (or its degree of similarity to the face-to-face medium) leads to the following effects in connection with a communication interaction: (1) increased cognitive effort, (2) increased communication ambiguity, and (3) decreased physiological arousal.

Kock (2005) developed a new theoretical model named the psychobiological model, which predicts variations in cognitive effort in computer-mediated collaborative tasks. The model proposed that there is a negative causal link between the “naturalness” of a computer-mediated communication medium, which is the similarity of the medium to the face-to-face medium, and the cognitive effort required from an individual using the medium for knowledge transfer (Kock, 2005). The model also stated that this link was balanced by schema alignment and cognitive adaptation. The schema alignment refers to the similarity between the mental schemas of an individual and those of other participants. The cognitive adaptation refers to an individual's level of schema development associated with the use of a particular medium. Higher cognitive adaptation and schema alignment leads to a lower degree of cognitive effort (Kock, 2005).

3.4 Mental Model Theory

Mental models are psychological representations of real, hypothetical, or imaginary situations. The concept was first postulated by Charles Sanders Peirce (Johnson-Laird, 1989; Peirce, 1896). However, psychologist Kenneth Craik first theorized the concept (Craik, 1967). He wrote:

> *If the organism carries a "small-scale model" of external reality and of its own possible actions within its head, it is able to try out various alternatives, conclude which is the best of them, react to future situations before they arise, utilize the knowledge of past events in dealing with the present and the*

future, and in every way to react in a much fuller, safer, and more competent manner to the emergencies which face it.

(Craik, 1943, Ch.5, P.61)

Humans are able to reason by manipulating symbolic representations and translating them back into actions or nothing correspondence between the external events and their internal representations (Staggers & Norcio, 1993). That is, the image of the world around us, which we carry in our head, is just a model. Nobody in his/her head images all the world, government or country. Humans have only selected concepts, and relationships between them, and use those to represent the real system (Forrester, 1971). In short, a mental model is an explanation of someone's thought process about how something works in the real world. Craik defined the term model as: "any physical or chemical system which has a similar relation-structure to that of the process it imitates" (Craik, 1967). The notion of mental model has been used to study humans' reasoning and learning process (Chiou & Anderson, 2010;

Johnson-Laird, 1989; Payne, 2003; Van Der Henst, 2000; Yang, Narayanan, Baburaj, & Swaminathan, 2016)

Numerous studies have shown that deep comprehension of discourse involves the construction and manipulation of mental representations that reproduce the state of affairs described (Cutica & Bucciarelli, 2011; Zwaan, Magliano, & Graesser, 1995). The listener builds such representations based on the semantic and pragmatic information contained in the text, together with his or her prior knowledge and any inferences that are drawn. Depending on the different theoretical frameworks within which this phenomenon has been studied, these mental representations are called mental models (Johnson-Laird, 2006; Johnson-Laird, 1989). A mental model is a mental representation that analogically reproduces a perceived or described state of affairs; it consists of elements, which stand for the perceived or described entities, and relationships between such elements, which stand for relationships between the entities (Cutica & Bucciarelli, 2011). Several authors have demonstrated that the more a listener is able to make links and place the information that is received within an integrated network, the higher his/her level of comprehension (Cutica & Bucciarelli, 2011).

Mental models are small-scale models that the individual believes is analogous to how the world works (Craik, 1967). Beyond this general definition, more detailed theory on mental models varies between authors (Jones, Ross, Lynam, Perez, & Leitch, 2011; Scott, 2018). Also, mental models are periodically used to describe the entire range of mental representations and cognitive processes (Scott, 2018), or a smaller subset of these processes (Doyle & Ford, 1998). They are considered by some authors to be temporary structures that reside in the working-memory (Johnson-Laird, 1989; Wilson & Rutherford, 1989).

There is no way to study mental models directly (Gentner & Stevens, 1983). Mental models cannot be elicited without distortion (Doyle, Radzicki, & Trees, 2008; Gentner & Stevens, 1983). Scott (2018) conducted a study to investigate the measurement of a mental model. The study relied on an inference that enduring changes in decision preferences are indicative of changes to deeper and more stable cognitive structures, such as mental models (Kahneman & Tversky, 1984). Scott (2018) concluded that there were two significant considerations to the study: separating measurement of mental models from the measurement of their change, and measuring change rather than perceived change (Scott, 2018).

Therefore, this thesis does not attempt to elicit mental models, but rather to investigate their alignment with the existing models in patients' minds. Research has shown that both mental model alignment and transfer influence a range of related outcomes, such as immersion (Biocca, 2006), flow (Sherry, 2004), and learning (Martinez-Garza & Clark, 2017) in the context of game playing (McGloin, Wasserman, & Boyan, 2018).

There has been much research on the concept of mental model alignment. Some studies were made to investigate how mental model alignment among group members affects group decisions and group agreements (Scott, 2018). Other studies have been done to investigate the interrelationships among people's mental models and external system situations in the context of game playing and model-based learning (Martinez-Garza & Clark, 2017; McGloin et al., 2018). For example, McGloin et al. (2018) proposed that: game players create and apply mental models as a means of making in-game decisions; players refine these models through repeated engagements with a game; alignment of game models and external situations can facilitate the player's transfer of mental models between game and external situations; and the degree of alignment of mental models to game models impacts media effects (McGloin et al., 2018). While the concept is heavily studied in teamwork, game playing, and learning topics, very limited studies have been done in healthcare contexts.

A principle of the modern theory of mental models is that a model has the same structure as the situation that it represents. Like a patient's model, the parts of the visiting doctor's model and their structural relations correspond to those it represents. According to the mental model theory, everyday reasoning depends on the simulation of events in mental models (Johnson-Laird, 2006). The context in which information is processed determines to a great extent which inferences people will make (Van Der Henst, 2000). The theory of mental models postulates that individuals reason by envisaging the circumstances in which the premises and any other starting information are true (Johnson-Laird, 2006; Johnson-Laird, 1989; Van Der Henst, 2000). In the context of VC, this principle suggests that the patient make evaluations of the consultation depends on the simulation of consultation in mental models. The patient will make inferences based on their mental models of FTF consultation to proceed online consultation. If the online consultation fits the inferences, the patient considers the consultation to truly represent FTF consultation and form better attitudes. To be short, this principle suggests an alignment of patients' VC model with their FTF consultation model, in the context of VC. The FTF consultation model could be models when the patient consults a familiar doctor or a new doctor.

3.5 Chapter Conclusion

This chapter reviewed three theories as the theoretical foundations of the thesis. The uncertainty reduction theory is commonly used in mass communication research. It applies to patient-doctor CMC because, despite the complexity of the consultation process, it still belongs to one type of mass communication with many information sending and receiving activities between patients and doctors.

Media naturalness theory was developed by Kock (2002) to go beyond media richness theory. It argues that the characteristics of media should include both information richness and time-space perspective. This theory fits well with the research model in this thesis by providing the measurement of media selection because media naturalness can be an important indicator of media.

Mental model theory is largely used to study human behaviour. It suggests that two persons' mental models aligning with each other could lead to a better quality of group work. This thesis suggests that healthcare system design should match patients' expectations and experiences for better outcomes. This design is comparable with the mental model theory. Therefore, this thesis chooses mental model as one of the theoretical foundations in pursuit of a solution to its aims.

4 Study One: A Content Analysis on Uncertainties in Virtual Consultation

4.1 Introduction

This chapter introduces a content analysis of patients' reviews to investigate their uncertainties towards VC. Evidence has shown that the quality, cost, and benefits of healthcare service have been consumers' primary concerns (Greenhalgh et al., 2016; Santana et al., 2010). Patients may be skeptical of online consultation's diagnosis accuracy, and they also doubt the cost including financial and time cost, and all the benefits online consultation brings comparing to traditional face-to-face doctor's visits. Consequently, VC providers face a critical challenge in capturing and keeping users. The challenge is to discover what determines users' positive attitudes towards VC and how to facilitate these sorts of responses.

As a viable way of decreasing uncertainty, user reviews have become a useful venue in the healthcare system market. Users can evaluate a VC system after usage and others can also check reviews before using the system. The reviews have different formats, ranging from score scale to text comment. As viewed by researchers, more detailed information in user feedback is particularly valuable (King, Racherla, & Bush, 2014; Qu, Wu, & Wang, 2009). Users' text comments may convey rich information about their attitudes toward the system and why which cannot be wholly captured through other review formats including star/score scale and so on (Kruse et al., 2017). This study applies content analysis on the patients' text reviews of VC systems and seeks to answer the first research question: What uncertainties do patients have during VC, and how do these uncertainties affect patients' satisfaction towards the consultation?

In-depth qualitative research in VC is needed, especially from a negative angle. This study fills these gaps by providing a comprehensive analysis of patients' uncertainties in VC. Additionally, the significance of this content analysis is twofold. From a practical perspective, this study reveals patients' uncertainties about VC services, despite easier access to healthcare and other benefits. This knowledge can help healthcare providers better understand patients' concerns surrounding VC and enable the creation of a better system design to improve patients' certainty and satisfaction. The study also reveals the connection between patient uncertainty and patient satisfaction on VC experience, which urges future studies on reducing patient uncertainty for higher level of patient satisfaction.

4.2 Conceptual Development

Many factors affect patients' attitudes and intentions to see doctors online. Wu et al. (2007) developed a revised technology acceptance model to examine what determines the acceptance of mobile healthcare systems (MHS) by healthcare professionals (Wu, Wang, & Lin, 2007). The results indicated that compatibility, MHS self-efficacy, and technical support and training significantly affect patients' attitudes towards mobile healthcare, including perceived usefulness and perceived ease of use.

Yu et al. (2009) conducted a survey to examine the determining factors of how caregivers in long-term care facilities accept health IT applications. (Yu, Li, & Gagnon, 2009). The antecedent variables in the paper included social influence factors (such as subjective norm and image), and demographic variables (including job title, age, work experience, and computer skills). The results showed that computer skills have a significant positive impact, whereas image has a significant negative impact on caregivers' intention to use health IT applications.

Of all the factors affecting the public's adoption of healthcare systems, healthcare quality and patient satisfaction are key metrics used by healthcare providers in their continuous process improvement efforts (Johnson, Russell, & White, 2016). Studies have shown that patients who are satisfied with their care are more likely to follow prescribed treatments (Matthew P. Manary, William Boulding, Richard Staelin, & Seth W. Glickman, 2013). Johnson et al. (2006) modeled the impact of patient perceptions of care quality on overall patient satisfaction in a rural healthcare organization over a three-year period. Johnson et al. (2006) discovered that dimensions and constructs of service quality significantly predict patient satisfaction (Johnson et al., 2016). Choi et al. (2005) investigated the relationships between service quality and satisfaction in a South Korean healthcare system (Kui-Son Choi, Hanjoon Lee, Chankon Kim, & Sunhee Lee, 2005). The results indicated that the general causal relationship between service quality and patient satisfaction was well supported in the South Korean healthcare delivery systems.

It is important to point out that most prior literature generally dwells on patient satisfaction in the context of common healthcare, which includes telemedicine, telemonitoring, personal health record and so on (e.g., Howard, Goertzen, Hutcbison, Kaczorowski, & Morris, 2007; Larsson & Wilde-Larsson, 2009). However, as one emergent and special format of healthcare, not many researchers have studied patient attitudes and care quality in the context of VC (Fatehi, Martin-Khan, Smith, Russell, & Gray, 2015; Segura & Bustabad, 2016).

Patient perceptions/attitudes have become key inputs for the assessment of healthcare quality, as well as incentives of healthcare system adoption (Johnson et al., 2016; Naidu, 2009). Patients' concerns greatly affect their perceptions and decision makings on using VC systems. Concentrating on uncertainty, a content analysis was conducted based on the framework presented in Figure 4.

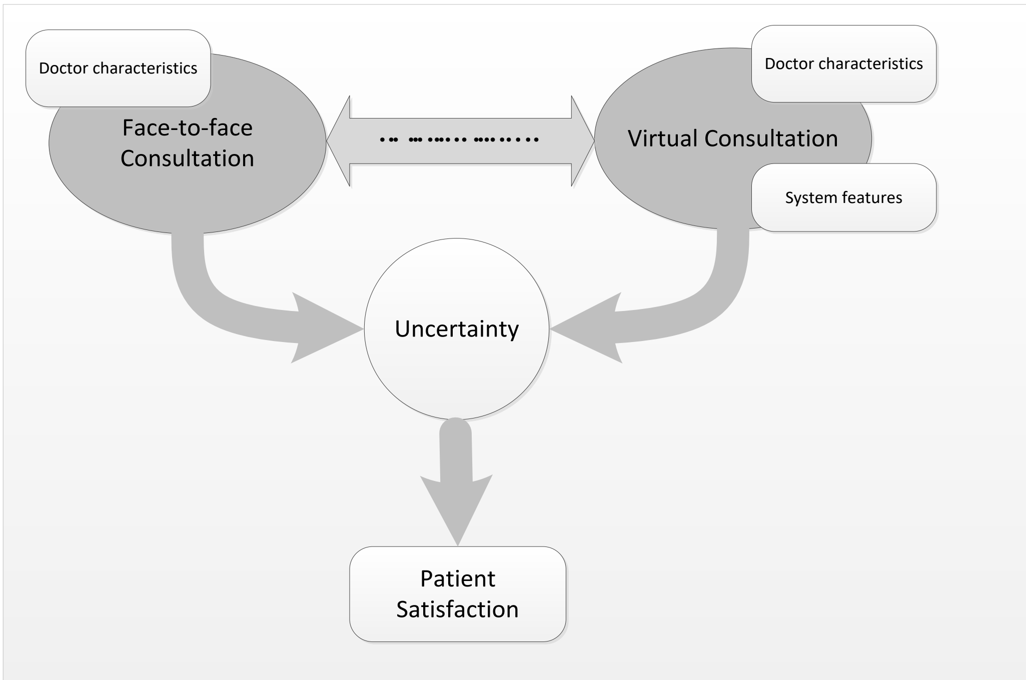

Figure 4. Patient uncertainty framework for content analysis (a comparison between virtual and face-to-face consultation)

Typically, both the format and quality of interaction between patients and doctors influence healthcare quality, consequently affecting patients' satisfaction. In the context of FTF consultation, people interact with one another in a straightforward and natural way. Quality of communication and healthcare mainly accounts on people per se, including professionalism of the doctor, disease description and so on. While in the context of VC, patients interact with doctors through media/system. Therefore, apart from the characteristics of users, system features can also influence communication between patients and doctors, therefore affecting healthcare quality.

Though some processes in VC are the same as in face-to-face consultation (for example, patients need to describe symptoms to the doctor), doctors need to diagnose and prescribe in both contexts. These processes may influence healthcare quality differently. Healthcare system mediation changes the way patients interact with doctors, by allowing them to communicate in different locations. These changes improve efficiency and convenience of doctor's visits while bringing challenges on how to keep communication results as good as face-to-face consultation. This study analyzed patient reviews to explore the advantages of VC and patients' uncertainties during patient-doctor communication.

4.3 Data Collection

Many healthcare apps/systems can provide virtual doctor visits all over the world. This study collects users' reviews on five well-known systems including MDLive, Doctor on Demand, American Well, HealthTap, and Teladoc, because they already have many users, and provide video consultations with certified doctors via both computer and mobile. The selected systems are private and non-universal.

The reviews collected for this study are from patients who used the systems to consult doctors. Users of these systems could play any roles in real life such as doctors, nurses, patients, and so on. This study only focused on the patient's perspective and eliminated reviews written by other users. The scope focused narrowly on patients seeing doctors via these healthcare systems, instead of generalized or other perspectives (e.g., search information, store personal medical record).

4.3.1 Accumulation and Tailoring of Reviews

Google was used to search for reviews on these systems/apps. The search parameters are constrained based on:

(a) a list of e-commerce stores and websites. Several examples are Amazon, Apple Store, iTunes, and Google Play.

(b) key search terms.

Phase 1: Primary Accumulation

For each system/app, the following three steps were applied to collect reviews:

1. The reviews for the five systems from websites were used, including Amazon.ca, Amazon.com, and others, including official websites.
2. The reviews for the selected systems from mobile App Stores were used, including iTunes and Google Play.

3. The final constraint was based on key search terms “review” and system name, e.g., “Doctor on Demand/DoD.”

The desired data was collected in this way because the websites and App Stores usually enable users to review the app/system after their purchase. Most people are willing to leave reviews and tend to do so on these websites and App Stores, as opposed to elsewhere. Thus, these websites and App Stores, where people can download/purchase the systems, provide many valuable reviews of the app. With Google as a supplementary search tool, it’s believed that many useful reviews of the app/system can be collected.

Phase 2: Tailoring of Data

Some reviews/sentences needed to be deleted based on the following rules:

- Irrelevant reviews
- Meaningless reviews, i.e., “I didn’t use this app”
- Reviews written by other users (i.e., doctors, nurses etc.) instead of patients

The final data set contained 362 reviews.

4.3.2 Classification by Research Framework

Once the reviews for the final data pool were identified, the initial step for coders was to read and re-read each review to get a sense of the whole, i.e., to gain a general understanding of what the patients are talking about. At this point, each review was examined and categorized according to the research framework introduced above. According to the research framework, human-computer interaction traits were identified including respective characteristics of *human* and *computer*, and *interaction*. In this study, the *human* ends include patients and doctors, while the *computer* ends are VC systems. The *interaction* is reflected as the communication between patients and doctors via VC systems. To specifically investigate patients' uncertainties during their interaction with doctors and their attitudes, two categories including uncertainty and satisfaction were used to classify the reviews. The details of the coding categories are presented in Table 1. Each review may be classified into multiple categories. For example, if one patient reviewed both doctor and system features, this review should be in both 'doctor' and 'system features' categories, rather than being in just one category. 'Number of reviews' represents how many reviews are about each category. The preliminary analysis helps to understand the basic components and structures of reviews, to further analyze details on patients' uncertainties and the relationship between uncertainty and patient satisfaction.

Table 1. Coding Categories and Numbers for Each Category in Content Analysis

Coding categories	**Description**	**Number of Reviews (NR)**
Doctor	Reviews about the professionalism of doctors and their attitudes	271
Features of system	Reviews about features and characteristics of VC systems (such as videoconferencing, easy to use, etc.)	190
Uncertainty	Reviews on patients' uncertainties on the VC experience during the patient-doctor communication	189
Satisfaction	Reviews about patients' attitudes towards the consultation. Positive attitudes implied that they were satisfied, otherwise they were unsatisfied.	301
Other (insurance etc.)	Reviews about other issues, including network, insurance and so on.	43

The first category is about the characteristics of the doctors. It could be patients' comments on doctors' professionalism or their attitudes, such as whether they are friendly, and whether they seem to care about patients. This category receives a relatively large number (NR=271) of reviews, representing an important role of doctors in patients' perceptions. It is shown that a professional and informative doctor makes it easier to build patients' trust and reassure them, which smooths patient-doctor CMC during virtual consultation.

The second category is about the design features of healthcare systems. It could be on how to present doctors' information, how to make recommendations, and how to do the consultation. For example, some patients prefer the design feature of MDLive that they can refer to other patients' reviews on a doctor before they choose one. Other outstanding features include providing recommendations on doctors, comprehending doctors' information while simplifying appointment making process, and multiple consultation options. This category receives 190 reviews.

The third category is the core concept of this study: patients' uncertainties during VC process. Due to the nature of digitalized systems, seeing doctors online somehow changed traditional physician office visits to a large extent, with fewer limitations on time, location, and control. These changes may bring benefits as well as challenges, including cost, privacy, and trust problems. This category could be patients' concerns and uncertainties both on doctors and systems. For example, in the reviews, many patients show hesitations on the qualification and professionalism of online doctors, communication quality, and how to do the consultation. This category receives 189 reviews.

Due to its critical role in measuring healthcare quality and patient-doctor communication outcomes, our fourth category is satisfaction. Reviews about whether patients are satisfied with the consultation experience belong to this category. This category helps us understand the advantages of VC and patients' attitudes on both benefits and uncertainties. Many of the reviews show a positive attitude towards VC, even when they express doubts and hesitations. This category receives the most number (NR=301) of reviews.

The last category includes all the other facets patients mentioned in their reviews, including customer service quality, insurance availability and other issues. It receives the least reviews (NR=43).

Overall, this preliminary analysis serves as a higher level of understanding on patients' attitudes towards VC and VC systems. The results show that more patients mentioned doctors comparing to VC systems, and quite a number of patients were uncertain about VC experience (189 out of 362). This suggests important roles of doctors and patients' uncertainties in studying patient-doctor communication in the VC context. Note that though we assume system features and other factors in Table 1 as independent, they could be affected by the patients' experiences and other factors. For example, patients may pay more attention on the negative system designs if they have a negative experience, and consequently this could influence patients' concerns and uncertainties on different negative aspects. We brought this to caution here although it is hardly to empirically identified.

4.4 Data Analysis

4.4.1 Developing Elements for Uncertainty

This study developed the concept of uncertainty in the healthcare area by examining the text reviews collected from the above sources (in section 4.3) and by following the literature on uncertainty. Relevant literature was first reviewed to identify dimensions of measuring uncertainty. In the context of traditional face-to-face communication, these dimensions include issues related to understanding and prediction (Berger, 1986). The dimensions provide this study with the basis for measuring uncertainty during patient-doctor CMC. Then, 20 out of 189 reviews that belonged to the *uncertainty* category were selected for test-coding between two researchers. We generated the uncertainty dimensions and elements based on both the test-coding results and the relevant literature.

Next, the two researchers applied the content analysis approach to the remaining169 reviews that belonged to the *uncertainty* category and generated a set of uncertainty elements that had been mentioned in the patients' reviews. The average intercoder agreement percentage being above 85% (the value is 89%) suggested a satisfying coding reliability. This was calculated as the average value of the agreement percentages for each element. For example, 300 out of 327 reviews had the same coding results from the two coders on the element of doctor's attitudes, then the agreement percentage for this element would be 92% (300/327).

Finally, the researchers examined the occurring frequency of those elements and removed three with very low occurring frequency in the data. Therefore, the final number of elements is 6, listed below in Table 2. Some examples of review units are also presented in the table.

Table 2. Elements of Uncertainty (UC) Ranked by Frequency			
Elements	**Description**	**Examples of Review Units**	**Number of Reviews**
UC-VC Process (VP)	Patients are not sure about how to visit a doctor remotely. In other words, they don't know how to do VC.	It seems easy and simple The app seems poorly implemented I'm not sure why I never get a call from the doctor Not sure how the waiting queue works It seems to take a lot of password resets and other glitches to get it work Spent half an hour and still not sure how it works	121
UC-Doctors' Behaviour (DB)	Patients have concerns about how the doctor will behave during online consultation, including whether the doctor is professional and qualified.	He seemed professional I doubt she was a real doctor It seemed the doctor's realm of knowledge was very limited I was a little skeptical of the doctor when it comes to pediatrics I wasn't sure how the online doctor could accurately diagnose just by talking to them	64
UC-Describing	Patients have concerns about what symptoms would be important and should be told to	I'm not sure how to talk to a doctor, over the phone? Or skype?	17

Symptoms (DS)	the doctor during online consultation	I had concerns on how to talk about my symptoms I doubt I would give information myself to an online doctor It seemed the doctor still couldn't understand my problem after I spent 15 minutes to describe my symptoms It seemed hard for me to point to the pain & problem via video I think the doctor was probably just guessing my problem since she can't run blood work, x-ray or anything	
UC-Doctor's Attitudes (DA)	Patients have concerns about whether the doctor is friendly and cares about them. This element focuses on how the doctor treats the patient while the element of DF focuses on how the doctor feels.	I think he had a condescending attitude The doctor seemed like too arrogate to listen to me I suspect he care about what I was saying The doctor acted like he just wanted to charge me for the visit The doctor seemed very rude	17
UC-Understanding Doctors (UD)	Patients have problems or concerns about clearly understanding the doctor during the online consultation.	I couldn't fully understand the doctor I'm not sure what that mean	14

		The doctor seemed dismissive and acted like I was wasting his time by asking more questions to understand him I think it's probably hard for the doctor to explain everything thoroughly within a consultation session	
UC-Doctor's Feelings and Emotions (DF)	Patients are uncertain about how the doctor feels or his/her mood.	He seemed very angry that I dare question his diagnosis He acted like a lack of enthusiasm I was apprehensive to have an honest conversation with a doctor online The doctor seemed defensive It looked like she was not in a good mood	5

It can be seen from the results that the largest number of reviews on the uncertainty element is 121 out of 169, while the smallest number is only 5. Patients mention VC process the most (NR=121) regarding uncertainty, followed by Doctor's Behaviour (NR=64). The elements of describing symptoms and doctor's attitudes receive equal number of reviews (NR=17). The next element is uncertainty on understanding doctors (NR=14), followed by the last element of doctor's emotions (NR=5). Except the elements of VP and DB, patients don't mention the other four elements very much. The results are not surprising, given the fact that patients would not express their uncertainties in reviews, and most of the reviews are from patients who already have positive attitudes towards and are familiar with VC. Most uncertainties are surrounding the usage of VC system and the online doctors' behaviour. These uncertainties could come from the poor design features of VC systems that confuse patients on VC process and cause them barriers to communicate with doctors especially new doctors. The results suggest that a key to reduce patients' uncertainties is to improve the VC system's ease of use and the communication between patients and doctors.

4.4.2 Further Analysis

The research framework suggested a link between patients' uncertainty level and their satisfaction. Thus, the relationship between each element and patient satisfaction was also sought in this study. It's suggested that if two categorical variables are associated, the probability of one will depend on the probability of the other (Cynthia Fraser, 2009). By looking at the crosstabulation of frequencies/probabilities of two categorical variable, one can roughly tell whether there is association between the two variables. That is, when conditional probabilities differ from joint probabilities, there is evidence of association (Cynthia Fraser, 2009). The crosstabulation of uncertainty and patient satisfaction is presented in Table 3.

Table 3. Crosstabulation: Patient Satisfaction Depends on Uncertainty

Count	**Satisfaction**		
Uncertainty Element	Satisfied	Unsatisfied	Total
1. Doctor's Behaviour	15	46	61
2. Describing Symptoms	10	6	16
3. Understanding Doctors	1	12	13
4. Doctor's Feelings/Emotions	1	3	4
5. Doctor's Attitudes	2	13	15

6. Virtual Consultation Process	43	74	117
Total	72	154	226
% of Row	**Satisfaction**		
Uncertainty Element	Satisfied	Unsatisfied	Total
1. Doctor's Behaviour	25%	75%	100%
2. Describing Symptoms	63%	38%	100%
3. Understanding Doctors	8%	92%	100%
4. Doctor's Feelings/Emotions	25%	75%	100%
5. Doctor's Attitudes	13%	87%	100%
6. Virtual Consultation Process	37%	63%	100%
Total	32%	68%	100%

To gauge association between *uncertainty* and *patient satisfaction*, the conditional probability of each element of *uncertainty*, given each condition of *satisfaction*, was compared to the unconditional, row probabilities of *uncertainty*. If these differ, there is evidence of association. Table 3 indicates that 32 percent of patients who are uncertain about the overall VC experience are satisfied, and 68 percent are unsatisfied. In fact, from the crosstabulation table we see that more than 32% patients (63%) who were uncertain about Describing Symptoms (second element) were satisfied, and more than 68% patients (92%) who were uncertain about Understanding Doctors (third element) were unsatisfied. Were uncertainty and patient satisfaction not associated, we would, for example, expect about 32% of 100 patients who were uncertain about the second element to be satisfied, or 30 (=.32 (100)). Instead, there are actually 60 (second, satisfied) patients. There is a greater chance, 63%, of being satisfied, given the second element, rather than the other uncertainty elements. Ignoring uncertainty, the probability of satisfaction is .32; acknowledging uncertainty, this probability of satisfaction varies from .08 (third element) to .63 (second element). These differences in row percentages suggest an association between *uncertainty* and *patient satisfaction*.

Numerous studies have reported the positive association between patient satisfaction, many characteristics of doctors and healthcare outcomes. Doctors' good communication skills, being informative and professional, good healthcare quality, as well as other advantages, can greatly increase patient satisfaction (Farley et al., 2014; Linder-Pelz & Struening, 1985; Meesala et al., 2017). The above results suggest an association between uncertainty and patient satisfaction. This association should be viewed as important and be studied thoroughly as well because patients' uncertainty can be the weak link to improve their satisfaction while other conditions are improved.

4.5 Discussions and Conclusions

Besides patients' uncertainties, we also coded all the benefits patients mentioned in their reviews to further understand VC's advantages. As can be seen, compared to face-to-face consultation, VC benefits patients on convenience, while still need to improve insurance, customer service and follow up services. The main benefits are presented in Table 4.

Table 4. Benefits of Virtual Consultation		
Benefits	**Descriptions**	**Number of Reviews**
Convenience	It's convenient for patients to visit doctors online, e.g., saving the trouble of driving to hospital, saving time in the waiting room etc.	298
Easy Prescription	Prescription is digitally sent to nearest pharmacy by doctor and it's easy to get treatment drugs for patients.	207
Access to care	Rural patients can access to a doctor at special times, including weekends, holidays, at night, in emergency conditions.	184
System usefulness	The website/APP is useful for patients to see doctors, and it's helpful with guiding people through consultation processes.	95
Customer service	Customer service is friendly. Patients will be followed up on after their consultation.	86
Saving money	Patients view online consultation as a more affordable way to visit doctors compared to visiting doctors in person.	76

Others	Other benefits mentioned by patients include insurance availability, medical record benefit and others.	132

Healthcare providers must decide where to invest in improving their healthcare service quality, to improve patient's satisfaction, and thus to promote patients' interest in using VC systems. This study applied a content analysis approach to identify six elements of patients' uncertainty and to examine the connection between uncertainty and patient satisfaction. Specifically, this study identified the most important uncertainty elements to patients including VC process, Doctors' Behaviour followed by Describing symptoms and Doctors' attitudes.

This study can shed light on how to improve current VC systems by understanding patients' uncertainties. Patient uncertainty is found to be critical in determining patient-doctor communication results and patient satisfaction towards VC. Many patients express concerns about doctor's behaviour and attitudes when they communicate with doctors. This illustrates that designs to assure patients that doctors are professional and informative enough to give a good diagnosis are important. One way could be by providing more of the doctors' information online to show that they are as qualified as patients' family doctors. Another way could be by providing online reviews from other patients, to help potential patients get a fuller picture of the doctor. The six elements of uncertainty could guide healthcare providers to understand patients better and to create a patient-centered environment.

This study also reveals the advantages of VC in comparison with traditional face-to-face consultations. Most patients who use VC think it is more convenient and easier to get a prescription than using face-to-face consultation. Though these benefits are not design features of VC systems, they are causally connected with system features and could be helpful to guide system design. Therefore, We recommend that VC system developers focus on how to design the system to improve the above two factors (convenience and easy prescription). For example, to reduce consultation time further, the system can ask fewer questions to make the registration quicker. To enhance convenience, the platforms on which systems operate should be available in multi-formats, including computer, mobile phone, and wearable devices. In this way, patients could access VC quicker and easier.

One of the limitations of the study comes from the extremeness of the reviews. It is well known that reviews are typically left when a person is either particularly happy or particularly unhappy with a given experience. The lack of neutral review may affect the findings for this study.

The results are also limited to users of the five popular private and non-universal VC systems (patients may have more negative feelings towards VC if they use other less popular systems), most of whom are from United States. This may limit the generalization of the findings in this study, as patients may have different expectations and concerns for different types of healthcare systems. Therefore, future research can extend the analysis to other different types of systems.

Another future direction can be analyzing elements beyond the six categories generated in this study. Although we ruled out the elements which were barely mentioned in the data set, for example, privacy and security, these factors may somehow impact patient's attitudes. In addition, the current six elements can be further sub-categorized into some specific indicators, which are more explicit and more feasible to be implemented. Finally, the future direction can be exploring actual design features to reduce patient uncertainty in the context of VC.

5 Study Two: A Field Experiment on Reducing Uncertainties in Patient-Doctor CMC

5.1 Introduction

The results of content analysis have shown that, despite all the benefits VC present, patients still have hesitations and uncertainties about both the doctor and the system during patient-doctor communication. It is important to reduce patients' uncertainty to boost patients' satisfaction on VC. These results served study two in two basic ways. First, six elements of uncertainty were identified to measure the construct of uncertainty in study two. This thesis focuses on actual online consultation process between the patient and doctor instead of the overall process. Thus, the elements investigated in study one could be used to measure uncertainty during online consultation in study two no matter how the patient and doctor remotely communicate. Second, the connection between patients' uncertainty and satisfaction was revealed as a basis to develop the causal relationship between the two in the research model in study two. This chapter introduces the second study on the role of media to reduce patients' uncertainty toward VC. It answers the second research question in this thesis: How does the medium affect patients' perceived uncertainties and their satisfaction with VC?

5.2 Research Framework and Hypothesis

In this section, the research model and hypothesis are introduced. We propose that naturalness and MMA influence patient satisfaction through affecting patients' uncertainty level. For the practical purpose, we use video conferencing and instant messaging to represent high and low level of naturalness, family doctor and new doctor to represent high and low level of MMA.

5.2.1 Research Model

The URT theory suggests three strategies (passive, active and inter-active) to reduce uncertainty during the three phases (entry, personal and exit) (Berger & Calabrese, 1975). Focusing on patient-doctor communication process which mostly belongs to the personal phase, this thesis aims to investigate interactive factors that can reduce patients' uncertainties about VC. The interactive strategy requires the VC system to provide a friendly and natural environment for patients to communicate with doctors. Therefore, it is important to select appropriate communication media and media design. Media selection and content play important roles in patient-doctor communication (George, Carlson, & Valacich, 2013). Different media have different level of naturalness which affects communication efficiency and effectiveness (Kock, 2010). Different design of media has different level of mental model alignment which affects patients' attitudes and concerns (Yang et al., 2016). In this study, we use media naturalness and mental model alignment as our independent variables, which influence patient satisfaction through uncertainty in the context of virtual consultation.

Naturalness is one of the independent variables. Patients can select different types of media to communicate remotely with doctors, including telephone, email, text, video and other platforms. According to media naturalness theory, these different forms of media have different levels of naturalness compared to face-to-face encounters, which enable people to use the media to deliver assorted quantities and different types of information to the receiving party. Humans evolved to be more comfortable communicating in a natural way (Kock, 2004). It is reasonable to propose that patients have more confidence during communication through mediums which provide them with a more natural way to communicate with doctors.

Mental model alignment is another independent variable. Patients rely on the content of media to get information, evaluate situations and form mental models, which makes the media design very important when it comes to reducing patient's uncertainty. According to the mental model theory (Legrenzi, Girotto, & Legrenzi, 1999; Van Der Henst, 2000), people rely on the models in their mind to perform reasoning and decision-making tasks. During the patient-doctor communication process, patients are more likely to believe/decide it is true when the situation matches or aligns with the pre-conceived mental models in their minds. That is, patients will be more confident about the situation, therefore reducing the uncertainty level.

When patients are uncertain about the doctor, they are not able to communicate with confidence and coherence. Patients' level of satisfaction may decrease if they cannot communicate well with their doctors. They will not get the best communication results, which influences patient satisfaction. Therefore, we propose that there is a path from uncertainty to patient satisfaction. The research model is present in Figure 5, as follows.

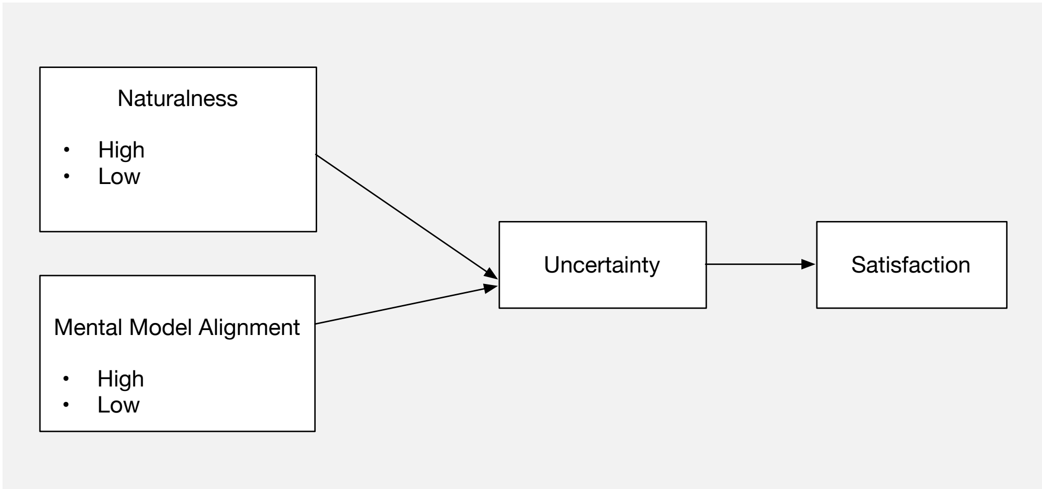

Figure 5. Research Model to Reduce Uncertainty During Patient-Doctor CMC

5.2.2 Hypothesis

Note that although the uncertainty is reduced as the process continues, as patients and doctors understand each other better, the quantity of reduced uncertainty differs for different situations in the communication process.

Selected media enables patients to communicate with doctors in different formats. The more natural the communication is, the more certain patients feel about both doctors and the media/system. That is, different media may have a different impact on uncertainty level during patient-doctor CMC, due to various levels of naturalness. Therefore, it is proposed in this study that media naturalness can influence patients' uncertainty about doctors and systems during patient-doctor CMC. The more natural the system is, the more certain patients feel about doctors and the system, and more positive on the communication results with the doctors. For example, in instant messaging, people communicate without seeing one another. Conversely, video conferencing gives patients opportunities to see the doctor whom they may not be familiar with and sometimes enables doctors to see and hear the symptoms. From a media naturalness point of view, video conferencing offers multiple channels to deliver verbal and non-verbal information, and it is more natural than instant messaging. Patients who consult doctors through video conferencing feel that the interaction is more natural and closer to traditional FTF consultation than instant messaging. Therefore, during patient-doctor CMC, video conferencing is proposed to give patients more certainty and more positive attitudes towards the consultation, while instant messaging fails to be perceived as natural by patients.

In this study, we use video conferencing and instant messaging as the two practical measure dimensions[1] for the construct of naturalness. The hypothesis is as follows:

> **H_1**: Increased media naturalness will reduce uncertainty during patient-doctor CMC.

[1] Media naturalness can be measured in different schemes and dimensions. For example, *verbal vs. non-verbal, visual vs. non-visual* etc. This study only selects instant messaging and video conferencing as representatives due to their popularity in VC.

One important assumption in this study is that people have certain mental models formed about visiting a doctor in their minds, either based on traditional consultation experiences or their imagination or expectations, before taking part in VC. If system design aligns with the mental model patients already have, they tend to believe that the situations are reliable and represent the real world, according to mental model theory. In this situation, patients are more certain and confident about the communication process and results. Therefore, patients have a lower level of uncertainty, in comparison to the situations when the design does not align with their mental models.

The misalignment between system design and patients' pre-conceived mental model could lead to misunderstanding and confusion during patient-doctor communication, which affects patients' description of symptoms and doctors' diagnosis. Patients are not sure how to deal with this situation as they cannot retrieve relevant information from existing mental models. So, they predict negative results, as people tend to make negative assumptions about situations that are unfamiliar (Scare, 1983). Contrarily, they are more confident about familiar situations in which their predictions are accurate, based on their previous experience.

Certain aspects of communication can vary widely among different doctors or patients (Verlinde et al., 2012). There are roughly two different types of VC systems in Canada, regarding the “ownership” of doctors. While many VC systems have certified doctors provided for patients to select (one example is *https://www.getmaple.ca/*), some systems serve solely as a platform which provides patients remote access to communicate with their family doctors (one example is *https://livecare.ca/*). For these systems, the VC systems do not “own” or certify many new doctors to be selected by patients. Instead, they require both patients and their family doctors to register on the system, which gives users greater access to one another by all means, including messaging and/or video conferencing. Patients already knew the doctors and likely had FTF consultations with the doctor before. Therefore, when patients remotely visit their doctors through these platforms, they are more certain about the doctor and the entire consultation process based on prior interaction, compared to systems where most doctors are new to patients. The prior interaction with family doctors can be viewed as the process by which patients build mental models of consulting doctors. From the mental model perspective, systems providing accesses to patients' familiar doctors aligns better with patients' mental models of doctor's visits. In this scenario, patients feel more comfortable about the communication and more confident about the consultation diagnosis by doctors whom they are familiar with. In this study, we choose new and family doctors as the two measuring dimensions[2] of mental model alignment. The hypothesis is as follows:

[2] Note that Mental Model Alignment practically could have many scenarios in the context of VC. These scenarios or dimensions could be about *different doc-*

H_2: Increased mental model alignment will reduce uncertainty during patient-doctor CMC.

When patients cannot fully understand the situation, they have doubts and hesitations about doctors and the system. It is hard for them to believe they will get an accurate and comprehensive diagnosis under these conditions. They may feel frustrated and be unable to maintain positive attitudes toward the consultation. That is, they may not be satisfied with either the consultation process or results. Therefore, it is proposed

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tors as we used, different appointment making methods, different prescription methods and content, and many other features regarding patients' consultation experience. We select new and family doctors as the method to represent different level of mental model alignment because doctor selecting is an important difference in VC compared to traditional FTF doctor's visits, and it's also a crucial factor that can affect patient-doctor communication.

in this study that uncertainty levels can influence the level of patient satisfaction. The hypothesis is as follows:

H_3: Increased uncertainty will reduce patient satisfaction during patient-doctor CMC.

5.3 Data Collection

An artefactual field experiment methodology was used to investigate the above hypothesis. An artefactual field experiment is one that employs a nonstandard subject pool, an abstract framing, and an imposed set of rules, according to Harrison and List (2004). It is a suitable methodology, considering the randomness and geographically distributed nature of VC. In this study, the general population was recruited to finish the task of answering questions, after being randomly assigned to one of the four controlled groups. The methodology is introduced in detail in the following section.

5.3.1 Measurement

In this section, the measurement of constructs in the research model are introduced. Based on the prior literature and analysis results of study one, we developed our measurement formatively. That is, the measurement items serve as composites of the constructs in the model. The items that fully represents the conceptual domain of the constructs may come from a variety of sources including reviews of the literature, deduction from the theoretical definition of the construct, suggestions from experts and so on (Mackenzie, Podsakoff, & Podsakoff, 2011).

The construct of Uncertainty

In the study of content analysis, six important elements were identified for measuring patients' uncertainty, primarily noting: doctor's behaviour, attitudes and feelings, understanding doctors, symptoms and the consultation process. Based on the content analysis results, we generated the following uncertainty measure items in the context of patient-doctor CMC (see Table 5). We framed the measure items in the positive format to keep the consistence with measure items for other constructs which were all in positive format. That is, instead of “I’m certain…”, we used “I’m certain…” at the beginning of each statement. This could reduce the risk of misunderstanding of the participants. Many literature (e.g., Bradac, 2001; Clatterbuck, 1979; Kellermann & Reynolds, 1990) used positive items to measure the concept of uncertainty and they all treated the measure as reflective. Since patient’s uncertainty during patient-doctor online communication is mainly reflected on the six elements, the construct of uncertainty is treated being reflective in this thesis.

Table 5. Measure Items for the Construct of Uncertainty (UC)

Number	Item	Elements from Study One
UC 1	I’m certain of how to do VC	VC Process
UC 2	I’m certain of how the doctor behaves	Doctor’s Behaviour
UC 3	I’m certain of the symptoms that are important to tell the doctor	Describing Symptoms
UC 4	I’m certain of the doctor’s attitudes	Doctor’s Attitudes

UC 5	I’m certain about the doctor’s feelings	Doctor’s Feelings/Emotions
UC 6	I’m certain I can understand the doctor well	Understanding Doctors

The Construct of Naturalness

The construct of naturalness is the independent variable. To many, this construct only serves to differentiate two groups (video conferencing vs. instant messaging) in this study, and it seems unnecessary to measure it. we argue that measuring naturalness enables to conduct manipulation check between the two groups and better interpret the relationships between naturalness and other constructs with consecutive values. For the same reason, we measured mental model alignment as well, which is the other independent variable.

There has been studies on the effect of media naturalness on communication results (Blau & Caspi, 2010; Kock, 2007). However, most of the studies used different media to represent different level of naturalness instead of developing measurement items (Kock, 2009; Wells & Dennis, 2016). To generate measure items for this study, we followed the definition of naturalness proposed by Kock (Kock, 2002, 2005, 2009). According to Kock (2002, 2005, 2009), naturalness can be assessed in two dimensions: (1) the space-time dimension, which comprises the degree to which a medium supports (a) colocation and (b) synchronicity; and (2) the expressive-perceptual dimension, which comprises the degree of support for the use of (c) facial expressions, (d) body language, and (e) speech. The degree of naturalness of a communication medium depends on how closely it incorporates all of the above elements (Kock, 2007). Thus, the measurement items generated based on the above elements are presented in Table 6.

Each item represents one facet, and together composite the construct of naturalness. That is, naturalness was measured formatively in this study. To examine whether the formative constructs exhibit convergent validity, we used redundancy analysis method suggested by Hair et al. (2016). This approach requires one or multiple items to reflectively measure the construct, to examine the relationships between two measure of the same construct (Chin, 1998). Hair et al. (2016) suggested that some research situations call for or even necessitate the use of single item measures, for example, when the population being surveyed is limited in size and nonresponse is a major concern (Joe F. Hair, Hult, Ringle, & Sarstedt, 2016). The details of this method is introduced in Table 27. In this study, to shorten questionnaire length, we only developed one or two items to measure formative constructs reflectively. For naturalness, NA1 and NA6 are for this purpose.

Table 6. Measure Items for the Construct of Naturalness (NA)

Number	Item	Corresponding Element
NA 1	Visiting a doctor online is similar to visiting the doctor in person	General understanding of naturalness
NA 2	I can use communicate with a doctor online in real time	Synchronicity, which would allow the individuals to quickly exchange communicative stimuli (Kock, 2005)

NA 3	I can convey and observe facial expressions with a doctor online	The ability to convey and observe facial expressions (Kock, 2005)
NA 4	I can convey and observe body language with a doctor online	The ability to convey and observe body language (Kock, 2005)
NA 5	I can communicate verbally with a doctor	The ability to convey and listen to speech (Kock, 2005)
NA 6	I can communicate with a doctor naturally	General understanding of naturalness
NA 7	Visiting a doctor online feels as if the doctor and I are talking in the same room	Colocation, which would allow individuals engaged in a communication interaction to share the same context, as well as see and hear each other (Kock, 2005)

The Construct of Mental Model Alignment

It's very hard to measure mental model (Gentner & Stevens, 1983), and most literature study mental model from relevant angles such as mental model changes, and mental model alignment instead of mental model per se (Doyle et al., 2008; GonzálezJ, Calderón, & González, 2012; Payne, 2003; Scott, 2018; Young, 2008). The alignment in this thesis refers to the sync-level between patients' mental models of VC and of face-to-face consultation. To further clarify the concept, we can visualize the two aligned mental models as two parallel non-straight lines. It is nearly impossible to test parallelism from each point or a select section of the two lines. However, we can always select important parts as indicators. If the indicators align more with one another, it is reasonable to say the entire lines align more with one another. This study focuses on patient-doctor CMC in the context of VC, so all the indicators which are important to patients during their communication with doctors will be selected.

After they have finished creating a valid account, patients can start VC by selecting a doctor (if available) and making an appointment. They then communicate with the selected physician, get a diagnosis from the doctor, and end the consultation by picking up a prescription from a selected pharmacy. Although this study only focuses on the patient-doctor communication phase, other phases could contribute equally if not more to the overall consultation quality and outcome of the consultation.

With a patient-centered lens during the communication phase, it is important that patients know how to communicate with doctors through selected media and describing symptoms to doctors. Patients should feel comfortable being examined by doctors and with the entire consultation process. With these important considerations as the indicators, the following measure items were generated for mental model alignment, which are presented in Table 7. Note that we specified each item to match each condition in the experiment to reduce participants' confusion. For example, MMA 1 was "The experience of visiting my family doctor online matches my experience of visiting him/her in person" for the condition of family doctor, while it was "The experience of visiting a new doctor online matches my experience of visiting a new doctor in person" for the condition of new doctor. The construct is formative as each indicator represents different facet of MMA. MMA1 was used later to examine the convergent validity of MMA.

Table 7. Measure Items for the Construct of Mental Model Alignment (MMA)

Number	Item	Indicator
MMA 1	The experience of visiting a doctor online matches my experience of visiting a doctor in person	The general understanding of MMA
MMA 2	Communicating with a doctor online matches my experience of communicating a doctor in person	Patients' communication with doctors
MMA 3	Describing my symptoms to a doctor online matches my experience of describing symptoms to a doctor in person	Patients' describing symptoms to doctors
MMA 4	Being examined by a doctor online matches my experience of being examined by a doctor in person	Patients' being examined by doctors
MMA 5	The process of visiting a doctor online matches my experience of the process of visiting a doctor in person	Patients' consultation process

The Construct of Satisfaction

A comprehensive and critical review of the patient satisfaction literature was first done by Ware et al. (1983). The conclusion revealed empirical studies of patient satisfaction dealt with many items which could be grouped then constructs which were implicitly intended to measure (Ware, 1978; Ware et al., 2017). Based on this conclusion, researchers did many empirical studies to theorize how to measure patient satisfaction including the Medical Interview Satisfaction Scale (MISS)(M. H. Wolf, Putnam, James, & Stiles, 1978), the Patient Satisfaction Scale (PSS) (Dimatteo et al., 1980), a form developed by Linder-Pelz and her colleagues (Linder-Pelz & Struening, 1985), and a questionnaire described by Osterweis and Howell (Osterweis & Howell, 1979; Ware et al., 2017).

We plan to measure satsifaction formatively in this study which requires the items covering all aspects of the construct and specificallly in the context of VC. Therefore, we designed the measure items for satisfaction in this study from the PSQ (Ware et al., 1983), which grouped satisfaction into seven dimensions with 18 items. The 18 items are retrieved in Table 8.

Table 8. Dimensions of Satisfaction Derived from Ware et al. (1983)

Dimensions	Items
Access to care (nonfinancial aspects)	1. Emergency care

	2. Convenience of service 3. Access
Financial aspects	4. Cost of care 5. Payment mechanisms 6. Insurance coverage
Availability of resources	7. Family doctors 8. Specialists 9. Hospitals
Continuity of care	10. Family 11. Self
Technical quality	12. Quality/competence 13. Prudence-risks 14. Doctor’s facilities
Interpersonal manner	15. Explanations 16. Consideration 17. Prudence-expenses
Overall satisfaction	18. General satisfaction

We selected all the applicable dimensions to form our measure items in the context of patient-doctor communication during virtual consultation, which are presented in Table 9.

Table 9. Measure Items for the Construct of Satisfaction (SF)		
Number	**Item**	**Dimensions from Ware et al. (1983)**
SF 1	I'm satisfied with my online consultation experience	18. General satisfaction
SF 2	I'm satisfied that my online consultation is convenient	2. Convenience of service
SF 3	I'm satisfied that it's easy to access a doctor online	3. Access
SF 4	I'm satisfied that the doctor is thorough and explains everything clearly	15. Explanations
SF 5	I'm satisfied that the doctor respects my feelings	16. Consideration

5.3.2 Experiment Design

Experiment Groups

The experiment task is to generate patients' uncertainties and perceptions towards two healthcare system design features that are to be applied during patient-doctor communication. A thoroughly explained and real-world simulated consultation environment is provided to conduct the experiment.

This experiment is a two by two design. Four groups provide four different scenarios for patients to complete tasks. Groups one and two communicate with a new doctor online while groups three and four communicate with their family doctor online. Participants do not know the new doctor and have never interacted with the doctor in any form before. Groups one and four communicate with a doctor via video conferencing, while groups two and three use instant messaging. The four groups are presented in Table 10.

Table 10. Four Experiment Groups with Conditions

Number	Condition
Group 1	New doctor + Video conferencing

Group 2	New doctor + Instant messaging
Group 3	Family doctor + Instant messaging
Group 4	Family doctor + Video conferencing

Procedure

Given that actual consultation is time-consuming and hard to control in experiment conditions, we chose to simulate the consultation process with scenario descriptions instead of making participants actually consult a doctor. The scenario description shown in Appendix one includes both text and snapshots for full immersion. Each group is expected to fully understand the scenario descriptions, and be able to finish the task of answering related questions after going through the description.

The experiment conditions for the four groups are four different scenario descriptions that are identical in all aspects except for the type of consultation method and the doctors.

Participants were randomly assigned to one online group with their consent. The scenario description and questionnaire were displayed to each group. After fully understanding the group conditions, participants were required to answer the questionnaire items on conditions, five constructs, prior experience with VC, and basic demographic information. We used 7-scale Likert-type questions for the measurement items of the five constructs (values of 1-7 for strongly disagree-strongly agree). Participants finished the experiment by submitting the questionnaire. The whole process was done online.

5.3.3 Pre-Tests

Once the measurement model and experiment design has been fomally specified, pre-tests were conducted in order to examine the experiment conditions, measurement model discriminant and validity.

This section introduces three pre-tests including their methods and results. The first pre-test focused on manipulation check, and the scenario description was modified according to participants' comments after this pre-test. Pre-test two and three had manipulation check after these changes.

Pre-test two focused on the wording of items to make sure the measure items effectively explain the variables in the research model. The wording for the measure items according to participants' comments and expertise suggestions after this pre-test.

Pre-test three focused on double-checking both the manipulation check and the measure items. It was performed the same way as the main-test. The results show that the setting of experiment is satisfactory to proceed the main-test.

5.3.3.1 Pre-Test One Method and Results

Method

To test the validity of experiment condition control, the first round of pre-test was conducted. The participants for this round were from the general population and were recruited by snowball sampling. All of them are from St. John's, Newfoundland & Labrador (NL), Canada and are native English speakers. The participants were randomly assigned into one of the four groups, and they were required to think out loud while experimenting online. They were encouraged to ask any questions and provide any suggestions on the description and questionnaire. We performed this process thoroughly with each participant, one-by-one, in person.

Each participant took on average 40 minutes to finish the task. They can skip any questions they feel uncomfortable answering, or may quit the experiment at any time by closing the browser.

Results

Questionnaires with all questions answered are considered as valid. We visited 42 participants in person and obtained 28 valid questionnaires [3]. The demographic distribution for the 28 valid questionnaires is present in Table 11.

As we can see from the demographic tables, most of the participants for pre-test one were females between the ages of 18-30 and had much computer experience in order to do VC. 78% of the participants did not have an online consultation experience.

Table 11. Demographic Distribution for Pre-Test One					
Gender (1: male; 2: female; 3: other)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	7	25.0	25.0	25.0
	2	21	75.0	75.0	100.0
	Total	28	100.0	100.0	

[3] Although other questionnaires are not considered valid, participants still contribute to the study by providing comments and suggestions.

Age (1: 18-30; 2: 31-50; 3: 51-70; 4: 70 & older)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	24	85.7	85.7	85.7
	2	4	14.3	14.3	100.0
	Total	28	100.0	100.0	

Computer skill (1: yes; 2: no; 3: not sure)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	19	67.9	67.9	67.9
	2	6	21.4	21.4	89.3
	3	3	10.7	10.7	100.0
	Total	28	100.0	100.0	

Statistics					
		VC experience (1: no; 2: yes)	Gender (1: male; 2: female; 3: other)	Age (1: 18-30; 2: 31-50; 3: 51-70; 4: 70 & older)	Computer skill (1: yes; 2: no; 3: not sure)
N	Valid	28	28	28	28
	Missing	0	0	0	0

VC experience (1: no; 2: yes)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	22	78.6	78.6	78.6
	2	6	21.4	21.4	100.0
	Total	28	100.0	100.0	

The purpose of manipulation check in this study is to test whether there are two groups with different levels of naturalness or mental model alignment established, that is, the difference between the two groups is so large that it could not be explained by chance. The paticipants were randomly assigned into each group, which means the data is independent of one another. The data is normally distributed after checking for normal distribution. Therefore, assumptions for t-test were met (these assumptions were checked each time before t-test). Then independent t-test was used to do condition manipulation check on the two constructs of naturalness and mental model alignment on two levels: practical level (video conferencing vs. instant messaging and family doctor vs. new doctor) and general level (high vs. low). The difference between groups is sufficiently large if the t-test results on either level are significant. The manipulation check results on both practical and general level are presented in Tables 12 to 15.

Table 12. Manipulation Check (Practical Level) on Naturalness for Pre-Test One

Naturalness (1: video; 2: msg)	Mean	N	Std. Deviation	Std. Error Mean
1	4.79	13	1.45	.40
2	4.71	15	1.14	.29

T-test				
	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference

				Lower	Upper
Equal variances assumed	.876	-.08	.49	-.92	1.08

Table 13. Manipulation Check (General Level) on Naturalness for Pre-Test One

Naturalness (1: high; 2: low)	Mean	N	Std. Deviation	Std. Error Mean
1	5.72	14	.58	.16
2	3.78	14	.97	.26

T-test					
	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
				Lower	Upper
Equal variances assumed	.000	1.95	.30	1.32	2.57

Table 12 shows that the two conditions (video vs. msg) have limited differences in naturalness, with the mean value of video conferencing group (mean=4.79) being slightly greater than that of the instant messaging group (mean=4.71). The t-test result (p=.876) shows that the difference between the two conditions of video conferencing and instant messaging is not significant. That is, group manipulation regarding naturalness on practical level is not successful. Then we did manipulation check on the general level. To do this, we grouped the data into high naturalness and low naturalness based on the average value of naturalness. That is, if the value of naturalness is higher than the average value, this set of data belongs to the group with high naturalness, vice versa.

Table 13 shows that the two groups are largely different from one another with the group with high level of naturalness demonstrating higher mean scores (mean = 5.72) compared to the low-level group (mean = 3.78). The "sig. (two tailed)" column indicates a significance level of .000, which result in a rejection of the null hypothesis (means of the two groups are equal). That is, the differences between the two groups are significantly large that it could not be considered by chance.

Table 14. Manipulation Check (Practical Level) on Mental Model Alignment (MMA) for Pre-Test One

MMA (1: new; 2: family)	Mean	N	Std. Deviation	Std. Error Mean
1	4.17	15	1.51	.39
2	4.40	13	1.52	.42

T-test

	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
				Lower	Upper
Equal variances assumed	.696	-.23	.574	-1.40	.95

Table 15. Manipulation Check (General Level) on MMA for Pre-Test One				
MMA (1: high; 2: low)	Mean	N	Std. Deviation	Std. Error Mean
1	5.49	14	.79	.21
2	3.07	14	.93	.25

T-test					
	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
				Lower	Upper
Equal variances assumed	.000	2.41	.325	1.74	3.08

The Table 14 shows that the two conditions have limited differences in MMA, with the mean value of family doctor group (mean=4.40) being slightly greater than that of new doctor group (mean=4.17). The t-test result (p=.696) shows that the difference between the two conditions of family doctor and new doctor is not significant. That is, group manipulation regarding mental model alignment on practical level (family doctor vs. new doctor) is not successful.

Table 15 shows that the two groups are largely different from one another with the group with high level of MMA demonstrating higher mean scores (mean = 5.49) compared to the low-level group (mean = 3.07). The "sig. (two tailed)" column indicates a significance level of .000, which result in a rejection of the null hypothesis (means of the two groups are equal). That is, the differences between the two groups are significantly large that it could not be considered by chance.

The t-test results suggest that there are significantly differences between high and low level of groups regarding naturalness and MMA. However, these differences are not specifically because of the practical conditions (family vs. new doctor; video vs. msg) we set for the experiment.

To get better manipulation check results, the scenario description was modified based on the participants' comments. For example, we bolded and underlined the conditions in the description text and enlarged them in the description snapshots to make sure they catch the participants' eyes easily. After the modifications, we did the second round of pre-test.

5.3.3.2 Pre-Test Two Method and Results

Method

We used the same method as pre-test one for the second round of pre-test. Besides the condition manipulation, we also focused on the questionnaire. The participants were all from the city of St. John's, Newfoundland & Labrador (NL), Canada and were native English speakers. They were different participants from pre-test one.

Results

We visited 44 participants this round in person and obtained 26 valid questionnaires. Half of the participants were male, and most of them were between ages 18 to 30. 15% of the participants had an online consultation experience. The t-test results on practical level are presented in Tables 16 and 17.

Table 16. Manipulation Check (Practical Level) on Naturalness for Pre-Test Two

Naturalness (1: video; 2: msg)	Mean	N	Std. Deviation	Std. Error Mean
1	6.58	13	.37	.10
2	2.81	13	1.62	.45

T-test					
	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
				Lower	Upper

Equal variances assumed	.000	3.77	.46	2.82	4.72

As we can see from the results, the mean value of video conferencing group (mean=6.58) is much greater than that of the instant messaging groups (mean=2.81). The t-test result (p=.000) is significant. That is, the manipulation of the two conditions (video conferencing vs. instant messaging) is successful. Participants can fully understand their conditions, and the measure items for the construct of naturalness are validated to reflect the change of naturalness conditions. Given that the manipulation check on practical level is more strict than on general level, it is not necessary to conduct t-test on general level since the result is already satisfying on practical level.

Table 17. Manipulation Check (Practical Level) on Mental Model Alignment (MMA) for Pre-Test Two

MMA (1: new; 2: family)	Mean	N	Std. Deviation	Std. Error Mean
1	3.10	16	1.46	.36
2	5.98	10	1.30	.41

T-test					
	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
				Lower	Upper

Equal variances assumed	.000	-2.88	.566	-4.04	-1.71

As we can see from the results, the mean of family doctor groups (mean=5.98) is much greater than that of new doctor groups (mean=3.10). The t-test result (p=.000) is significant. That is, the manipulation of the two conditions (family doctor vs. new doctor) is successful. Participants can fully understand their conditions, and the measure items for the construct of mental model alignment are validated to reflect the change of MMA conditions.

The principles underlying formative measurement are fundamentally different from the reflective type (Joe F. Hair, Sarstedt, Hopkins, & Kuppelwieser, 2014). Reflective models assume the factor is the "reality" and measured variables are a sample of all possible indicators of that reality, while in formative models each indicator represents a dimension of meaning of the latent variable (Garson, 2016). Unlike reflective model where the indicators for each factor are related, an indicator that was theorized to contribute to a formative index can be irrelevant (Joe F. Hair, Ringle, & Sarstedt, 2011). Therefore, the commonly used evaluation criteria for reflective model to check reliability and validity are not applicable anymore for formative model. MacKenzie (Mackenzie et al., 2011) suggested interviews with practitioners and experts to identify the key aspects (or attributes) of a construct. Hair et al. (2011) also stated that theoretical rationale and expert opinion play a more important role in the evaluation of formative indexes than statistical criteria (Joe F. Hair et al., 2011). To make sure the measure items (questionnaire statements) correctly extract the variables in the research model, we followed participants' comments and some experts' suggestions to correspondingly modify the measure items.

These modifications were mainly on wording and grammar level and did not change the actual meaning of the measurement items. The main modifications are attached as Appendix 2.

5.3.3.3 Pre-Test Three Method and Results

Method

In this round of pre-test, we did the experiment the same way as in the main test. That is, instead of visiting participants in person and letting them think out loud, the entire process was online, from recruiting participants to their submitting the questionnaire. Potential participants signed a consent form online and then were randomly assigned to one of the four groups. With the information from the scenario description, participants were required to finish a questionnaire and submit it. For this round of pre-test and the main test, participants were not allowed to skip questions. They could still quit the experiment at any time by closing the browser.

Results

We used the BREP (Business Research Experience Pool) program in the Faculty of Business Administration at Memorial University of Newfoundland (MUN) to recruit students as the participants for this round of pre-test. By participating in this study, each student in the Faculty of Business Administration can get a bonus 0.5 course credit. In the end, 53 valid questionnaires were obtained through a time length of two semesters. This satisfied the minimum sample size requirement to do PLS-SEM according to the 10 times rule (the sample size should be greater than 10 times the maximum number of inner or outer model links pointing at any latent variable in the model) (Joe F. Hair et al., 2016; Joe F Hair, Ringle, & Sarstedt, 2011). Students took on average 10 minutes to complete the experiment. The t-test results for manipulation check were significant for both naturalness and mental model alignment on practical level. The results are attached as Appendix 3 and 4. The following will focus on the evaluation of measurement constructs with PLS-SEM approach. The evaluations of measurement model in this study are for both reflective and formative constructs.

- Evaluation of the Reflective Measurement Constructs

According to Hair et al. (2016), four PLS-SEM results should be checked to evaluate reflective measurement models including internal consistency (composite reliability), indicator reliability, convergent validity (average variance extracted) and discriminant validity (Joe F. Hair et al., 2016). They stated that internal consistency reliability (composite reliability) should be higher than 0.708 (in exploratory research, 0.60 to 0.70 is considered acceptable), the indicator's outer loadings (to assess indicator reliability) should be higher than 0.708, the AVE (average variance extracted) which is used to evaluate convergent validity should be higher than 0.50 (Joe F. Hair et al., 2016). They also developed rules to assess discriminant validity of reflective constructs. Since there is only one reflective construct in this study, discriminant validity wasn't checked.

Before analyzing the PLS algorithm results, the number of iterations was checked to make sure it is lower than the maximum number of iterations (300 in this study). The results of the PLS-SEM for the reflective measurement constructs are presented in Table 18. All outer loadings of the reflective construct *Uncertainty* are well above the threshold value of 0.708. the indicator UC1 (outer loading: 0.777) has the smallest indicator reliability with a value of 0.604 (0.777^2), while the indicator UC4 has the highest indicator reliability with a value of 0.856 (0.925^2). Thus, all the indicators for the reflective construct are well above the minimum acceptable level for outer loadings.

The composite reliability value of 0.914 demonstrates that the reflective construct has high level of internal consistency reliability. Convergent validity assessment builds on the AVE value as the evaluation criterion. The table shows that the AVE value (0.706) of *Uncertainty* is well above the required minimum level of 0.50. Thus, the measure of the reflective construct has high level of convergent validity. As can be seen from Table 18, all model evaluation criteria have been met, providing support for the measure's reliability and validity for the reflective construct *Uncertainty*.

Table 18. Evaluation of Reflective Measurement Constructs

Reflective Constructs	Indicators	Outer loadings	Composite Reliability	AVE
Uncertainty	UC1	0.777	0.914	0.706
	UC2	0.840		
	UC3	0.904		
	UC4	0.925		
	UC5	0.853		
	UC6	0.818		

- Evaluation of the Formative Measurement Constructs

Although theoretical rationale and expert opinion are more important in the evaluation of formative indexes, PLS-SEM also offers some statistical criteria for assessing formative measurement models' quality (Joe F. Hair et al., 2011). Ringle et al. (Ringle, Sarstedt, & Straub, 2012) commented that future research in MIS Quarterly should improve the validation of formative constructs by more closely following the recommendations given by scholars such as Diamantopoulos and Winklhofer (Diamantopoulos & Winklhofer, 2001), Hair et al. (Joe F. Hair et al., 2011; Joseph F Hair, Sarstedt, Pieper, & Ringle, 2012), MacKenzie et al. (Mackenzie et al., 2011) and Petter et al. (Petter, Detmar, & Rai, 2007). This thesis will follow the recommendations on the statistical criteria of formative measurement model given by Hair et al. (2011&2012) and the assessment procedure given by Hair et al. (2016) which is shown in Figure 6.

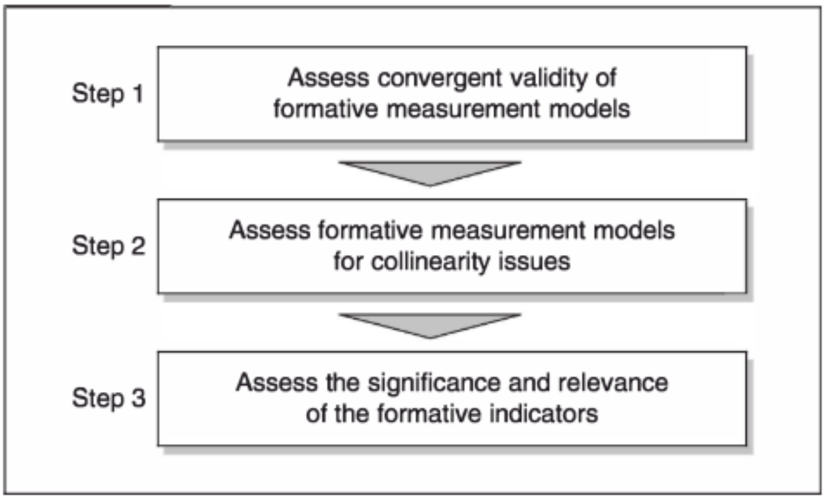


Figure 6. Formative Measurement Models Assessment Procedure (Retrieved from Hair et al. (2016) Exhibit 5.1)

According to Hair et al. (2011, 2012, 2014), PLS-SEM is the superior option for formative measurement and structural models (Joe F. Hair et al., 2011, 2014; Joseph F Hair et al., 2012). The choice of data analysis methodology will be introduced in next section further. Hair et al. (2012, 2014 and 2016) gave some rules of thumb for formative measurement model evaluation including indicator's weight and loading, significance, and multicollinearity. SmartPLS 3.0 was used in this study to do PLS-SEM to check the above rules. The results and the rules for each step retrieved from Hair et al. (2011, 2012, 2014 and 2016) are presented as follows.

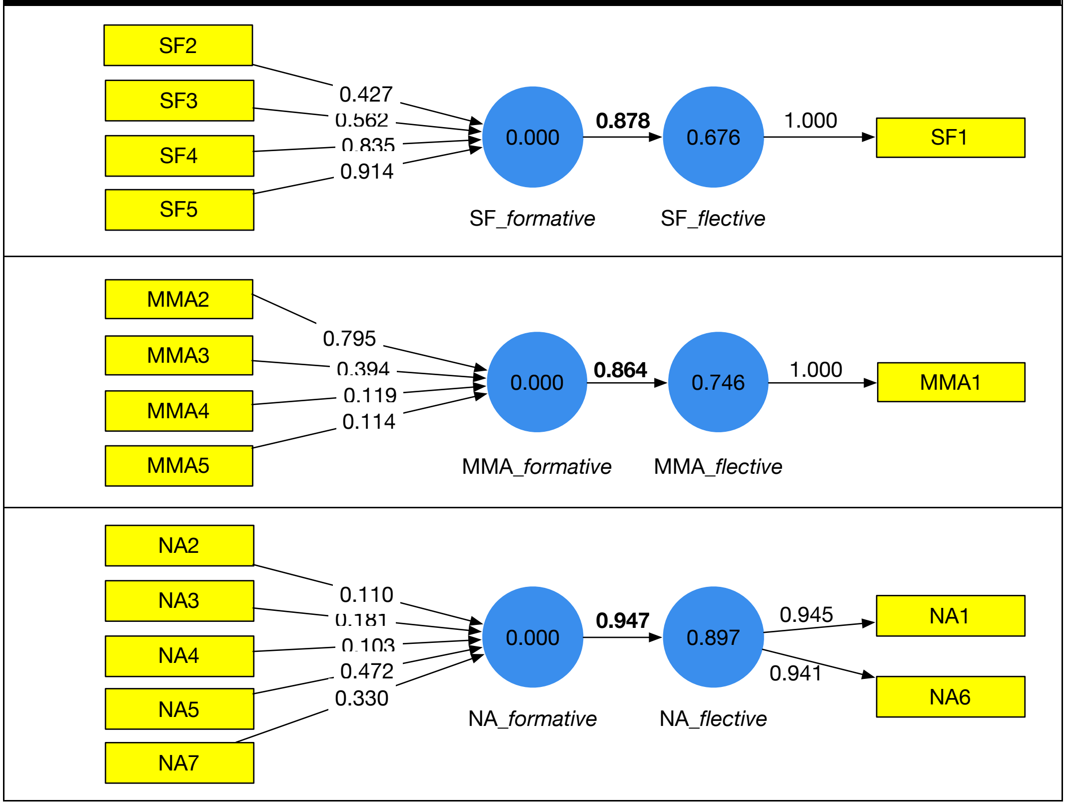
> *Rule 1. Assess the formative construct's convergent validity by examining its correlation with an alternative measure of the construct, using reflective measures or a global single item (redundancy analysis). The correlation between the constructs should be 0.80 or higher* (Joe F. Hair et al., 2016, 2011, 2014).

First, we examined whether the formative constructs exhibit convergent validity according the above rule. To do this, we carried out separate redundancy analysis for each formative construct following the method proposed by Chin (Chin, 1998). The results are presented in Table 19.

According to Chin (1998), one has to use the formatively measured construct as an exogenous latent variable predicting an endogenous latent variable operationalized through one or more reflective indicators, to proceed redundancy analysis. In this study, we used one single item to validate the formative measurement of mental model alignment and satisfaction, and two items for naturalness. Hair et al. (2016) suggested using a single item for validation purposes is a compromise to balance the problems of questionnaire length and the need to validate formative constructs. The strength of the path coefficient linking the two constructs (exogenous and endogenous latent variables with different measurements) is indicative of the validity of the designated set of formative indicators in tapping the construct of interest, and ideally a magnitude of 0.90 or at least 0.80 and above is desired (Chin, 1998; Joe F. Hair et al., 2016).

To test convergent validity, we created the new models for each formative construct following the above method introduced by Chin (1998), as shown in Table 19. The first box in the table shows the results for the redundancy analysis for the satisfaction construct. The original formative construct is labeled with SF_formative, whereas the global assessment of the patient satisfaction using a single-item construct is labeled with SF_reflective. As can be seen, this analysis yields a path coefficient of 0.878, which is above the threshold of 0.80, thus providing support for the informative construct's convergent validity. The redundancy analysis of naturalness and MMA yield estimates of 0.864 and 0.947, respectively. Thus, all formatively measured constructs have sufficient degrees of convergent validity.

Table 19. Convergent Validity Assessment of Formative Measurement Constructs



Rule 2. Multicollinearity: Each indicator's variance inflation factor (VIF) value should be higher than 0.20 and lower than 5 (Joe F. Hair et al., 2016).

In this step, we checked the formative measurement models for collinearity of indicators. High correlations between two formative indicators, also referred to as collinearity or multicollinearity if more than two indicators involved, can prove problematic from a methodological and interpretational standpoint (Joe F. Hair et al., 2016). The collinearity statistics result is presented in Table 20. According to Hair et al. (2011), researchers could calculate the VIF to examine the degree of multicollinearity. High levels of multicollinearity could cause information redundancy for an indicator, and cause problems when the indicator is used to do regression analysis (Joe F. Hair et al., 2011). Table 20 shows that MMA2 has the highest VIF value (3.48). Hence, VIF values are uniformly below the threshold value of 5. We conclude, therefore, that multicollinearity does not reach critical levels in any of the formative constructs and is not an issue for the estimation of the research model.

Table 20. Variance Inflation Factor (VIF) Results					
Naturalness		Mental Model Alignment		Satisfaction	
Indicators	VIF	Indicators	VIF	Indicators	VIF
NA2	2.41	MMA2	3.48	SF2	2.60
NA3	2.62	MMA3	2.46	SF3	2.79
NA4	1.50	MMA4	3.33	SF4	2.16
NA5	2.16	MMA5	2.36	SF5	2.34
NA7	2.31				

Rule 3. Examine each indicator's weight (relative importance) and loading (absolute importance) and use bootstrapping to assess their signifi- cance. The minimum number of bootstrap samples is 5,000, and the number of cases should be equal to the number of observations in the original sample. Critical t-values for a two-tailed test are 1.65 (significance level = 10 percent), 1.96 (significance level = 5 percent), and 2.58 (significance level = 1 percent). (Joe F. Hair et al., 2011)

The final step is to analyze the outer weights and loadings for their significance and relevance. Bootstrapping was conducted to examine the indicators' loadings and weights presented in Table 21, with the settings of bootstrap samples being 5000 and significance level being 0.05.

It is seen that all the weights and loadings are positive, and all the indicators' weights and loadings are significant. The results indicate that all the indicators are both relatively and absolutely important in measuring the corresponding constructs. All the t-values for two-tailed test are above the critical value (t=1.96) suggested by Hair et al. (2011). These results provide empirical support to keep all the indicators.

Table 21. Indicator Weights Significance Results for Formative Constructs in Pre-test Three

Formative Constructs	Indicators	Outer Weights (Outer Loadings)	t-value	Significance Level	p-value	Confidence Intervals
Naturalness	NA2	0.256 (0.713)	2.925	***	.000	[0.080, 0.421]
	NA3	0.195 (0.447)	2.706	**	.003	[0.065, 0.261]
	NA4	0.171 (0.497)	2.503	**	.003	[0.101, 0.361]
	NA5	0.161 (0.545)	2.097	**	.002	[0.133, 0.249]

	NA7	0.370 (0.803)	3.787	***	.000	[0.175, 0.563]
Mental Model Align-ment	MMA2	0.373 (0.867)	2.995	***	.000	[0.128, 0.617]
	MMA3	0.549 (0.899)	4.912	***	.000	[0.32, 0.760]
	MMA4	0.188 (0.676)	2.68	**	.003	[0.172, 0.336]
	MMA5	0.258 (0.778)	2.128	**	.012	[0.127, 0.421]
Satisfac-tion	SF2	0.269 (0.744)	2.591	**	.003	[0.042, 0.373]
	SF3	0.285 (0.746)	2.798	**	.028	[0.017, 0.349]
	SF4	0.307 (0.841)	3.395	***	.000	[0.128, 0.480]
	SF5	0.517 (0.925)	5.699	***	.000	[0.328, 0.683]

(Note: Bootstrap confidence intervals for 5% probability of error (α=0.05). *p<.05. **p<.03. ***p<.01)

The analysis of outer weights concludes the evaluation of the formative measurement models. Considering the results from evaluation for reflective and formative constructs jointly, all the constructs exhibit satisfactory levels of quality. The conclusion suggests that the experiment design and measurement items are ready for the main test. The main test is introduced in the following section.

5.3.4 Main-Test

All three rounds of pre-tests were conducted within Canada where VC is not as widely accepted as in the United States of America. Participants who are familiar with the concept of VC may be able to understand the scenario description better and provide a better quality of answers. The findings in study one is concluded by analyzing reviews of US patients, which may have some limitations regarding the generalization power of the results. To weaken this limitation, we wanted to recruit US participants to perform the experiment who share the same background and expectations with the patients in study one.

Although we required participants thinking out loud during pre-tests, one fact that is worth noting is that the data size may not be big enough to do a high-quality analysis. Taking the two limitations of pre-tests into consideration, we hired a US company (Qualtrics) to recruit participants for this study with hopes of getting a large and high-quality data size (more than 200 valid questionnaires).

To get better data quality, the criteria for a valid questionnaire was as follows:

- Duration time must be no less than 3 minutes.
- Participants must choose "I will provide my best answers" to the commitment questions.
- Participants must be correct on the condition check questions.
- Answers to all the Likert-type questions should not be the same.

5.4 Data Analysis

In the end, 741 subjects participated in this study, and 327 valid questionnaires were obtained, after applying the above criteria. This section first introduces the method (PLS-SEM) we used to analyze the data, then presents the demographic, manipulation check and evaluation results for both measurement and structural models.

5.4.1 Data Analysis Methods

Partial Least Squares Structural Equation Modeling (PLS-SEM)

The main objective of the experiment is to study the impact of system design on patient-doctor communication in the context of VC. The detailed objectives are as follows:

1. To investigate the negative impact of naturalness on patients' uncertainty.

2. To investigate the negative impact of MMA on patients' uncertainty.

3. To investigate the negative impact of uncertainty on patients' satisfaction.

To fulfill all the above objectives, we need to select a flexible data analysis method that can effectively test complex relationships among multiple variables. Structural equation modeling (SEM) is a collection of statistical techniques that allow a set of relationships between one or more independent variables (IVs) (either continuous or discrete), and one or more dependent variables (DVs) (either continuous or discrete), to be examined (Ullman & Bentler, 2012). Though it could also be used for exploratory purposes, SEM is more of a confirmatory technique

(Schreiber, Stage, King, Nora, & Barlow, 2006) which is useful testing the model in this study. One of the strengths of SEM is its flexibility, which permits examination of complex associations, use of various types of data (e.g., categorical, dimensional, censored, count variables), and comparisons across alternative models (E. J. Wolf, Harrington, Clark, & Miller, 2013). Two important approaches to do SEM are PLS-SEM and Covariance-based SEM (CB-SEM) (Sarstedt, Hair, Ringle, Thiele, & Gudergan, 2016). PLS-SEM is the method of choice if the hypothesized model contains composites (Henseler, 2017).

PLS-SEM was chosen in this study because the research model is formative. The software we used for data analysis was SmartPLS 3.0 because it was considered as one of the superior tool to do PLS-SEM for formative models (F. Hair Jr, Sarstedt, Hopkins, & G. Kuppelwieser, 2014; Henseler, Ringle, & Sarstedt, 2012; Ringle, Da Silva, & Bido, 2014; Ringle et al., 2012).

Sample size

Recommendations for the minimum number of observations range from 30 to 100 cases for PLS-SEM (Sarstedt, Ringle, & Hair, 2014). However, it is not easy to decide the least needed sample size for a specific model. 10 times rule (Joe F. Hair et al., 2016) was used in the pretests to roughly determine the minimum sample size. To obtain a more accurate number, in the main test, we used the software: GPower (*http://www.gpower.hhu.de/*) to determine the minimum sample size. Cohen (1988) and Hair et al. (2014) recommended values of 0.80 and 0.15 for the two parameters: the power of the test (Power=1-β err prob.ц) and the size of the effect (f^2) (Cohen J., 1988; F. Hair Jr et al., 2014). Here 0.95 was used as the power value for better results. The research model has two predictors for the construct of satisfaction. Figure 7 demonstrates the result of the test using the software.

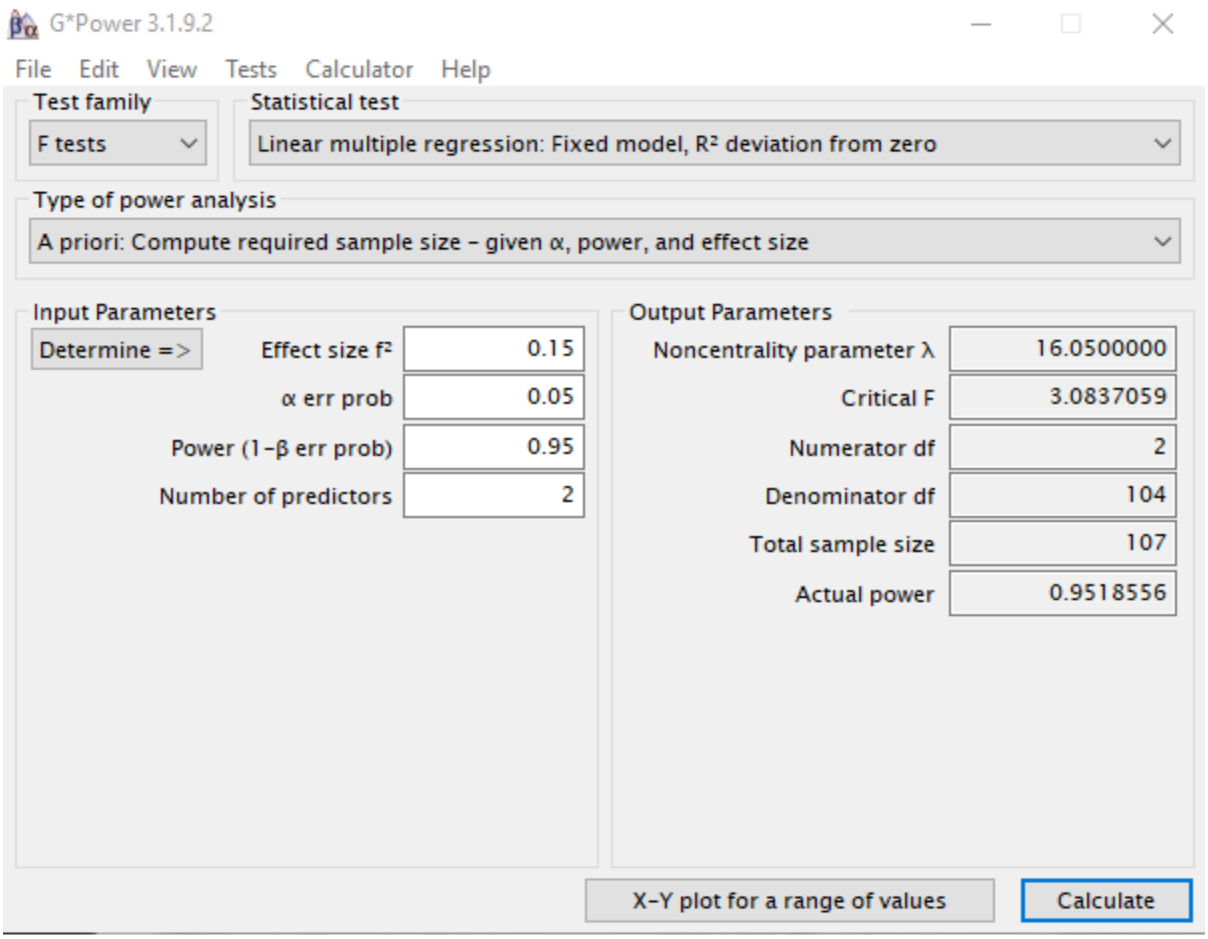


Figure 7. Screen of the Software G*Power 3.1.9.2 with the Calculation of the Minimum Sample of Main Test.

The calculated minimum sample for this study should be 107 cases. However, it is suggested to double or triple this amount in order to have a more consistent model (Ringle et al., 2014). We have 327 valid questionnaires, so the sample size to do SEM is a satisfactory.

5.4.2 Results for Main-Test

This section introduces the results of the main-test including demographic, manipulation check and evaluation results for measurement and structural models. The manipulation check and measurement model evaluation were performed following the same procedure as in pre-test three. The construct relationships, R^2 values and predictive relevance were analyzed to measure the structural model. The hypothesis were supported by the data analysis results.

5.4.2.1 Demographic Results

All the 327 valid questionnaires satisfied the criteria introduced in the previous section. All the duration times were above 120 seconds and were on average 367 seconds. All the 327 participants answered the condition-check questions correctly and committed to providing their best answers.

Participants were from all age range, and 83% of them were females. Most participants (80%) were confident of having enough computer skills to do VC, while very few of them (14%) had experience of VC. The demographic distribution result is present in Table 22.

Table 22. Demographic Distribution of Main Test

		Count	Percent	Valid Percent	Cumulative Percent
VC experience (1: yes; 2: no)					
Valid	1	280	85.6	85.6	85.6
	2	47	14.4	14.4	100.0
	Total	327	100.0	100.0	
Gender (1: male; 2: female; 3: other)					
		Count	Percent	Valid Percent	Cumulative Percent
Valid	1	52	15.9	15.9	15.9
	2	272	83.2	83.2	99.1
	4	3	.9	.9	100.0
Computer skill (1: yes; 2: no; 3: not sure)					
		Count	Percent	Valid Percent	Cumulative Percent
Valid	1	261	79.8	79.8	79.8
	2	25	7.6	7.6	87.5
	3	41	12.5	12.5	100.0
	Total	327	100.0	100.0	
Age (1: 18-30; 2: 31-50; 3: 51-70; 4: 70 and older)					
		Count	Percent	Valid Percent	Cumulative Percent
Valid	1	99	30.3	30.3	30.3
	2	140	42.8	42.8	73.1
	3	72	22.0	22.0	95.1
	4	16	4.9	4.9	100.0

	Total	327	100.0	100.0	

5.4.2.2 Manipulation Check Results

The assumptions of t-test were checked before manipulation check as in pre-test one, and all conditions were satisfied. The manipulation check results on the practical level for the two independent variables are presented in Tables 23 and 24.

The results show that condition manipulation for the construct of naturalness is satisfactory. The mean value of video conferencing groups (mean=5.14) is much greater than that of instant messaging groups (mean=3.76). The t-test result is significant (p=.000). That is, the video conferencing group and instant messaging group have sufficient large enough difference on the level of naturalness.

Meanwhile, the manipulation check for the construct of MMA is not so satisfactory on practical level, with t-test result being nonsignificant (p=.855) (see Table 24). The mean values of MMA for experiment groups (mean value: 3.80 vs. 3.77) differ from one another only slightly, which means that family doctor groups and new doctor groups do not have statistically significant differences regarding MMA construct.

Table 23. Manipulation Check (Practical Level) on Naturalness for Main Test

Naturalness (1: video; 2: msg)	Mean	N	Std. Deviation	Std. Error Mean
1	5.14	167	1.05	.08
2	3.76	160	1.14	.09

T-test

	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
				Lower	Upper
Equal variances assumed	.000	1.38	.12	1.15	1.62

Table 24. Manipulation Check (Practical Level) on MMA for Main Test

MMA (1: new; 2: family)	Mean	N	Std. Deviation	Std. Error Mean
1	3.80	171	1.43	.11
2	3.77	156	1.38	.11

T-test

	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
				Lower	Upper
Equal variances assumed	.855	.03	.16	-.28	.34

Since the manipulation check for MMA on practical level was not successful, we then checked the manipulation on the general level. That is, we checked if the data had established high and low levels of MMA that was different from one another sufficiently. The result is presented in Table 25. It shows that high_level group has greater mean value (mean=4.84) than low_level group (mean=2.52). The t-test result being significant suggests that the differences regarding MMA between the two groups are significantly large that it could not be considered by chance.

Table 25. Manipulation Check (General Level) on MMA for Main Test

MMA (1: high; 2: low)	Mean	N	Std. Deviation	Std. Error Mean
1	4.84	178	.78	.06
2	2.52	149	.81	.07

T-test

	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
				Lower	Upper
Equal variances assumed	.000	2.33	.09	2.15	2.50

Theoretically, patients will be more comfortable and confident about the consultation process and results when they visit a family doctor whom they are familiar with than a doctor who is stranger to them. Nevertheless, the manipulation check results on the practical level did not show support on this. One possible explanation could be US participants' visiting new doctors being the norm in VC. People are so familiar with the VC concepts that they understand that a new doctor is very likely to be visited when they do online consultation. Whether it is a new doctor or familiar doctor does not influence patients' expectations of the VC process and communication methods. Therefore, the patient's mental model alignment level does not change a lot with the selection between new and family doctors. Further research can be done on this, to facilitate healthcare providers' understanding of patients' psychological perceptions in the healthcare area.

Although the mean values for different MMA groups (family doctor vs. new doctor) on practical level do not show significant differences, we argue that the results are still statistically useful. Aside from the fact that the result on general level was significant which suggested that different levels of MMA had been established, another reason could be that mean values were used to determine whether there were any statistically significant differences between the means of different groups on practical level. That is, the mean values instead of actual answers for each questionnaire were used to check manipulation. In the meantime, the SEM method we later used for model testing is on each answer instead of on mean values. Therefore, given that different levels of MMA are established, the data is statistically useful to test the influence of MMA on *Uncertainty*.

5.4.2.3 Evaluating Measurement Model

We evaluated the measurement model the same procedure with pretest three. The indicator reliability, internal consistency, convergent validity to evaluate the reflective construct, the three steps to evaluate the formative constructs were checked. The details are introduced in the following sections.

- Evaluation of the Reflective Measurement Constructs

There is one reflective construct *Uncertainty* in the research model, and the PLS-SEM results for its measurement are presented in Table 26.

All outer loadings of the construct are above the threshold value of 0.708. The indicator UC1 (outer loading: 0.738) has the smallest indicator reliability with a value of 0.545 (0.738^2), while the indicator UC4 (outer loading: 0.831) has the highest indicator reliability with a value of 0.690 (0.831^2). Thus, all the indicators for the reflective construct are well above the minimum acceptable level for outer loadings.

The composite reliability value of 0.881 (>0.708) demonstrates that the reflective construct has high level of internal consistency reliability. The table also shows that the AVE value (0.555) of *Uncertainty* is above the required minimum level of 0.50. Thus, the measure of the reflective construct has high level of convergent validity. All model evaluation criteria have been met, providing support for the measure's reliability and validity for the reflective construct Uncertainty.

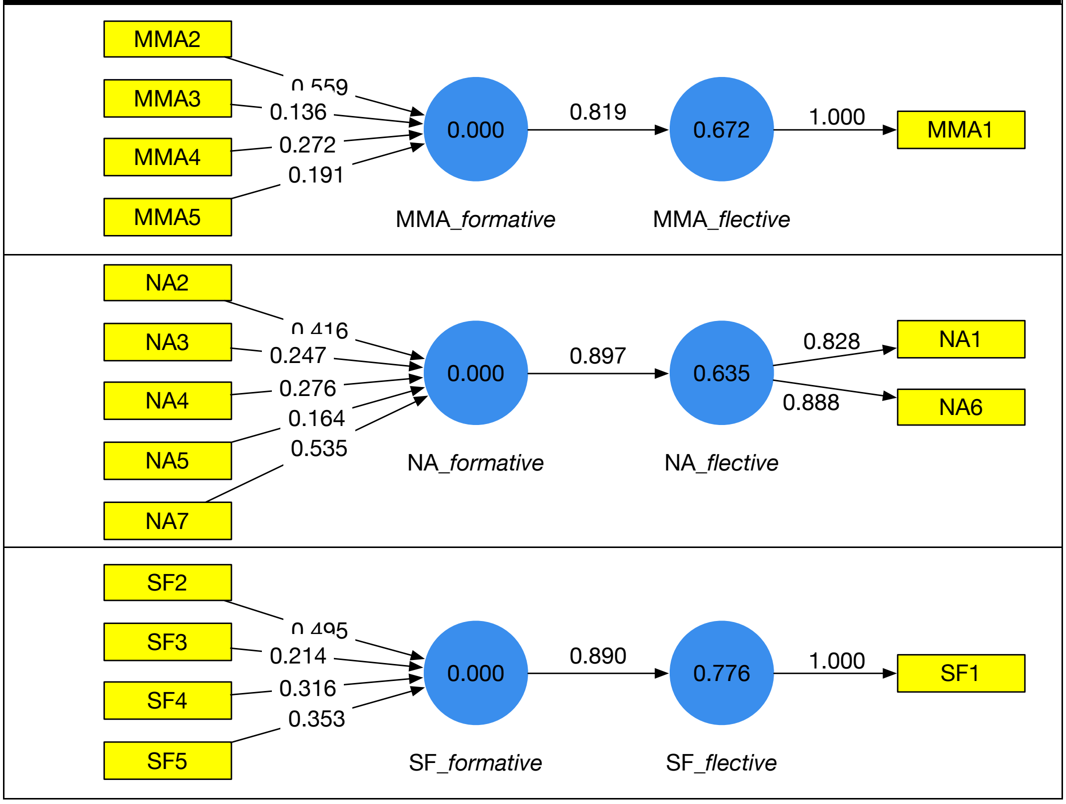
Table 26. Evaluation of Reflective Measurement Constructs in Main Test				
Reflective Constructs	Indicators	Outer loadings	Composite Reliability	AVE
Uncertainty	UC1	0.738	0.881	0.555
	UC2	0.760		
	UC3	0.742		
	UC4	0.831		
	UC5	0.786		
	UC6	0.792		

- Evaluation of the Formative Measurement Constructs

We followed the three steps introduced in pre-test three to evaluate the formative measurement constructs. The results are introduced step by step in the following sections.

First, we examined whether the formative constructs exhibit convergent validity according to the rule that the coefficient for the redundancy analysis models should be above 0.80. The redundancy analysis models were created as the same ones in pre-test three. The results are presented in Table 27. The redundancy analysis of MMA, naturalness and satisfaction yield estimates of 0.819, 0.897 and 0.890, which are above the threshold of 0.80. Thus, all formatively measured constructs have sufficient degrees of convergent validity.

Table 27. Convergent Validity Assessment of Formative Measurement Constructs in Main Test



The second step is to check the formative measurement models for collinearity of indicators. VIF values were used to examine the degree of multicollinearity. The results are presented in Table 28. The indicator NA4 has the highest VIF value (3.99). Hence, VIF values are all below the threshold value of 5. It is concluded, therefore, that multicollinearity does not reach critical levels in any of the formative constructs and is not an issue for the estimation of the research model.

Table 28. Variance Inflation Factor (VIF) Results in Main Test

Naturalness		Mental Model Alignment		Satisfaction	
Indicators	VIF	Indicators	VIF	Indicators	VIF
NA2	1.59	MMA2	2.34	SF2	1.96
NA3	3.61	MMA3	1.63	SF3	1.95
NA4	3.97	MMA4	2.43	SF4	2.00
NA5	1.68	MMA5	3.24	SF5	2.20
NA7	1.69				

The final step is to examine each indicator's weight and significance level. We still used the same settings (sample is 5000, significance level = 0.05) as in pre-test three to do bootstrapping. The results are presented in Table 29. All the outer weights are significant. Looking at the t-values for the indicators, they are above the critical value

(1.96 at significance level being 0.05). The results provide empirical support to retain all the indicators for the formative constructs.

Table 29. Indicator Weights Significance Results for Formative Constructs in Main Test						
Formative Constructs	Indicators	Outer Weights (Outer Loadings)	t-value	Significance Level	p-value	Confidence Intervals
Naturalness	NA2	0.440 (0.361)	4.742	***	.000	[0.120, 0.626]
	NA3	0.106 (0.479)	2.699	**	.015	[0.321, 0.755]
	NA4	0.239 (0.533)	2.873	**	.003	[0.282, 0.336]
	NA5	0.192 (0.582)	2.864	**	.002	[0.224, 0.391]
	NA7	0.617 (0.759)	6.581	***	.000	[0.416, 0.782]
Mental Model Alignment	MMA2	0.373 (0.868)	2.897	***	.000	[0.120, 0.626]
	MMA3	0.548 (0.698)	4.930	***	.000	[0.321, 0.755]
	MMA4	0.189 (0.676)	3.682	**	.023	[0.152, 0.336]
	MMA5	0.159 (0.778)	2.112	**	.006	[0.124, 0.436]
Satisfaction	SF2	0.168 (0.643)	3.616	***	.000	[0.041, 0.367]
	SF3	0.183 (0.745)	2.227	**	.002	[0.019, 0.343]

	SF4	0.309 (0.842)	3.414	***	.000	[0.128, 0.484]
	SF5	0.427 (0.639)	5.653	***	.000	[0.326, 0.686]

(Note: Bootstrap confidence intervals for 5% probability of error (α=0.05). *p<.05. **p<.03. ***p<.01)

According to the evaluation results for both reflective and formative constructs, it can be concluded that all the constructs exhibit satisfactory levels of quality. Thus, we can proceed with the evaluation of the structural model in the following section.

5.4.2.4 Evaluating Structural Model

Once it is confirmed that the construct measures were reliable and valid, the next step addressed the assessment of the structural model results. This section introduces the model's predictive capabilities and the relationships between the constructs.

The evaluation of structural model in this study followed the steps suggested by Hair et al. (2016), including assessing collinearity issues, construct relationships, R^2, and predictive relevance (Joe F. Hair et al., 2016). They also suggested researchers should avoid to use Goodness-of-fit index (GoF) for PLS-SEM, since GoF cannot reliably distinguish valid from invalid models and its applicability is limited to certain model setups (Joe F. Hair et al., 2016). Henseler et al.'s research also showed that the GoF does not represent a goodness-of-fit criterion for PLS-SEM (Henseler et al., 2012). Therefore, goodness of fit was not assessed in this study.

Collinearity Assessment results

To assess collinearity, we applied the same measures as in the evaluation of formative measurement constructs. That is, VIF values of the predictor variables should be lower than 5.0 and higher than 0.20. In the research model for this study, the constructs of naturalness and MMA jointly explain uncertainty. Therefore, we need to check whether there are significant levels of collinearity between the two predictor variables, that is naturalness and MMA. The results are presented in Table 30. As can be seen, both VIF values are clearly below the threshold of 5.0.

Therefore, collinearity among the predictor constructs is not an issue in the structural model, and we can proceed the following steps.

Table 30. Collinearity Assessment Results in Main Test	
Constructs	VIF
Naturalness	1.484
MMA	1.484

Construct relationships, R^2 and predictive relevance results

The assessment of the structural model builds on the results from the standard model estimation, the bootstrapping routine, and the blind-folding procedure (Joe F. Hair et al., 2016). After running the PLS-SEM algorithm in SmartPLS, the path coefficients, the t values and their significance levels, p values and the confidence intervals are represented in Table 31. The general results are presented in Figure 8.

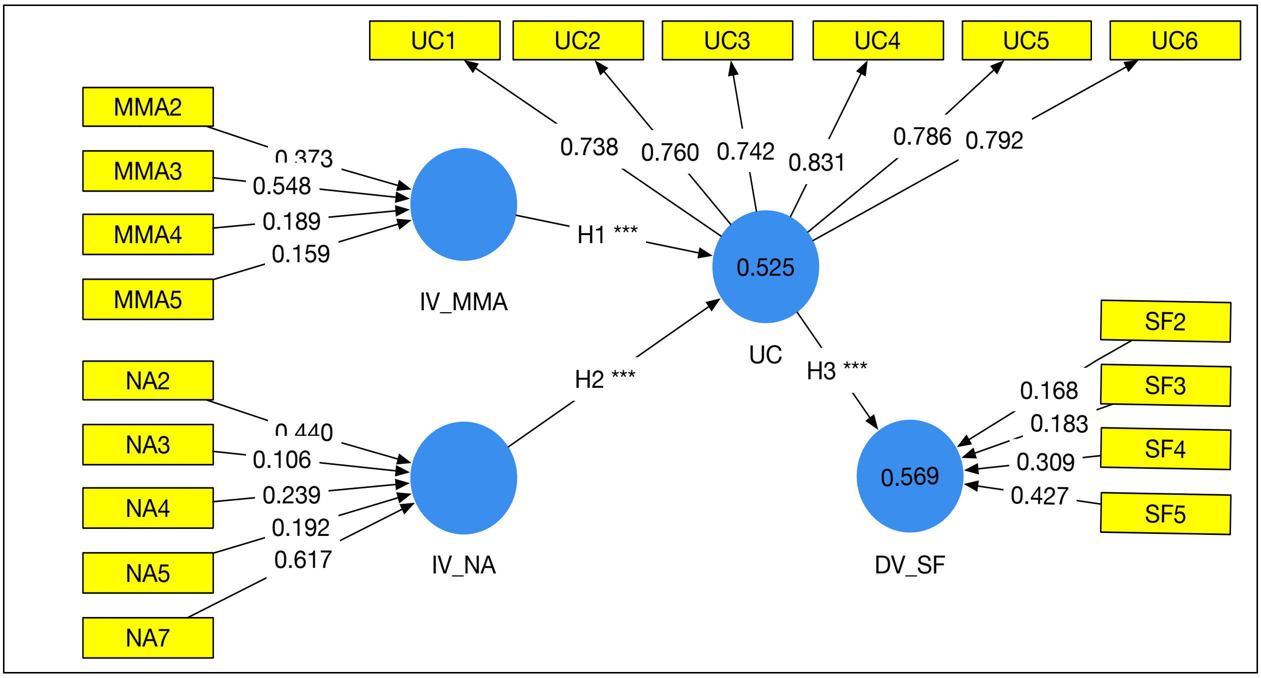


Figure 8. General Results for Structural Model in Main Test

Table 31. Significance Testing Results of the Structural Model Path Coefficients in Main Test

	Path Coefficients	t Values	Significance Levels	p Values	95% Confidence Intervals
NA->UC	0.381	6.391	***	.000	[0.266, 0.499]
MMA->UC	0.355	6.363	***	.000	[0.254, 0.473]
UC->SF	0.685	22.192	***	.000	[0.627, 0.748]

(Note: *p<.05. **p<.03. ***p<.01)

The most commonly used measure to evaluate the structural model is the coefficient of determination (R^2 value) (Joe F. Hair et al., 2014; Henseler et al., 2012). The R^2 values represent the amount of explained variance of the dependent variables in the structural model (Chengalur-Smith, Duchessi, & Gil-Garcia, 2012). The R^2 values in Figure 8 reveal that the research model explains about 53% of the variation in UC and about 57% of the variation in SF. In general, R^2 values of 0.75, 0.50, or 0.25 for the endogenous constructs can be described as respectively substantial, moderate, and weak (Joe F. Hair et al., 2016). Following this rule, the R^2 values of uncertainty (0.525) and satisfaction (0.569) can be considered moderate.

Looking at the relative importance of the exogenous driver constructs for uncertainty in Table 31, one finds that the construct *Naturalness* and *MMA* are almost equally important with path coefficient value (0.381) for naturalness being slightly higher than it (0.355) for MMA. It is advisable for healthcare providers to focus on both the selection of media and the design of the content to align with patient's mental models.

By also taking the construct's indicator weights into consideration (see Figure 8), we can identify that NA7 and MMA3 have high weights (0.617 and 0.548) which need to be focused on. These two items relate to the survey question "Visiting a doctor online feels as if the doctor and I are talking in the same room" and "Describing my symptoms to a doctor online matches my experience of describing symptoms to a doctor in person". Thus, healthcare providers or healthcare system designers should try to enhance patients' feelings of colocation with online doctors, and enable patients better describe their symptoms. The path coefficient value being 0.685 suggests a strong positive relationship between uncertainty and patient satisfaction. Table 31 also shows that all relationships in the research model are significant.

By running the blindfolding routine in SmartPLS, the predictive relevance Q^2 values for each endogenous construct were obtained as shown in Table 32. According to the rules developed by Hair et al. (2016), the resulting Q^2 values larger than 0 indicate that the exogenous constructs have predictive relevance for the endogenous construct under consideration (Joe F. Hair et al., 2016). Table 32 shows that all Q^2 values are considerably above zero, thus providing support for the model's predictive relevance regarding uncertainty and patient satisfaction.

Table 32. Results of Q^2 Values in Main Test	
Endogenous Latent Variables	Q^2
UC	0.213
SF	0.292

After analyzing the path coefficients, R^2 and other above PLS-SEM results, it is concluded that the hypothesis proposed in this study were well supported as shown in Table 33.

Table 33. Hypotheses Testing Results for the Research Model

Number	Hypothesis	Results
H_1	Increased media naturalness will reduce uncertainty during patient-doctor CMC。	Supported ($t>0.2$; $p<0.05$)
H_2	Increased mental model alignment will reduce uncertainty during patient-doctor CMC.	Supported ($t>0.2$; $p<0.05$)
H_3	Increased uncertainty will reduce patient satisfaction during patient-doctor CMC.	Supported ($t>0.2$; $p<0.05$)

5.5 Discussions and Conclusions

After the above analysis, we also did the mediating analysis to test the mediating effect of uncertainty in the model, and the measurement invariance analysis to ensure the results would not be affected by group-related factors including gender (male, female and other), age (18-30, 31-50, 51-70, and 70 and older), VC experience (yes and no), computer skill (yes, no and not sure), and group conditions (four conditions).

5.5.1 Mediating Analysis

We also tested the mediating effect of uncertainty following Preacher and Hayes (Preacher & Hayes, 2004; Preacher, Hayes, & Preacher, 2008) and Hair et al. (Joe F. Hair et al., 2016). Without uncertainty, the direct effects were significant from naturalness and MMA to patient satisfaction in the model. Under this condition, the mediator of uncertainty may absorb some of this effect or the entire effect. Then we bootstrapped our model with the mediator of uncertainty and found that the two indirect effects (naturalness-> satisfaction and MMA -> satisfaction) were significant which concludes that uncertainty mediates the relationship between naturalness, MMA and patient satisfaction individually. Then we checked the *variance accounted for* (VAF) to determine how much the mediator variable absorbed. Consequently, 82% of naturalness's (VAF=0.82) effect on patient satisfaction is explained via the uncertainty mediator, while the VAF value is 0.85 for MMA.

According to Hair et al. (2016), one can assume a full mediation when the VAF has very large outcomes of above 80% (Joe F. Hair et al., 2016). Therefore, we can conclude that in our model, the relationship between naturalness and MMA, and patient satisfaction is largely mediated by uncertainty.

5.5.2 Measurement Invariance

We also tested measurement invariance to ensure that the construct measures are invariant across different groups. That is, the categorial moderators' (age, gender, experience, group conditions) effects are restricted to the path coefficients and do not entail group-related differences in our model. Taking VC experience as example, we first grouped the data set (n=327) based on whether the participants have VC experience or not. 67 participants have VC experience while 260 do not. After ensuring the number of observations in the two group meets the rules of thumb for minimum sample size requirements, we did multi-group analysis in SmartPLS. The results are presented in Table 34.

Table 34. PLS-MGA Results

	Group 1: No VC experience		Group 2: With experience		Group 1 vs. Group 2	
	$P^{(1)}$	STDEV	$P^{(2)}$	STDEV	$\lvert p^{(1)}-p^{(2)} \rvert$	P value
NA -> UC	0.401	0.062	0.440	0.121	0.039	0.554
MMA -> UC	0.366	0.058	0.400	0.114	0.034	0.572
UC -> SF	0.689	0.034	0.784	0.062	0.095	0.890
n	260		67			

As can be seen, all the relationships (path coefficients) differ insignificantly across the two groups indicating that there is no significant difference in the effect of our independent variables on patient satisfaction between people with VC experience and people without it. Similarly, we did multi-group analysis for gender, computer skill, age and the group condition separately, and the results suggest no significant difference for different groups generated based on each of the above factors. Thus, we conclude that the measurement invariance was achieved in the model.

5.5.3 Chapter Conclusion

This chapter evaluated the impact of media intervention on patients' perceptions and attitudes towards VC during patient-doctor communication. With naturalness and mental model alignment as the independent variable, this study expected to explore principles to select and design media. Uncertainty is the mediating variable between independent variables and the dependent variable of patients' satisfaction. This study proposed that system design affected patients' satisfaction on VC through its impact on patients' uncertainty during patient-doctor communication. A field experiment was conducted to test the propositions and hypothesis. Three pre-tests and one main-test were completed to collect data. PLS-SEM was used to analyze the obtained data.

The quantitative results showed that there were significant effects of media naturalness and mental model alignment on patients' uncertainty and their satisfaction, during patient-doctor CMC in the VC, thus providing support for hypothesis one, two and three. The results provided evidence for the importance of system selection and content design to reduce patient uncertainty in the context of VC.

6. Contributions, Limitations, Future work, and Conclusions

Understanding patients' concerns and uncertainties enable healthcare providers to improve care quality and to reduce costs. Amongst all the encounters, communication between patient and doctor is crucial to determine patients' perceptions and attitudes towards online consultation. Despite the ongoing effort to improve patient-doctor communication results, unresolved issues of patient-centered uncertainties and perceptions may significantly restrict the expansion of VC. This thesis provided a theoretical understanding of patients' uncertainties during patient-doctor CMC and offered theory-based suggestions to reduce uncertainty. The thesis makes several contributions to theory and practice.

6.1 Contributions to Research and Practice

6.1.1 Reconceptualizing Uncertainty in Health Care

This thesis attempted to open the black box of patients' uncertainty during VC and argued that the important concept was missing in the prior VC research. This aim requires extending academia's understanding of uncertainty during patient-doctor computer-mediated communication as they ignored the characteristics of patient-centered uncertainty and did not reflect upon the impact of media. A definition of uncertainty in VC was proposed: the extent to which patients are certain on patient-doctor communication which can be assessed on the following main six elements: (1) Doctors' Behaviour; (2) Describing Symptoms; (3) Understanding Doctors; (4) Doctors' Feelings and Emotions; (5) Doctors' Attitudes; and (6) VC Process. Rather than traditional "two-party" conceptualization of uncertainty in communication, this definition is patient-centered, recognizing six important elements for known uses and future, unanticipated uses.

This thesis provides a theoretical foundation and empirical evidence of the importance of studying patients' attitudes through uncertainty. These include findings of:

a) a broad range of elements which patients are still not certain about, including doctors and systems, despite the wide acceptance of VC (Chapter 4);

b) a close connection between patient uncertainty and satisfaction (Chapter 4);
c) significant dependence of uncertainty on the selection and design of media in the context of patient-doctor CMC (Chapter 5);
d) a higher level of patient satisfaction in the condition of having fewer uncertainties (Chapter 5).

These results are novel and provide strong empirical evidence of the advantages of uncertainty studies in the context of VC. The contribution of reconceptualizing uncertainty is in recognizing the important role of patient-centeredness in VC research. This recognition naturally leads to a search for more effective system designs to improve patients' satisfaction, while reducing their uncertainties during patient-doctor communication.

6.1.2 Exposing Patient-Centered Uncertainty as a Factor Contributing to Improve Satisfaction

This thesis increases our understanding of the patients' uncertainty and its role in boosting patients' satisfaction towards VC. Patient satisfaction has long been an important outcome measure of service-based healthcare area (Farley et al., 2014). As one of the patients' perceptions, patient satisfaction is facilitated through a combination of responsiveness to patients' views and needs, and continuous improvement of the healthcare services, as well as continuous improvement of the overall patient-doctor relationship (Zineldin, 2006). Numerous studies have been done on the factors affecting patient satisfaction ranging from physician performance to the outcomes of the current healthcare system. Most of these studies took an outcome-based approach, suggesting a close link between patient satisfaction and healthcare quality or other benefits. Few of them established a connection between patients' negative perceptions and their satisfaction, from a relationship-focused angle.

Using an in-depth method of content analysis (Chapter 4), this thesis provided empirical evidence of the importance of uncertainty in creating patients' perceptions of VC. Despite all the benefits VC can provide (including convenience, easier access to care, easier getting prescription and treatment, and others), patients still have a broad range of concerns about both doctors and systems. Six main elements patients are not certain about when they do VC are doctors' behaviour, describing symptoms, understanding doctors, doctors' feelings and emotions, doctors' attitudes, and VC process. The results demonstrated that uncertainty should be carefully considered by healthcare providers for seeking better ways to get patients' appreciation, as it can be the bottleneck while other conditions are improved.

In the meantime, the patient satisfaction was largely influenced by their uncertainties. That is, patients who are uncertain about the VC facets tend to be unhappy and likely refuse to use the system again. One reason they make this decision could be failing to assure themselves on some uncertainties about both doctors and systems which results in a negative perception of the consultation experience. This result challenges the traditional outcome-based approaches to study patient satisfaction by proving that patient uncertainty is an important factor for their perceptions during the patient-doctor communication, and thus it is crucial to understand the patient-centered uncertainties in VC.

Patient-centeredness is about seeing the patient as a person with a unique personal history and individual needs (Verlinde et al., 2012). From a handful of studies, we can take a glance at the usefulness of patient-centeredness. Patients who are actively involved in a patient-centered consultation experience better clinical outcomes (Zilliacus et al., 2010). Doctors who are more patient-centered with patients are perceived as better communicators, more satisfied, and more likely to adhere (Street et al., 2007). VC systems which can provide an adequate environment of patient-centeredness receive more adherence and satisfaction from patients (Abbott et al., 2018). Disclosure of patients' concerns and uncertainties are important for healthcare providers in creating patient-centered environments.

6.1.3. Novel Approaches to Reducing Uncertainty in the Context of Virtual Consultation

This research points to the potential of patient-centered uncertainty study on improving patients' satisfaction in the context of VC. By conducting a content analysis on patients' reviews of some popular VC systems, this thesis managed to understand patients' uncertainties during their communication with doctors online, as well as the benefits of VC. The results call for more and deeper research on patient-centered uncertainty in the healthcare area.

This thesis further contributes by providing a framework on how to reduce patients' uncertainty during patient-doctor CMC, from both media selection and content perspectives. This thesis additionally demonstrated the effect of the two specific design features on reducing patients' uncertainty by conducting a 2 x 2 field experiment. The field experiment supported the propositions in study two and provided a blueprint that practitioners can follow when design patient-centered healthcare systems.

This research demonstrated a context in which more naturalness and mental model alignment of media can lead to lower patient uncertainty during patient-doctor CMC. The result is clearly useful when healthcare providers seek to reduce patients' uncertainty and improve their satisfaction. Additionally, patients who communicate with doctors using video conferencing have few uncertainties than when they use instant messaging. Surprisingly, whether patients have pre-interaction with doctors or not does not affect their expectations of VC. These results can be combined with other specific design features when healthcare providers want to choose a main method for the communication between patients and doctors and want to design the system content as aligned as possible with patients' existing mental models of consultation.

6.2 Limitations

As with any study, there are several limitations that present opportunities for future research. Although the sample of five healthcare systems in the content analysis is sufficiently diverse to support the findings, this could be a limitation that most of the patients' reviews collected are positive since the five systems already build a reputation and have many users. Therefore, the coding data set in the first study may not reflect all the uncertainties or issues patients have towards VC. Meanwhile, the five US-based systems in study one are private and non-universal which are different from Canadian healthcare systems. This may also limit the generalization of the findings as patients may have different expectations and concerns towards VCS. Future studies could sample a larger set of systems to confirm that the results of the content analysis hold. For example, including unpopular or public systems would allow for an analysis of the potentially moderating effect of company reputation and the type of healthcare systems.

Second, although it provides better manipulation on the experiment with simulation of the consultations by describing the scenario instead of demanding the participants actually to consult a doctor, there is a limitation that patients completed the required tasks based on their personal experience instead of the scenario description, especially for patients who had the VC experience before. Future research could conduct some pilot studies or experiments which allow patients actually consult doctors instead of just snapshots and text description.

A third limitation is on the participants of the main-test. The demographic results showed that the majority (83%) of participants were females, which may cause a bias for data analysis. Considering all the participants (the number is 741) included, this percentage is 56% which is still higher than the value for men. This could be because women care more about healthcare and are willing to spend more time on it. This is a limitation for this study but could be an interesting topic for future study to explore the reason for more women willing to participate in healthcare surveys than men. Another problem is that all the participants for the main-test are from the United States of America who may already have a norm of VC and could not fully immerse into the experiment. It remains uncertain whether the analysis results would be the same if the demographic structure is different.

A fourth limitation is on the data quality of the main-test. Although strict criteria was applied to filter the data pool to get high-quality data, there is no way to guarantee the data quality is good enough to reflect the true perceptions of patients. These limitations could weaken the generalizability of the results and require further studies to reassure the findings in this thesis.

6.3 Future Research

This thesis provides a basis for a significant future research program that builds on the theoretical arguments and empirical findings presented here. Key directions for future research are provided below.

6.3.1 Impact of Other Factors on Uncertainty in and Beyond Patient-Doctor CMC

This thesis provides a theoretical argument and empirical evidence for the impact of media naturalness and mental model alignment on reducing patients' uncertainty in patient-doctor CMC. One avenue for future research is extending the theoretical understanding of the relationship between media selection and content, and uncertainty by investigating other media dimensions and characteristics.

In addition, this thesis focuses on reducing uncertainty in patient-doctor CMC. One direction for future research is seeking strategies and design features to reduce uncertainty in other VC phases. For example, patients select doctors and make appointments before they communicate with selected doctors. Future research could be on how to present information to reduce patients' uncertainty while selecting doctors, how to ask questions when patients make appointments online, and such.

6.3.2 Impact of Uncertainty on Other Health Care Quality Dimensions

This thesis demonstrates the important role of uncertainty on improving patient satisfaction in VC. An important question that remains open is the impact of uncertainty on other patients' perceptions and decision-makings, and healthcare quality. For example, future research can examine healthcare quality dimensions that can be influenced by patients' uncertainty.

6.3.3 From Virtual Consultation to Other Domains

Another area for future research is applying the proposed perspective on VC to other media-involved domains. Although this work was framed in terms of VC, it can also be applied to other areas when users complete certain tasks with information systems. For example, if the design of an electrical commerce website aligns with consumers' mental model of purchasing products, consumers tend to have fewer uncertainties and are expected to be more satisfied with the transaction. Also, if the design of the website is not natural, consumers could struggle to find the information they need while being overwhelmed by tons of useless information. In this condition, they have fewer uncertainties and tend to think of the experience negatively.

6.4 Thesis Conclusions

As providers invite various formats of VC into the world of healthcare, they face the challenges of persuading patients to use their systems to do VC without uncertainties. Virtual consultation, like video conferencing with doctors, creates opportunities for patients to access healthcare in a convenient way. Despite the potential for online consultation, the prevailing issues and uncertainties patients have on these consultations may limit the usage and development of healthcare systems.

The online environment in which patients communicate with doctors is different from the traditional face-to-face consultation because of computer mediation. First, the selection of media may bring barriers to communication as well as advantages, compared with a face-to-face consultation. One of the important standards to select suitable media for communication is media naturalness. Media with different naturalness level may enable patients to deliver information through different modalities. Second, the content design of media may not be in patients' comfort zone, which give rise to their uncertainties on online communication with doctors. This is different from patients communicating in person with doctors whom they are familiar and comfortable with.

It is important for healthcare providers to understand patients' uncertainties during patient-doctor CMC and to create a patient-centered environment for VC.

This research focuses its attention on patient-centered uncertainty. By evaluating existing patients' uncertainties toward VC, this thesis draws attention to a number of critical questions and provides insights on how to reduce patients' uncertainty in patient-doctor CMC and to improve patients' satisfaction on VC.

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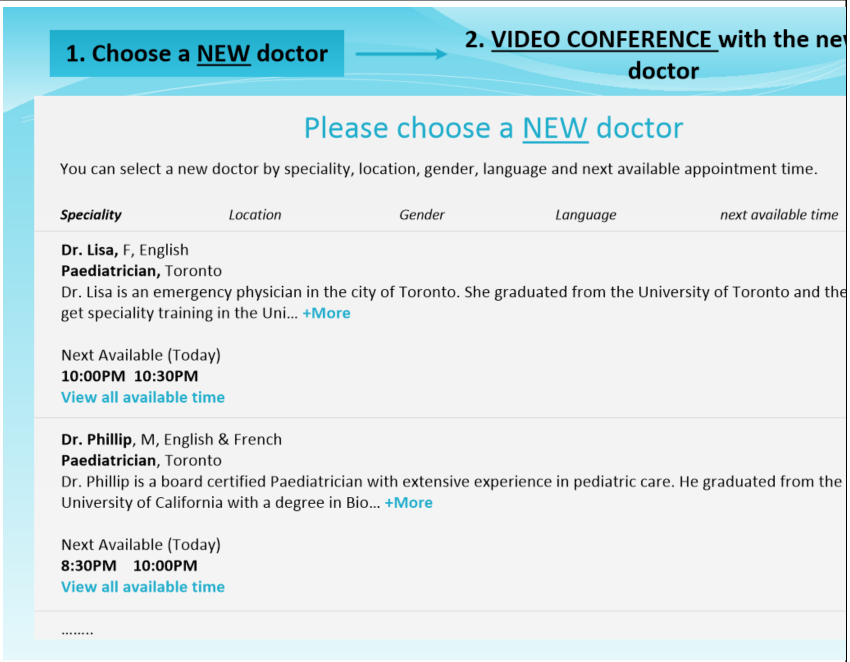
Appendix 1: Scenario Description (Text and Snapshots) for Four groups in Field Experiment

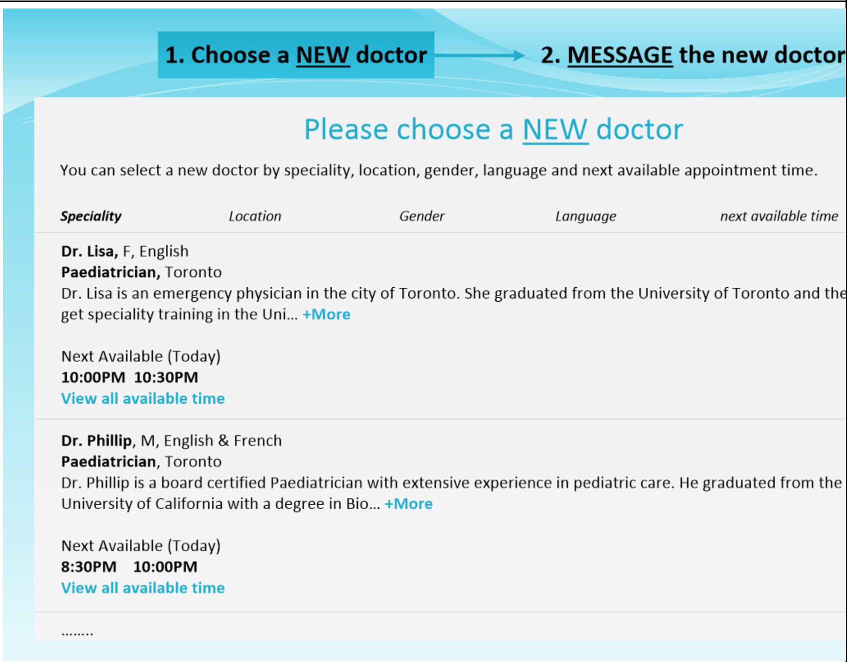
Group one: New doctor + Video conferencing
Please complete this survey based on the following scenario: VirtualDoctor.ca is a website that allows you to visit a **new doctor** online rather than in person regarding many common health conditions. You don't know this new doctor except the information provided by the website. All the doctors registered on the website are certified and as qualified as your own family doctor. You will start by searching for a new doctor by specialty, next available appointment time, location, gender, or language on VirtualDoctor.ca and make an appointment. During this scheduled appointment, you will **video conference** with this new doctor at VirtualDoctor.ca. You will describe your symptoms to the new doctor on video as if you were in his/her

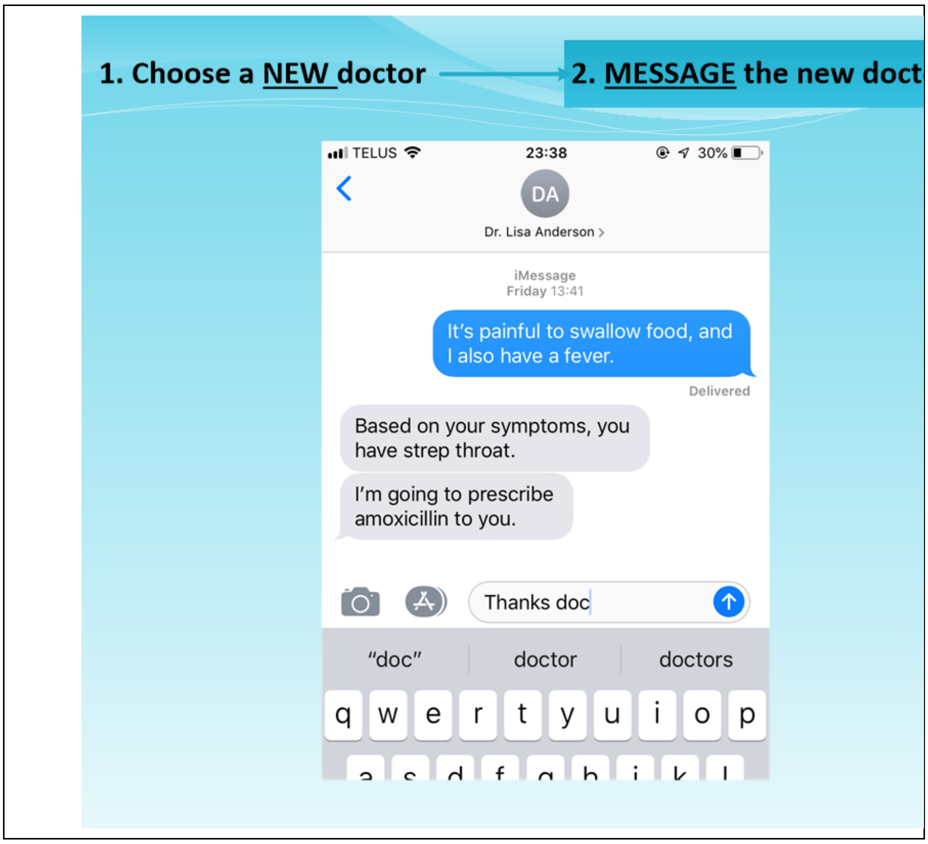
office, get diagnosis and prescriptions as necessary from him/her. The following pictures illustrate how VirtualDoctor.ca works.



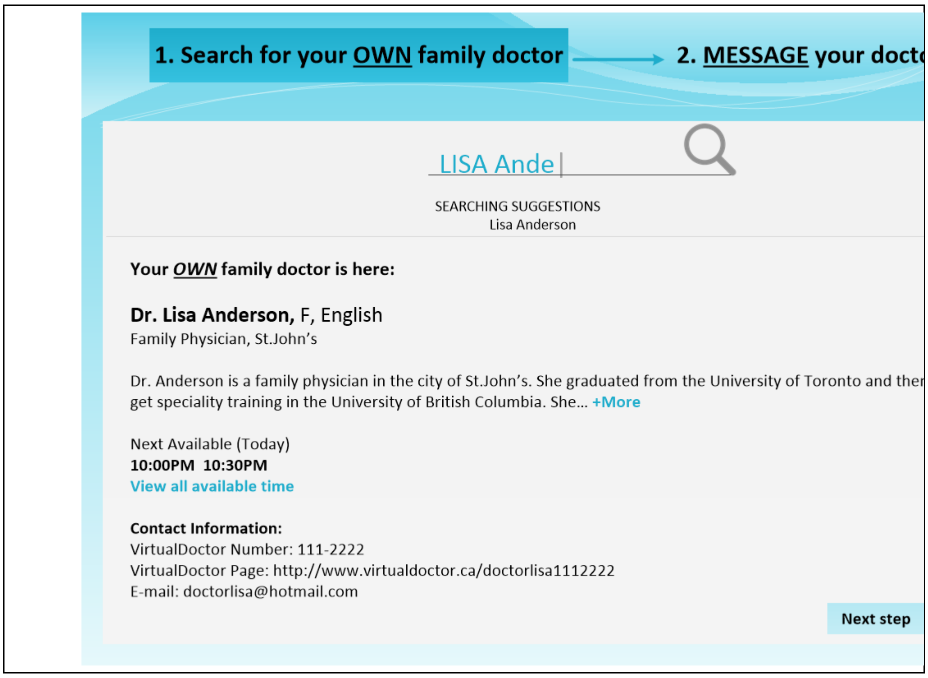
Group two: New doctor + Instant messaging
Please complete this survey based on the following scenario: VirtualDoctor.ca is a website that allows you to visit a **new doctor** online rather than in person regarding many common health conditions. You don't know this new doctor except the information provided by the website. All the doctors registered on the website are certified and as qualified as your own family doctor. You will

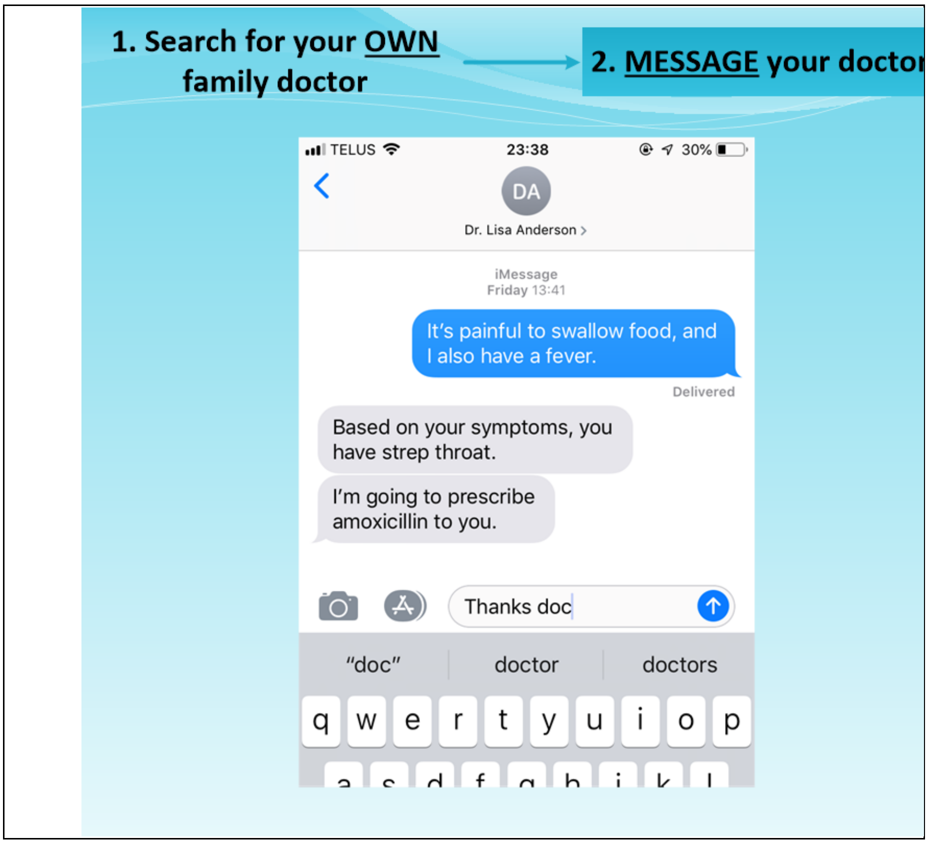
start by searching for a new doctor by specialty, next available appointment time, location, gender, or language on VirtualDoctor.ca and make an appointment. During this scheduled appointment, you will **<u>instant message</u>** with this new doctor at VirtualDoctor.ca. You will describe your symptoms to the new doctor with messages, get diagnosis and prescriptions as necessary from him/her. The following pictures illustrate how VirtualDoctor.ca works.



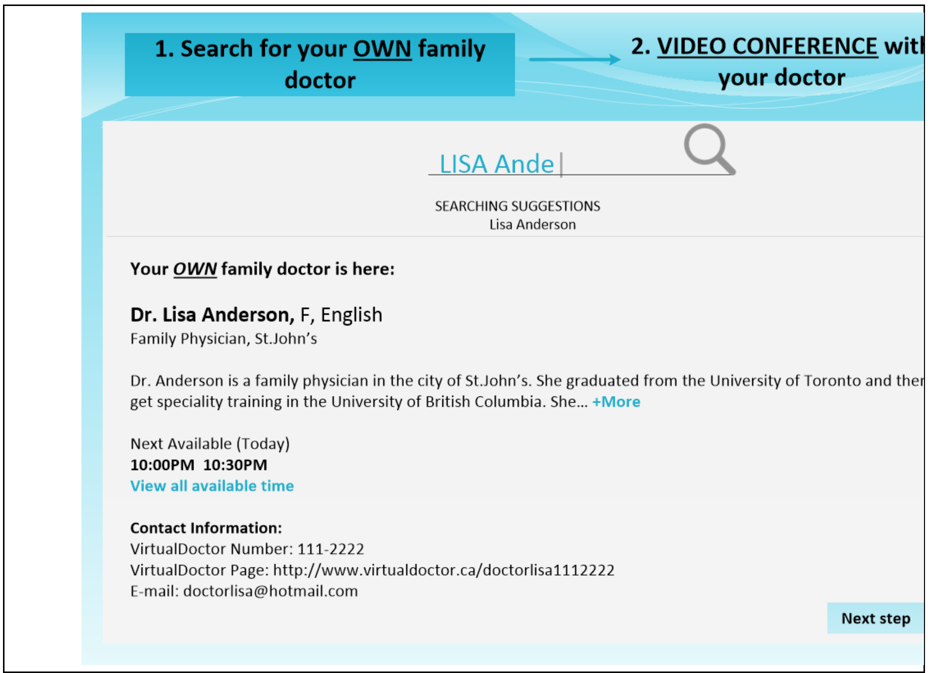

1. Choose a NEW doctor
2. MESSAGE the new doct
TELUS
23:38
30%
DA
Dr. Lisa Anderson
iMessage
Friday 13:41
It's painful to swallow food, and I also have a fever.
Delivered
Based on your symptoms, you have strep throat.
I'm going to prescribe amoxicillin to you.
Thanks doc
"doc"
doctor
doctors

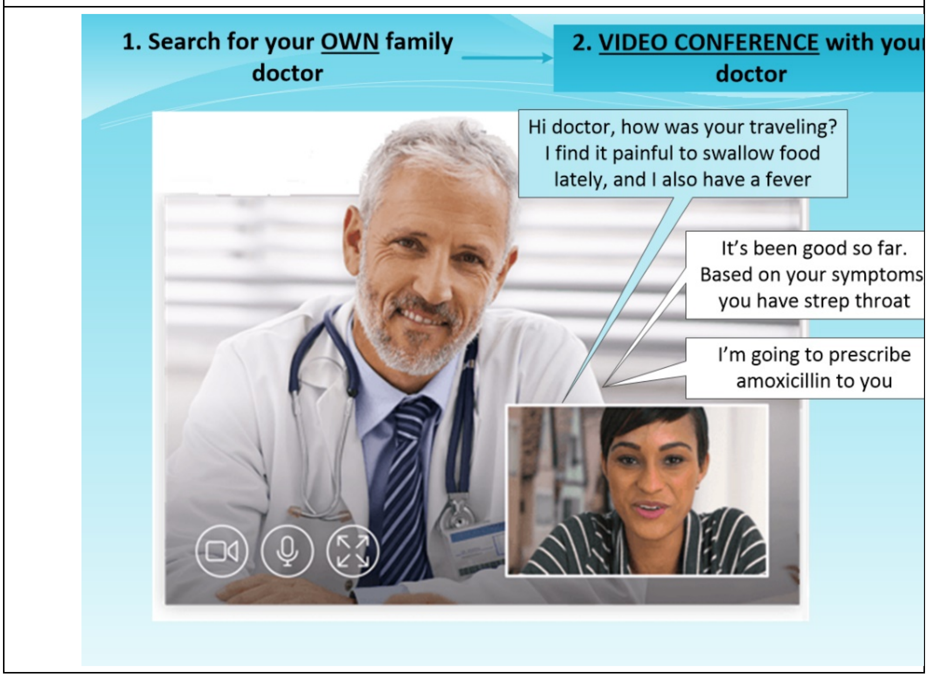
Group three: Family doctor + Instant messaging
Please complete this survey based on the following scenario: VirtualDoctor.ca is a website that allows you to visit your **own family doctor** online rather than in person, regarding many common conditions. You will start by searching for your family doctor by name, registration ID, or other information you know on VirtualDoctor.ca and make an appointment. During this scheduled appointment, you will **instant message** with your doctor at VirtualDoctor.ca. You will describe your symptoms to your doctor with messages, get diagnosis and prescriptions as necessary from him/her. The following pictures illustrate how VirtualDoctor.ca works.


1. Search for your OWN family doctor
2. MESSAGE your docto
LISA Ande
SEARCHING SUGGESTIONS
Lisa Anderson
Your OWN family doctor is here:
Dr. Lisa Anderson, F, English
Family Physician, St.John's
Dr. Anderson is a family physician in the city of St.John's. She graduated from the University of Toronto and then get speciality training in the University of British Columbia. She... +More
Next Available (Today)
10:00PM 10:30PM
View all available time
Contact Information:
VirtualDoctor Number: 111-2222
VirtualDoctor Page: http://www.virtualdoctor.ca/doctorlisa1112222
E-mail: doctorlisa@hotmail.com
Next step


1. Search for your OWN family doctor
2. MESSAGE your doctor
TELUS
23:38
30%
DA
Dr. Lisa Anderson
iMessage
Friday 13:41
It's painful to swallow food, and I also have a fever.
Delivered
Based on your symptoms, you have strep throat.
I'm going to prescribe amoxicillin to you.
Thanks doc
"doc"
doctor
doctors

Group four: Family doctor + Video conferencing
Please complete this survey based on the following scenario: VirtualDoctor.ca is a website that allows you to visit your **own family doctor** online rather than in person. You will start by searching for your family doctor by name, registration ID, or other information you know on VirtualDoctor.ca and make an appointment. During this scheduled appointment, you will **video conference** with your doctor at VirtualDoctor.ca. You will describe your symptoms to your doctor on video as if you were in his/her office, get diagnosis and prescriptions as necessary from him/her. The following pictures illustrate how VirtualDoctor.ca works.


1. Search for your OWN family doctor
2. VIDEO CONFERENCE with your doctor
LISA Ande
SEARCHING SUGGESTIONS
Lisa Anderson
Your OWN family doctor is here:
Dr. Lisa Anderson, F, English
Family Physician, St.John's
Dr. Anderson is a family physician in the city of St.John's. She graduated from the University of Toronto and then get speciality training in the University of British Columbia. She... +More
Next Available (Today)
10:00PM 10:30PM
View all available time
Contact Information:
VirtualDoctor Number: 111-2222
VirtualDoctor Page: http://www.virtualdoctor.ca/doctorlisa1112222
E-mail: doctorlisa@hotmail.com
Next step


1. Search for your OWN family doctor
2. VIDEO CONFERENCE with your doctor
Hi doctor, how was your traveling? I find it painful to swallow food lately, and I also have a fever
It's been good so far. Based on your symptoms you have strep throat
I'm going to prescribe amoxicillin to you

Appendix 2: Modification on Measurement Statements based on Pre-test Two

Statement	Before	After
UC 1	I'm certain about how VirtualDoctor.ca would work during my consultation	I'm certain about how to do video consultation at VirtualDoctor.ca
UC 3	I'm certain what symptoms would be important to tell the new doctor during my consultation using VirtualDoctor.ca	I'm certain what symptoms would be important to tell the new doctor during my video consultation
UC 4	I'm certain about the new doctor's attitudes during my consultation	I'm certain about the new doctor's attitudes during my video consultation

SF 1	I would be satisfied with my consultation experience using VirtualDoctor.ca	I would be **satisfied** on my video consultation experience with the new doctor
SF 4	I am satisfied that the new doctor would be thorough and explain everything clearly using VirtualDoctor.ca	I am satisfied that the new doctor would be **thorough and explain everything clearly** during the video consultation
SF5	I am satisfied that the new doctor would respect my feelings during my consultation using VirtualDoctor.ca	I am satisfied that the new doctor would **respect my feeling** during my video consultation

Appendix 3. Manipulation Check on Naturalness in Pre-test Three

Table. Manipulation Check (Practical Level) on Naturalness for Pre-Test Three

Naturalness_mean

Naturalness (1: video; 2: msg)	Mean	N	Std. Deviation	Std. Error Mean
1	6.14	20	.87	.19
2	2.78	21	1.33	.29

T-test

Naturalness_mean

	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
				Lower	Upper
Equal variances assumed	.000	3.37	.35	2.65	4.08

Appendix 4. Manipulation Check on MMA in Pre-test Three

Table. Manipulation Check (Practical Level) on Mental Model Alignment (MMA) for Pre-Test Three				
MMA_mean				
MMA (1: new; 2: family)	Mean	N	Std. Deviation	Std. Error Mean
1	3.04	24	1.36	.28
2	5.64	17	1.22	.30

T-test					
MMA_mean					
	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
				Lower	Upper
Equal variances assumed	.000	-2.59	.414	-3.43	-1.76