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The Compensatory Interaction Between User Capabilities and Technology Capabilities in Influencing Task Performance: An Empirical Assessment in Telemedicine Consultations[1]

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Although technology-enabled task performance has been a long-standing outcome of interest in information systems research, existing studies primarily emphasize characteristics of the technology and task, rather than the user, in shaping performance outcomes. Given that both technology and people have inherent limitations, a worthwhile research pursuit is to examine how one might compensate for the limitations of the other in order to achieve successful task performance. We propose a new conceptualization of user abilities, task-specific user capabilities, and examine their compensatory effects with technology capabilities in shaping performance outcomes within the context of e-consultations (i.e., technology-mediated expert consultations). Specifically, we theorize the user capabilities of presentation (information giving) and elicitation (information seeking) as the task-specific user capabilities in this context. Leveraging the theory of compensatory adaptation, we propose that these user capabilities can overcome the limitations of technology and result in successful task performance outcomes. We employ mixed methods (qualitative field study, survey field study, and a lab experiment) to develop and test our model within the context of telemedicine consultations, a form of e-consultation. Convergent findings across the studies suggest that both user capabilities and technology capabilities are important facilitators of task performance and that these capabilities compensate for each other.

Keywords: Task–technology fit, system use outcomes, task performance, user capabilities, technology capabilities, telemedicine, telehealth, health information technology

Introduction

Task performance is one of the main downstream impacts of individual level information systems (IS) use and has been a long-standing phenomenon of interest in IS research (DeLone and McLean 1992, 2003; Goodhue and Thompson 1995). Seminal works within this research stream have discussed the importance of task, technology, and user characteristics in influencing task performance outcomes. For example, Burton-Jones and Grange (2012) elaborate on the concept of effective system use, which is comprised of "three elements… the competencies and motivations of users, the nature and purpose of systems, and the characteristics of tasks" (p. 634).

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The appendices for this paper are located in the "Online Supplements" section of the *MIS Quarterly*'s website (http://www.misq.org).

Task–technology fit theory also discusses the importance of fit between individuals, tasks, and technologies in predicting IS-enabled task performance[2] (Goodhue and Thompson 1995). Although referred to as task–technology fit (TTF) for simplicity, Goodhue and Thompson (1995) proposed that "a more accurate label for the construct would be task–individual–technology fit" (p. 218), given the vital role that users play in influencing task performance.

However, existing empirical IS research primarily has emphasized and theorized the roles of *technology* and *task* in influencing task performance (e.g., Jiang and Benbasat 2007a; Kahai and Cooper 2003; Kositanurit et al. 2006; Muhren et al. 2009; Overby and Konsynski 2010). The role of the *user* in shaping successful *task performance* has not been theorized richly or explored in depth (Marcolin et al. 2000; Wang and Haggerty 2011). Extant empirical studies in this domain have focused mainly on two types of user characteristics: (1) individual differences that are both *technology-neutral* and *task-neutral* and (2) *technology-specific* user characteristics. Individual differences that have been studied include gender (Hess et al. 2005), cognitive style (Liu et al. 2011; McLeod et al. 2008), and professional experience (Fisher et al. 2003; Ko and Dennis 2011; Mennecke et al. 2000; Parkes 2013). Technology-specific user characteristics examined in this domain include variations of user competence (i.e., technology expertise) (Benlian 2015; Goodhue 1995; Marcolin et al. 2000; Munro et al. 1997; Wang and Haggerty 2011; Yoon 2009), computer playfulness (Hess et al. 2005), and IS experience (Benlian 2015).

Although individual differences and technology-specific user characteristics are indeed important facilitators of task performance, they fail to account for *task-specific* user capabilities, which are also key drivers of task performance. Task-specific capabilities are individual abilities that pertain to the focal task(s) that the user aims to accomplish when using an IS, and these abilities can exist and be developed *independently* of IS use. For example, written communication skills are task-specific capabilities when composing e-mails, and artistic abilities are task-specific capabilities when using graphics design software. These individual abilities are malleable and can be developed specifically to facilitate desired task performance and, thus, should be conceptualized as part of the holistic nomological network of effective system use.

The importance of studying task-specific user capabilities to IS research lies in untangling how these user capabilities may substitute or complement technology characteristics to influence task performance outcomes. As it is, we live in a world of imperfect technology and imperfect people—for example, technology is presently limited in its abilities to replicate various senses (Overby 2008), and humans possess limitations with their working memory and information processing abilities (Cowan 2010; Miller 1956). Given that both technology and people have inherent limitations, a worthwhile research pursuit is to discover how technology and users might compensate for the limitations of the other in order to achieve successful system use outcomes.

Accordingly, this study's main purpose is to address these gaps and questions by exploring task-specific user capabilities and their role *vis-à-vis* technology capabilities[3] in shaping task performance. We assess our research questions within the context of technology-mediated expert consultations (referred to as e-consultations hereafter).

RQ1: What are the task-specific user capabilities that influence task performance in e-consultations?

RQ2: How do task-specific user capabilities interact with technology capabilities in determining task performance in e-consultations?

The context of e-consultations is particularly relevant to study, given the rise in distributed work in the workforce today and because of heightened shortages of expertise across various professions (Finkle and Randewich 2012; Ingersoll and Perda 2010; Kirch et al. 2012; Voelker 2009), which will prompt greater demand for technology-mediated expert consultations.

Our study's empirical context involves telemedicine consultations in the healthcare domain. Telemedicine consultations allow the delivery of healthcare services at a distance and have been touted as a potential solution to the "triple aim" challenges (reducing costs, improving health quality and outcomes, and increasing healthcare access) currently afflicting the United States healthcare system (Berwick et al. 2008; Van Demark 2012).

While our theoretical development is situated within the telemedicine context, we argue that the specific factors we identify generalize to other types of e-consultations and to user–task–technology contexts more broadly. Throughout our theoretical development, we integrate concepts from various

[2]The focus of this paper is on IS-enabled task performance as a system use outcome. For ease of exposition, we subsequently use the abbreviated term *task performance* to denote this concept.

[3]Various terms appear in the literature to portray attributes of users and technology, such as *characteristics*, *abilities*, and *capabilities*. There are also terms specific to technology, such as *functionality* and *features*. For both users and technology, we chose the term *capability* to capture the dynamic actions that each is able to accomplish, rather than focus on static traits.

domains of e-consultations (e.g., systems development, technology help desks) to illustrate the generalizability of our research model. In fact, the particular type of expert consultation we reference in telemedicine, the doctor–patient consultation, has been used as a metaphor for expert consultations in the management discipline for many decades. Most notably, Edgar Schein describes a generic organizational consultation model as the "doctor–patient model" in which organizational members (the patients) seek the help of consultants (the doctors) to diagnose their organization's problems and recommend solutions (Schein 1969, 1999). Along these lines, in the field of information systems, the concept of "problem diagnosis" is commonly referenced with respect to system development projects (e.g., Ginzberg 1981) and technical support (i.e., help desk) consultations (e.g., Muller 1996). Hence, given the well-established precedence of generalizing concepts from medical consultations to other types of expert consultations, the telemedicine context is an apt domain to leverage in order to develop and test theory related to e-consultations.

Although we make a theoretical contribution by identifying the specific user capabilities that are important in an e-consultation context, our study's primary theoretical contributions are in (1) developing the concept of task-specific user capabilities as an important component of the nomological network leading to task performance and (2) explicating the nature of the interactions between task-specific user capabilities (hereafter referred to as *user capabilities*) and technology capabilities in influencing task performance.

Theoretical Development

To build the conceptual framework for our study (Figure 1), we draw upon task–individual–technology fit theory (Goodhue and Thompson 1995). Given the numerous studies that have probed the task–technology aspect of the theory, we focus our theoretical development on the individual–technology subset of the TTF framework. The task performance[4] concept in our context is called *perceived e-consultation diagnosticity,* defined as the perceived ability of the e-consultation to enable expert consultants to understand and evaluate the problem faced by the remote client (i.e., perform the problem solving, or diagnostic, task). Successful e-consultations hinge on the core participants' levels of perceived e-consultation diagnosticity.

Qualitative Inquiry

Because limited research exists concerning user capabilities for e-consultations, we also grounded our theorizing in a qualitative field study in which we interviewed 39 telemedicine stakeholders regarding factors that influence the successful diagnostic performance outcomes of telemedicine consultations. Specifically, the qualitative field study informed the user capabilities and technology capabilities important in this context as well as how the two interact to affect performance (see Appendix A for additional details concerning the qualitative study). This sequential mixed methods approach allowed us to gain a rich understanding of the factors that shape e-consultation diagnosticity through qualitative exploration and to subsequently test the emergent research model using multiple quantitative methods (Creswell and Plano Clark 2010; Teddlie and Tashakkori 2008). We integrate findings from the qualitative study throughout the theoretical development of the constructs and hypotheses of our research model.

Expert Consultation Process

Because the focus of the study is on identifying user and technology capabilities relevant to expert consultations, it is important to first understand the expert consultation process. Based on a comprehensive review of the literature related to expert consultations across various domains, such as systems development consultations (e.g., Browne and Rogich 2001; Hickey and Davis 2004), help desk consultations (e.g., Dray 2000), medical consultations (Bickley and Szilagyi 2009; Byrne and Long 1976; Fortin et al. 2012; Silverman et al. 2005), and library reference interviews (e.g., Dervin and Dewdney 1986), we developed a generic process model of the expert consultation process (Figure 2) that generalizes across many different professions.

An expert consultation session begins with establishing the reason for the consultation. Once the problem is stated, the information gathering phase begins, in which there is an exchange of important information between the client and consultant. The consultant analyzes the information exchanged and diagnoses the problem. The consultant then explains solutions to the problem and recommends courses of action. The session closes with a summary of the key points and discussion of possible follow up. In this study, because

[4]Task performance is the extent to which the individual is able to effectively and/or efficiently execute task(s) that involve use of the specific system (Goodhue and Thompson 1995) and involves an assessment of the degree to which the task output meets the task goals (Burton-Jones and Straub 2006). For example, in an e-consultation, task performance reflects the extent to which system use enables the expert to effectively diagnose the client's problem. In technology-mediated communications, task performance may be communication effectiveness or convergence in understanding between the sender and receiver.

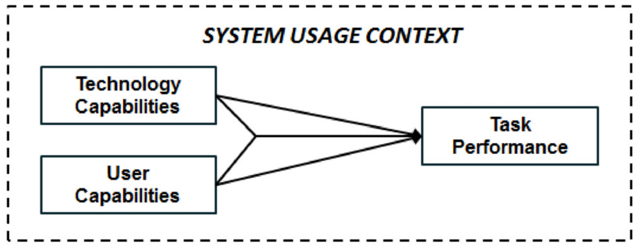

Figure 1. Conceptual Model

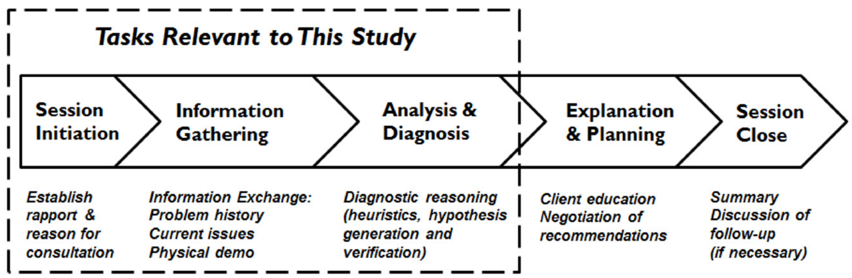

Figure 2. Expert Consultation Process

the focal task performance outcome is e-consultation diagnosticity, the first three phases are most relevant in informing our theoretical development, with the analysis and diagnosis phase corresponding with evaluation tasks relevant to e-consultation diagnosticity, and the session initiation and information gathering phases representing antecedent tasks to diagnostic problem solving. Although the last two phases of the expert consultation are also important, these steps occur *after* the problem has been diagnosed and represent downstream effects of e-consultation diagnosticity. For the sake of scope, we bound our theorizing to e-consultation diagnosticity and its antecedents.

Task Performance: Perceived E-Consultation Diagnosticity

Perceived trial diagnosticity originates in marketing and describes consumer cognitions of a product trial process in evaluating a product or service; it refers to consumers' perceived helpfulness of a product trial experience in enabling consumers to evaluate product attributes (Kempf and Smith 1998). The IS e-commerce literature has adapted this construct to explain phenomena concerning consumers' evaluations of online products. In these studies, perceived diagnosticity refers to the ability of a website to facilitate consumer evaluations of products (e.g., Jiang and Benbasat 2005; Pavlou and Fygenson 2006). We adapt this conceptualization to develop the construct of *perceived e-consultation diagnosticity*, which we define as the perceived ability of the e-consultation to enable consulting experts to understand and evaluate the problem facing a remote client. In telemedicine, the e-consultation refers to the telemedicine consultation session; the consulting expert is the consulting clinician (typically, a physician); and the remote client is a remote patient. In other words, perceived e-consultation diagnosticity in a telemedicine context is the perceived ability of the telemedicine consultation to enable clinical evaluations of patient problems remotely.

Having provided an overview of the e-consultation process, we next describe in turn the technology capabilities and user capabilities and their interactions that influence the performance of diagnostic evaluations. The research model for the study is shown in Figure 3.

Technology Capabilities: Representation

Studies of perceived diagnosticity in e-commerce and of diagnostic confidence[5] in telemedicine point to technology

[5]Diagnostic confidence is a clinician's general subjective assessment of his/her confidence in his/her diagnosis of a patient's condition (Ng and Palmer 2007).

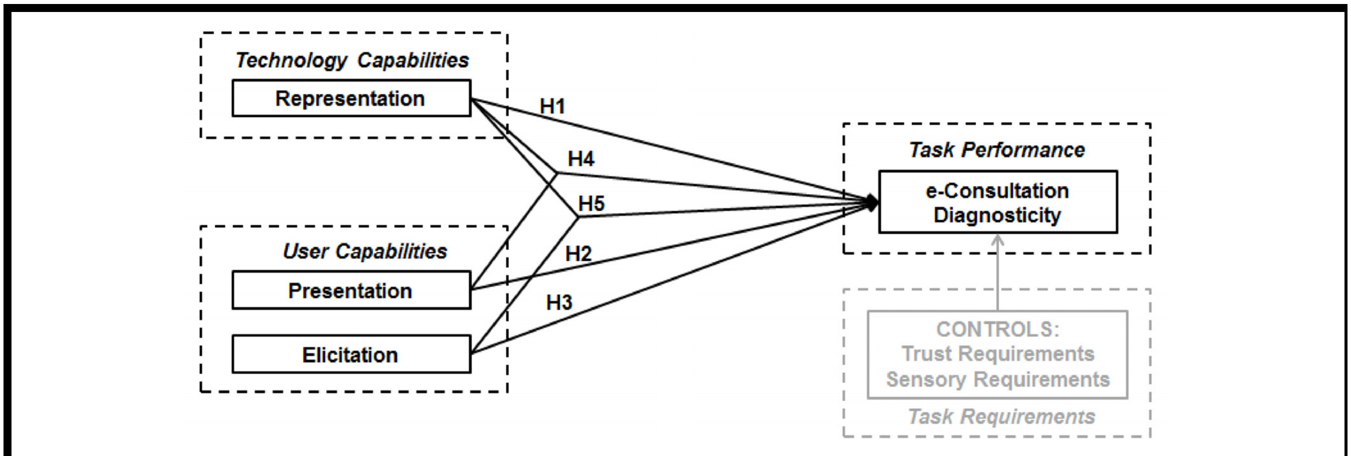

Figure 3. Research Model

factors that enhance perceptions of diagnosticity. The primary technological determinants in these studies reflect the representational richness of the technology—that is, the extent to which the technology can represent or simulate the face-to-face evaluation experience (Edison et al. 2008; Jiang and Benbasat 2007a, 2007b). We refer to this technology capability as *representation*, a theoretical construct included in process virtualization theory (Overby 2008), and define it as the perceived capacity of the e-consultation technology to present information relevant to the problem evaluation process, including simulations of actors and objects within the physical setting, their properties and characteristics, and how process participants interact with them. This concept is similar to representational fidelity, which is the extent to which users obtain representations from the technology that faithfully reflect the domain being represented (Burton-Jones and Grange 2012). In e-commerce studies, this construct has been conceptualized as the website's capability to represent physical interactions with products and vivid sensory information about products to aid consumers in evaluating them (Jiang and Benbasat 2005, 2007a, 2007b). In telemedicine studies concerning diagnostic confidence, very similar concepts have been explored, although in the forms of image and video quality (e.g., High et al. 2000) and media richness (e.g., Edison et al. 2008) (typically comparing face-to-face versus telemedicine consultations). Thus, in an e-consultation context, the extent to which the e-consultation technology can simulate relevant physical evaluation experiences and transmit relevant information to the expert consultant will influence perceptions of e-consultation diagnosticity. Specifically, we suggest that the relevant representation capabilities in this context are the ability of the technology to transmit (1) the communication cues needed to facilitate effective information sharing and (2) the sensory information needed to perform relevant physical evaluations.

We offer several reasons in support. The main activities that inform the problem-solving process in expert consultations are the information exchange between the consultant and client and, in many cases, the consultant's physical observations of the proposed problem (Hickey and Davis 2004; McNeilis 2002). In terms of information exchange, two aspects of communication that are relevant include (1) the trust and relationship building between the client and consultant and (2) the particular communication tasks in which the client and consultant must engage to facilitate problem-solving processes (Chakraborty et al. 2010; Hughes and DeForest 1993; Ko 2014; Ko et al. 2005). For relationship building, interpersonal relationships that facilitate open and honest information sharing are more easily established through face-to-face interaction, a medium that most effectively enables synchronous verbal and nonverbal communication between communication participants (Daft and Lengel 1986; Short et al. 1976). Telemedicine studies have found that establishing telepresence and "virtual eye contact" in telemedicine encounters are important enablers of trust (LeRouge, Garfield, and Hevner 2005; LeRouge, Hevner, and Collins 2007). Thus, the information exchange between the consultant and client is facilitated by richer communications media that enable natural communication and the development of trust and rapport (Kock 2004, 2005). This is particularly relevant within a telemedicine context, given that the medical history of the patient (client) contributes the most relevant diagnostic information to clinicians (consultants) in medical consultations (Kroenke 2014). Moreover, in expert consultations, one of the primary objectives of the information exchange between the client and consultant is for the consultant to accurately understand the problem facing the client (Monsen and Frederickson 2002). This may require convergence communication processes, which are facilitated by "rapid, back and forth information transmission" (i.e., synchronous) communication media (Dennis et al. 2008, p. 580). Hence, the more that consultants and clients perceive that the technology enables effective information exchange, the more confidence they will have in using e-consultations for diagnostic evaluations (Demiris et al. 2005). These sentiments were echoed by telemedicine clinicians we interviewed,[6] as illustrated in the following quote:

> ***Primary Care Physician**: It's hard to build a relationship through telemedicine like that because you're not face-to-face. I mean, you are face-to-face but not physically face-to-face. This is important in getting them to open up…and discuss the issues that they have.*

In addition to the information exchange between the consultant and client, consultants often gather important information through physical observations. In medical consultations, for example, clinicians often must perform a physical examination of the patient to evaluate specific signs related to the patient's problem. In this context, seeing, hearing, and touching are usually the most salient sensory requirements, with their relative importance being determined by the nature of a patient's health problem. However, representation of sensory information via even the richest electronic communication medium is currently limited to visual and auditory information because the senses of smelling, touching, and tasting are difficult to replicate electronically (Overby 2008). This technological limitation may impact consultants' ability to evaluate clients' problems via e-consultations (Miller 2003). The more that e-consultation technology is able to transmit the sensory information needed for physical problem evaluations, the higher the perception of e-consultation diagnosticity. The following quote from our interviews illustrates this point:

> ***Primary Care Physician**: If I could listen to [auscultate] that patient on telemedicine....Well, if I could look at him on telemedicine and listen, I can tell you if it's A-Fib [atrial fibrillation] or PAC's [premature atrial contractions]...I can't tell that over the phone.*

Therefore, when the e-consultation technology can transmit (1) the communication cues needed to facilitate effective information sharing and (2) the sensory information needed to perform relevant physical evaluations, there will be higher perceptions of e-consultation diagnosticity. Thus, we posit

> *H1: Representation is positively related to e-consultation diagnosticity.*

[6]All interview quotes stem from interviews we conducted with clinicians as part of the qualitative field exploration that preceded the quantitative study presented later in the paper. Details of the qualitative study can be found in Appendix A.

User Capabilities: Presentation and Elicitation

While technology capabilities are important in determining e-consultation diagnosticity, the capabilities of the users involved in the e-consultation are also important. In expert consultations, there is a client who has a problem to be solved and an expert consultant who is tasked with solving the client's problem. Hence, the communication competence of consultation participants is important to achieving a successful consultation outcome (Chakraborty et al. 2010; Ko et al. 2005; LeRouge, Hevner, and Collins 2007). In communications research, communication competence is viewed as a dyadic concept in which both communication partners' level of communication competence influences the fulfillment of communication goals (McNeilis 2002; Wiemann 1977). In e-consultations, this dyadic perspective takes into account the communication competence of both clients and consultants. Regardless of the e-consultation technology's representation capabilities, the communication skills of clients and consultants in e-consultations will heavily influence the problem evaluation process.

In medical consultations, the communication competence of the participants is paramount in determining successful diagnostic evaluations (Beck et al. 2002; Cegala, Coleman, and Turner 1998; Cegala, McGee, and McNeilis 1996; Stewart 1995). In the words of one of our respondents, a neurologist experienced in telemedicine consultations, "*The technology was fine. Telemedicine use breaks down when communication barriers exist*." Thus, an important success factor in e-consultations is the communication competence of both the client and consultant, with particular skills unique to each role. Specifically, the quality of the information exchange between the client and consultant is influenced by the *information giving* skills of the client and the *information seeking* skills of the consultant (McNeilis 2002; Ong et al. 1995). In other words, clients must impart relevant information regarding their problem, and consultants must actively solicit information needed to evaluate the problem (Chakraborty et al. 2010; Moody et al. 1998; Ong et al. 1995). We call these core communication skills *presentation* and *elicitation* and describe them next.

Presentation

The main task of the client in an e-consultation session is that of *information giving*—that is, to present all information relevant to the client's problem to the expert consultant. To capture this element of communication competence, we develop a new construct called *presentation* and define it as the clients' capacity to relay information relevant to their problem domain, based on their ability to articulate pertinent information and execute actions that inform the problem-solving process. This communication skill is essentially a "show and tell" technique for presenting information. In the medical consultation literature, this communication task is referred to as the problem presentation (Ijäs-Kallio et al. 2011; Robinson and Heritage 2005) or the case presentation (Anspach 1988; Dell et al. 2012; Gold 1988) and mainly entails the communication of the patient's chief complaint, current symptoms, and medical history.

Communication skills related to the problem presentation, in any expert consultation setting, are key determinants of efficacious diagnostic problem solving (Bernstein and Bernstein 1980; Cegala, McClure, et al. 2000). As such, although our conceptualization of this construct and its relationship to e-consultation diagnosticity stem from the health communications literature and our interviews with telemedicine clinicians, the construct generalizes to other e-consultation contexts. Characteristics of an effective presentation, in general, include a thorough description of the problem, dissemination of the relevant information (e.g., filtering out unnecessary information), the ability to stay focused and on topic, and the ability to respond to questions appropriately (Cegala, McGee, and McNeilis 1996; Davenport et al. 2008; Dell et al. 2012; Gold 1988). Clients need to present to the consultant an accurate and thorough description of their problem, the details leading up to the problem (i.e., the history), current symptoms, and any actions that have been taken to solve the problem. Clients who are able to articulate information regarding their problem clearly and concisely to the consultant will aid the diagnostic process.

Another aspect of clients' problem presentation skills is their ability to physically demonstrate relevant details of the problem to the consultant. For example, in a help desk context, the client may have to navigate to a particular computer screen or error to show to the help desk consultant. In a medical consultation, these physical tasks are usually related to the physical examination of the patient, in which the patient must perform specific functions as part of the exam in order to facilitate the clinician's diagnostic evaluation of the patient's problem.

Hence, both the client's physical (show) and verbal (tell) communication skills are important in presenting information germane to the client's problem. Because the diagnostic evaluation process faced by consultants is often knowledge-intensive and characterized by uncertainty (Griffin et al. 1998), the quality of information presented by the client facilitates the problem solving process by reducing some of this uncertainty. We thus posit that the clients' presentation capability in e-consultations will positively influence e-consultation diagnosticity.

> *H2: Presentation is positively related to e-consultation diagnosticity.*

Elicitation

On the other side of the coin is the consultants' competence in *information seeking*—that is, eliciting and gathering all relevant information related to the client's problem. We call this construct *elicitation* and define it as the consultants' capacity to solicit information relevant to a problem domain, based on their ability to interview and instruct clients in a manner that informs the problem-solving process.

In many consultant professions, interviewing skills represent a core competency of the consultant (Browne and Rogich 2001; Cowgill et al. 2008; Fortin et al. 2012; Hughes et al. 1997; Schein 1969, 1999). For example, in medical professions, clinicians are specially trained in conducting the medical interview, and their ability to perform an effective medical interview is considered one of the key elements of clinical competence (Epstein and Hundert 2002). Similarly, reference librarians are trained to conduct the reference interview during which they elicit library patrons' research questions (Nilsen and Radford 2009). In systems development, systems analysts and consultants must perform requirements elicitation, which heavily involves interviewing clients to gather information that guides the systems analysis and design process (Browne and Rogich 2001). In all of these examples, the elicitation skills of the consultant are deemed critical in ensuring a successful solution to the client's problem.

One of the primary elements of elicitation competence is being highly skilled in question asking techniques, specifically with respect to asking both closed and open questions (Bickley and Szilagyi 2009; Byrd et al. 1992; Davis et al. 2006; Nilsen and Radford 2009). One technique, referred to as neutral questioning, allows the consultant to view and formulate questions from the client's perspective to avoid premature diagnosis (Cowgill et al. 2008; Dervin and Dewdney 1986). Another questioning strategy employs prompting techniques to guide the client's recall of important details related to the problem space (Browne and Rogich 2001). Furthermore, because consultants and clients often do not use the same language with regard to the client's problem (Bostrom 1989), it becomes imperative for consultants to learn how to communicate with clients in a manner in which they are clearly understood by the clients—for example, by avoiding the use of technical jargon when interviewing clients (Bernstein and Bernstein 1980).

In the medical interview, clinicians (consultants) elicit relevant information from patients (clients) through the employment of linguistic devices, such as continuers (e.g., asking "What else?" to prompt the patient to elaborate; Barrier et al. 2003) and open-to-closed cones (Bickley and Szilagyi 2009; Kurtz et al. 2005; Lipkin et al. 1995). The latter refers to using open questions in the exploratory phases of the interview and closed questions in the confirmatory phases of the interview. These interviewing skills are particularly important for history taking and targeting possible diagnoses, as affirmed by one of our interview respondents:

> ***Primary Care Physician**: I think the patient history is pretty important…it helps you narrow down what you're dealing with. I mean when you're asking a patient questions, you start out with this broad [question]….Say they come in with a headache, for instance; that is a very common one. You know, you start out with fairly broad questions and try to narrow it down to, is it a migraine? Is it an aneurysm? Is it a brain tumor? But you gradually get it down to kind of a couple of different choices as opposed to a hundred different choices.*

Another instrumental aspect of gathering information relates to physical observations of the problem space (Bickley and Szilagyi 2009; Byrd et al. 1992; Hickey and Davis 2004). In a medical consultation, a clinician physically observes the patient during the interview and physical examination process to look for signs indicative of the diagnosis. Furthermore, the clinician often makes physical observations through prompting and instructing the patient to perform tasks related to the clinical evaluation, usually as part of the physical examination. Many of the clinicians we interviewed gave examples of having to instruct patients to complete various physical tasks, such as engaging in certain types of breathing, performing specific motor functions, or completing other types of physical assessments as part of the clinical evaluation process. In these situations, the clinician's ability to clearly guide the patient to provide the necessary information helps determine the quality of information that is gathered. We propose that a consultant who is highly skilled in elicitation techniques is able to solicit higher quality information in e-consultations, which facilitates the diagnostic evaluation process.

> *H3: Elicitation is positively related to e-consultation diagnosticity.*

Compensatory Adaptation: User Capabilities Interacting with Technology Capabilities

Although we posit direct effects of user capabilities and technology capabilities on the success of e-consultations, we also propose compensatory effects of these two types of capabilities, in which users and technology compensate for limitations in the other and thereby facilitate the diagnostic process. Drawing on compensatory adaptation theory (Kock 1998, 2001; Kock et al. 2006), we discuss how users can leverage communication skills to compensate for representational weaknesses in the technology in order to influence successful e-consultation outcomes. Compensatory adaptation theory specifically addresses the "e-collaboration paradox" in which use of an imperfect e-collaboration technology can lead to similar or better performance outcomes as those achieved in face-to-face interaction (Kock and D'Arcy 2002).

Communication technology inherently poses limitations on communication tasks (Daft et al. 1987) and increases the cognitive effort involved in the communication process (Ferran and Watts 2008; Kock 2004; Overby 2008). In interactive video telemedicine consultations, patients and clinicians are limited to communicating using audio and video channels only. Hence, they have more limited symbol sets by which they can exchange information; this limitation results in the loss of physical contact and nonverbal cues, which could potentially impede the quality of information exchanged and, thus, the diagnostic evaluation process (Miller 2001, 2003).

According to the theory of compensatory adaptation (Kock 1998, 2001; Kock et al. 2006), despite the fact that communication technology poses obstacles to communication, use of communication media can still lead to positive task performance. The reason for these positive outcomes is that humans have the innate ability to adapt when faced with obstacles to completing a task and overcome these challenges by adjusting their behavior. For example, when people communicate with one another via an audio-only medium (e.g., telephone), rather than indicate agreement through head nodding, they will modify their behavior to replace nonverbal communication with verbal utterances such as "yes" or "I agree" to compensate for the medium's "reduced cue situation" (Short et al. 1976, p. 64).

We extend compensatory adaptation theory by identifying the specific user capabilities that facilitate compensatory behaviors. While Kock proposes that all individuals have the ability to enact compensatory adaptation, we posit that the extent to which individuals are able to compensate (*how well* they compensate) hinges on their task-specific capabilities (i.e., their knowledge and skills with respect to performing the focal task). Next, we discuss how task-specific user capabilities in e-consultations facilitate compensatory adaptation.

Compensatory Effects Between Presentation and Representation

Presentation capability entails knowledge and skills related to communicating the pertinent details of the problem and physically demonstrating needed information, such as showing a series of steps or a visual representation of the problem space to the consultant. Arguably, the understanding and skills required for high quality problem presentations entail a certain level of tacit knowledge, which is more deeply rooted in context (here, the client's problem domain) (Nonaka 1994; Polanyi 1966). Problem solving processes that rely on high levels of such tacit presentation knowledge and skills are more difficult to simulate via technology-mediated communication compared to face-to-face interaction (Overby 2008; Paul 2006), *unless* the client possesses the necessary tacit knowledge to capture and relay the needed information to the consultant. In this regard, the need for rich communication media to convey multiple symbol sets is reduced because the client is able to observe the relevant information independently of the consultant and then effectively communicate this information to the consultant.

We offer a few examples to illustrate this point. Within the context of telemedicine consultations, the client is sometimes a clinician who is seeking expert advice from another clinician (e.g., a primary care physician seeking the expertise of a neurologist). Because clinicians are specially trained in delivering oral patient case presentations, they are uniquely skilled in communicating patient problems effectively (Davenport et al. 2008; Dell et al. 2012; Green et al. 2005). In so doing, these clients are able to compensate for limitations in the e-consultation technology in a manner that facilitates information exchange in an e-consultation. For example, a physician we interviewed discussed how the lack of touch in telemedicine consultations can impede clinical evaluations, particularly when patients report the symptom of abdominal pain, which requires the physician (consultant) to palpate for tenderness and spasms. However, our respondent noted that when the client is another clinician presenting the problem, the client clinician is able to "touch and feel" for the consultant physician and effectively communicate the findings, thus compensating for the lack of tactile feedback in e-consultations. He explained,

> *When you press on it, there [pointing to an area of the abdomen], the muscle is going to spasm. That's called rebound tenderness. That one, unless the other person tells you, "Okay, I feel a rebound here; there's rebound tenderness," you can't tell on telemedicine.*

In this example, the client is able to provide the consultant with the information needed to solve the problem by articulating the relevant information (in this case, physical observations) to the consultant. The example also illustrates that the client needs to possess the tacit knowledge of what rebound tenderness feels like and how to communicate this finding to the consultant using the proper nomenclature.

Similarly, other physicians we interviewed stated that when they consult with a client who is highly skilled in giving effective problem presentations, there is often no need for the video channel in telemedicine consultations. In fact, in these communication situations, they reported that phone (i.e., audio-only) consultations were just as effective and usually more efficient in exchanging the information needed to diagnose the problem. Similar examples can be observed in other e-consultation contexts. For instance, in a help desk consultation, a client who is more "tech-savvy" is able to communicate more useful information concerning the technical problem to the help desk consultant compared to a client who lacks the relevant technical knowledge. In this case, it may not be necessary for the help desk consultant to use e-consultation technology that enables the consultant to remotely access and control the client's desktop; the information articulated by the client may be sufficient to analyze and solve the problem.

Clients adept in presenting information relevant to the problem domain can compensate for the lack of needed technology representation capabilities or make such capabilities less important in determining e-consultation diagnosticity. Conversely, technology representation capabilities become pivotal in diagnosing problems if clients have limited presentation capabilities. Therefore, we hypothesize that the client's presentation capabilities and the e-consultation technology's representation capabilities function in a compensatory manner such that limitations in technological capabilities can be compensated by presentation skills and vice versa.

H4a: *Technology representation will moderate the effect of user presentation capabilities on e-consultation diagnosticity, such that presentation will have a stronger effect on e-consultation diagnosticity when technology representation is low than when technology representation is high.*

H4b: *User presentation capabilities will moderate the effect of technology representation* *on e-consultation diagnosticity, such that representation will have a stronger effect on e-consultation diagnosticity when presentation is low than when presentation is high.*

Although the test for the two hypotheses is mathematically equivalent in that they are both tested using an interaction term containing representation and presentation, we posit both hypotheses to highlight the notion that each capability can compensate for the other. The analysis we present (partial derivatives, response surface plot, and interaction graphs from both perspectives) is consistent with this objective.

Compensatory Effects Between Elicitation and Representation

The consultant's elicitation capability also enables the gathering of relevant information needed to solve the client's problem. In e-consultations, the representational weaknesses of the technology can inhibit the manner in which participants are accustomed to gathering information in traditional face-to-face contexts. However, when the participants are motivated to complete the information gathering task, they will find ways to adapt their communication behavior to obtain the necessary information (Kock 1998, 2001; Kock et al. 2006). Regarding telemedicine, LeRouge and her colleagues (LeRouge, Garfield, and Hevner 2005; LeRouge, Hevner, and Collins 2007) propose a concept called *telemedicine adaptability*, defined as the ability and willingness of telemedicine clinicians to adapt their behavior to maximize effectiveness in the presence of technology constraints. This adaptability skill is exemplified aptly by one of their respondents who explained that telemedicine clinicians (consultants) must learn to "touch differently." In other words, telemedicine clinicians need to "learn new ways of asking questions, educating patients, and working 'through' a remote person (client)…to replace touch with questions, complements, and detailed instructions" (LeRouge, Hevner, and Collins 2007, p. 1296). One of the physicians we interviewed also expressed this same notion:

> ***Psychiatrist**: If I was looking at you for side effects—Parkinson's is a big deal, for example—you know, if I heard your mouth, if I had you get up and walk across the room, turn around quickly and stop, start and stop and then sit down…I can't do all that [with telemedicine] so I have to rely on a more focused interview. I don't think the information is worse; it's just different from what I would do in my office.*

Oftentimes, the patient (client) is unaware of the information that needs to be relayed, so the clinician (consultant) must guide the information elicitation process through interviewing and instructing the patient. This elicitation capability becomes especially important in telemedicine consultations due to the obstacles presented by the representational limitations of the technology. Examples of compensatory communication behavior in telemedicine consultations include the clinician's asking the patient to describe how something feels to the touch (e.g., a rash or nodule) or instructing the patient to gather vital signs, such as taking his/her temperature or weight, since the clinician is unable to physically complete these tasks when using e-consultation technology. Alternatively, rich technology representation can compensate for low elicitation capabilities—for example, the sensory cues provided by a rich representation (e.g., visual and auditory) can provide the needed information to the clinician without the need for the clinician to remember or be highly skilled to solicit this information. Thus, we propose that the consultants' elicitation capability is able to overcome the representational limitations of e-consultation technology, and vice versa, thereby allowing effective information exchange and enabling diagnostic problem solving.

H5a: Technology representation will moderate the effect of user elicitation capabilities on e-consultation diagnosticity such that elicitation will have a stronger effect on e-consultation diagnosticity when representation is low compared to when representation is high.

H5b: User elicitation capabilities will moderate the effect of technology representation on e-consultation diagnosticity such that representation will have a stronger effect on e-consultation diagnosticity when elicitation is low compared to when elicitation is high.

As with H4, these two hypotheses are mathematically equivalent, and both are presented to depict the idea that representation and elicitation capabilities can compensate for one another.

Multiple Research Methods

Given the inherent limitations of all research methods, we used a multimethod approach to empirically test our hypotheses and triangulate our results. Specifically, we conducted two studies: a survey study of clinicians who have used telemedicine and an experiment with nursing student subjects who evaluated a patient (confederate) through telemedicine. One of the key benefits of employing multiple methods in research is to capitalize on the relative strengths of different methodological approaches and compensate for limitations. Whereas a field study provides more realism, a lab experiment provides greater control in testing the causal relationships of a research model (McGrath 1981). We present the two studies next.

Methodology: Study 1

Study 1 employed a survey methodology, and the instrument development procedures are detailed in Appendix B. The survey targeted a cross-section of U.S. clinicians with experience using interactive video telemedicine to evaluate and diagnose patients. Because practicing clinicians represent a population that is difficult to penetrate for data collection, coupled with the fact that we were targeting clinicians who met specific telemedicine experience criteria, we chose to employ purposive sampling techniques for data collection. We contacted individuals based on two criteria: (1) they were identified as a key contact within a state's telemedicine network or program, or (2) they were identified as a current or former telemedicine clinician who acted in the consultant role. The main sources that informed these two criteria were the American Telemedicine Association membership directory and Web searches of telemedicine networks, organizations, programs, and research centers as well as news articles identifying telemedicine initiatives within the United States. Furthermore, telemedicine clinician directories were obtained for telemedicine networks in both Missouri and Georgia.

We contacted a total of 70 key contacts within U.S.-based telemedicine networks and 458 clinicians with telemedicine consultation experience. The telemedicine network contacts were informed about the study and asked to e-mail a link to the online survey to telemedicine clinicians in their network. The other 458 telemedicine clinicians were contacted directly and invited to participate in the online survey. A total of 21 network contacts responded affirming they would distribute a link to the online survey to known consulting clinicians in their telemedicine networks and programs. Although we requested the number of clinicians to whom they shared the survey link, only a few contacts responded to report this number. Therefore, we were not able to determine a response rate for this group. However, we were able to calculate a response rate based on the individuals we directly contacted to participate in the online survey.

A total of 204 completed surveys were received. Of the 458 clinicians whom we directly contacted, 160 completed the survey (35% response rate). The remaining 44 respondents were invited to participate in the study by one of the telemedicine network contacts we identified. After screening the data for outliers, three observations were dropped, yielding a total sample size of 201 respondents. Respondents' sample characteristics are shown in Appendix C.

To assess nonresponse bias, we compared the 114 respondents who completed the survey with no reminders to the 87 respondents who completed the survey after receiving a reminder (sent one week and two weeks after the initial invitation), as suggested by Armstrong and Overton (1977). Unpaired t-tests showed no significant differences in demographic factors, extent of telemedicine use, or responses for independent and dependent variables, suggesting that nonresponse bias is not a significant concern.

Control Variables

Because task requirements have been deemed important predictors of task performance (e.g., Goodhue and Thompson 1995), we included these as control variables. Two important requirements of diagnostic problem solving in expert consultations are trust requirements and sensory requirements (akin to the constructs of relationship requirements and sensory requirements in Overby (2008)). As discussed, a central determinant of successful information exchange is rapport and trust so that the client is comfortable sharing relevant information with the consultant, and expert consultations vary in terms of their need for trust. Furthermore, expert consultations vary in their need for physical (i.e., sensory) observations, and the degree of physical assessment needed could impact perceptions of e-consultation diagnosticity.

Data Analysis and Results: Study 1

Measurement Validation

The psychometric properties of the scales were assessed through a confirmatory factor analysis (CFA) in AMOS 21.0. The fit indices (CFI = 0.97, TLI = 0.96, GFI = 0.88, and RMSEA = 0.05) indicate a good fit (Gefen et al. 2011; Hu and Bentler 1999), providing support for construct validity. We further assessed convergent and discriminant validity by examining item loadings, inter-construct correlations, and the average variance extracted (AVE) (see Appendix D). All item loadings are significant ($p < 0.001$) and greater than

*0.707, and all AVE values exceed 0.50 (range from 0.61 to 0.89) indicating good convergent validity (Fornell and Larcker 1981). Additionally, the constructs exhibit good reliabilities with a minimum composite reliability score of 0.89. The scales also exhibit discriminant validity since the square root of the AVE is larger than the inter-construct correlations (Chin 1998). We further assessed discriminant validity through chi-squared difference tests between the unconstrained model and a series of models where the correlation between each possible combination of constructs was set to 1; the test results provide further support for discriminant validity.

Common Method Bias

Given that both the independent and dependent variables are measured using the same method at the same point in time, there is potential for common method bias. We conducted two tests to assess common method bias. First, we ran a CFA which included a common method factor (Podsakoff et al. 2003; Podsakoff, MacKenzie, and Podsakoff 2012). Results show significant item loadings on the trait factor and nonsignificant item loadings on the common method factor. Further, the AVE for the trait factors exceed 50 percent and the AVE for the common method factor is 3.8 percent. Second, Harman's single factor test (Harman 1967) shows that the most variance explained by a single factor is 35.9 percent, which does not account for the majority of the variance. Therefore, common method bias does not appear to pose a significant threat in this study.

Hypothesis Testing

To test the hypotheses, we employed hierarchical regression using standardized weighted means for the construct scores. As suggested by Aiken and West (1991) in testing interaction effects, we first ran a main effects model and then added interaction effects in each subsequent model until a full set of hypothesized interaction effects were tested (see Table 1).

Results of the regression analyses reveal that the independent variables in the main effects model account for approximately 63.6 percent of the variance in e-consultation diagnosticity (Table 1, Model 2). Together, the main effects and interaction effects account for 64.6 percent of the variance in e-consultation diagnosticity (Table 1, Model 5). In all models that include the main effects (Table 1, Models 2–5), the relationships between the control variables and e-consultation diagnosticity are nonsignificant, and the main effects of representation, presentation, and elicitation are significant and positive, supporting H1–H3.

To further probe the main effects, we assessed the relative impact of user capabilities versus technology capabilities on e-consultation diagnosticity by examining the additional explained variance that each contributes to the regression model. Representation capability and the control variables explain 49.7 percent of the variance (Table 2, Model 3). This supports the traditional technology-centric conceptualization of technology's impact on task performance. When the user capabilities of presentation and elicitation are added, the explained variance increases by 13.9 percent (sig. F change < .001) (Table 2, Model 4). The user capabilities and control variables (without the technology capabilities) explain 56 percent of the variance, pointing to the importance of the influence of the user's capabilities on task performance. The results provide additional support for H1–H3 indicating that while the representation capability of the technology is a significant determinant of e-consultation diagnosticity, so too are the user capabilities of presentation and elicitation.

To test the interaction effects (H4 and H5), we added the interaction terms to the regressions, first one at a time and then together (Table 1, Models 3–5). When entered one at a time, both interaction terms are significant, but they are nonsignificant when entered together in the same regression. This may be due to a few different reasons. First, it is possible that these relationships are, indeed, nonsignificant. However, it is also possible that these interactions were nonsignificant because of multicollinearity and power concerns, which are common causes of failure to detect significant interaction effects (Aiken and West 1991; Jaccard et al. 1990). Despite the fact that all variance inflation factor values for the regression coefficients were below the recommended threshold of 3.3 (Craney and Surles 2002; Kock and Lynn 2012), given the high correlation between the interaction terms (0.60), multicollinearity is possibly still a concern (Goodhue et al. 2011). Further, power calculations reveal that there is low statistical power with our sample size in detecting significant interaction effects. For Models 3 and 4 (Table 1), which include only one of the two interaction terms, the statistical power is 0.55 (effect size 0.022), and the statistical power when including the second interaction term is 0.15 (effect size 0.006). Thus, lack of statistical power is a likely explanation for the lack of significant interaction effects in the full model that includes both interactions.

In addition to testing interaction effects with regression, we performed Chow tests (Chow 1960) using high/low splits based on the mean and median of representation as the moderator, and the findings indicate significant differences between the regression coefficients of elicitation and presentation at different levels of representation ($p < .001$). The same was found for high/low splits based on the mean and

Table 1. Results of Hierarchical Regression Analysis (DV = E-consultation Diagnosticity)

	Model 1		Model 2		Model 3		Model 4		Model 5	
Variable	**Beta**	**(S.E.)**	**Beta**	**(S.E.)**	**Beta**	**(S.E.)**	**Beta**	**(S.E.)**	**Beta**	**(S.E.)**
Controls										
Sens Req	-.039	(.070)	.035	(.044)	.041	(.043)	.037	(.043)	.040	(.043)
Trust Req	.205**	(.070)	.059	(.044)	.069	(.044)	.076	(.044)	.076	(.044)
Main Effects										
Presentation			.189**	(.062)	.139*	(.067)	.209**	(.063)	.173*	(.073)
Elicitation			.345***	(.067)	.358***	(.067)	.283***	(.072)	.311***	(.078)
Representation			.367***	(.057)	.337***	(.059)	.332***	(.059)	.325***	(.060)
Interaction Effects										
Rep × Pres					-.106*	(.036)			-.062	(.043)
Rep × Elic							-.118*	(.033)	-.080	(.040)
Sig. F Change	.013		.000		.045		.034		.330	
R^2	.043		.636		.644		.644		.646	

Standardized coefficients (standard errors), n = 201; ***p < 0.001; **p < 0.01; *p < 0.05.

Table 2. Results of Reduced Hierarchical Regression Analysis (DV = E-Consultation Diagnosticity)

	Model 1		Model 2		Model 3		Model 4	
Variable	**Beta**	**(S.E.)**	**Beta**	**(S.E.)**	**Beta**	**(S.E.)**	**Beta**	**(S.E.)**
Controls								
Sens Req	-.039	(.070)	.020	(.048)	.025	(.051)	.035	(.044)
Trust Req	.205**	(.070)	.078	(.048)	.094	(.051)	.059	(.044)
Main Effects								
Presentation			.267***	(.067)			.189**	(.062)
Elicitation			.520***	(.067)			.345***	(.067)
Representation					.686***	(.051)	.367***	(.057)
Sig. F Change	.013		.000		.000		.000	
R^2	.043		.560		.497		.636	

Standardized coefficients (standard errors), n = 201; ***p < 0.001; **p;<;0.01; *p < 0.05.

median of elicitation and presentation as moderators, with significant differences between the regression coefficients of representation at different levels of presentation (p < .001) and elicitation (p < .001). Combined, these findings provide support for significant interaction effects. To further probe the separate interaction effects, we interpreted each interaction using partial derivative analysis, response surface plots, two-way interaction plots, and simple slope tests. We present these results in Appendix E. Results show that the relationship between presentation and e-consultation diagnosticity is strongest at low levels of representation and not significant at high levels of representation. Likewise, the relationship between representation and e-consultation diagnosticity is strongest at low levels of presentation and not significant at high levels of presentation. In addition, elicitation has its strongest effect on e-consultation diagnosticity at low levels of representation and no significant effect at high levels of representation. Similarly, representation influences e-consultation diagnosticity the most at low levels of elicitation and has no significant impact at high levels of elicitation. Altogether, these results suggest that the user capabilities of presentation and elicitation matter most when representation is low, and vice versa, supporting H4 and H5.

Post Hoc Analysis

Due to the possibility of multicollinearity between the interaction effects (correlation = .60) and the fact that the two interaction effects are nonsignificant when entered together in the regression, we combined the two user capabilities into a composite user capability construct and reran the regression (see Appendix F). Results indicate that user capabilities and technology capabilities as well as their interaction are significantly related to e-consultation diagnosticity, and the interactions follow the same pattern as those depicted in the figures in Appendix E.

Methodology: Study 2

In Study 2, we conducted a controlled laboratory experiment with 93 subjects to test the hypotheses in the research model. We employed a 2 × 2 × 2 between-subjects factorial design. The three factors investigated were representation (audio-only/video-and-audio), presentation (low/ high information giving), and elicitation (low/high information seeking).

Participants

Nursing students at a large southern university were recruited to participate in the experiment. All subjects (junior and senior undergraduate students and graduate students) had successfully completed a course in health assessment, in which they learned hands-on skills on how to conduct face-to-face patient health assessments, and a course in adult health and illness, in which they learned about various acute and chronic health problems in the adult population. The majority of the students (64.5%) had over one year of experience in performing face-to-face patient health assessments in a practitioner clinical setting.

Experiment Task and Procedures

The subject's task was to interview a patient (played by a confederate) using telemedicine to elicit enough information regarding her health condition in order to form an idea of the health disorder afflicting the patient and to conclude the session by providing her with triage advice. The hired confederate had professional experience as a registered nurse as well as acting experience, and her role was to play the part of a patient suffering from hyperthyroidism (see Appendix G for a description of hyperthyroidism) who was seeking triage advice via a nursing hotline. The health condition was chosen because visual information (e.g., goiter, flushed hands and face, fidgeting) can provide cues helpful to the evaluation of the condition.

When subjects arrived, they received a formal explanation of the experimental procedures and were informed that they would conduct a telemedicine-based health assessment of a patient in a rural community who was seeking triage advice concerning her health problem. Neither the health condition nor the fact that the patient was fictitious was disclosed to the subjects. At the conclusion of the telemedicine assessment, each subject completed a survey and was paid cash for his/her participation (see Appendix H for more details of the experimental procedures).

The experiment procedures, instruments, and manipulations were validated through two pretests (n = 5) and two pilot tests (n = 13) with nursing students. All telemedicine sessions were recorded using LifeSize UVC Video Center.

Variable Operationalization

Representation

Low representation was achieved through audio-only interaction with the confederate, whereas high representation entailed both real-time video and audio interaction (see Figure 4). In the high representation condition, the visual signs of hyperthyroidism were achieved through application of theatrical makeup (e.g., red, flushed cheeks and palms of hands; dark circles under eyes; shading on the front of the neck to simulate swelling of the thyroid) and the confederate's scripted nonverbal communication (e.g., shaky hands; fidgeting) (see Figure 5). The makeup was touched up frequently during breaks between subjects to maintain a consistent appearance in the video conditions. Additionally, we employed two video production LED lights and bounced the lights off of two white surfaces to project the proper coloring and tones of the confederate's visual signs on the subjects' end. For the telemedicine technology, we employed two LifeSize HD videoconferencing systems (a leading high fidelity videoconferencing solution for telemedicine) for real-time video and audio conferencing. This solution was very stable and enabled a clear picture of the visual signs of the confederate in the high representation condition.

Presentation

To manipulate presentation, the confederate followed two scripts, one in which she was forthcoming in presenting her symptoms and medical history (high presentation) and one in which she withheld most of this information unless pointedly asked (low presentation). Two nursing experts and the first author of this study co-wrote the scripts. To differentiate the two scripts, there were differences in the number of symptoms presented initially and overall. Further, in the low presentation script, the confederate mainly only provided information

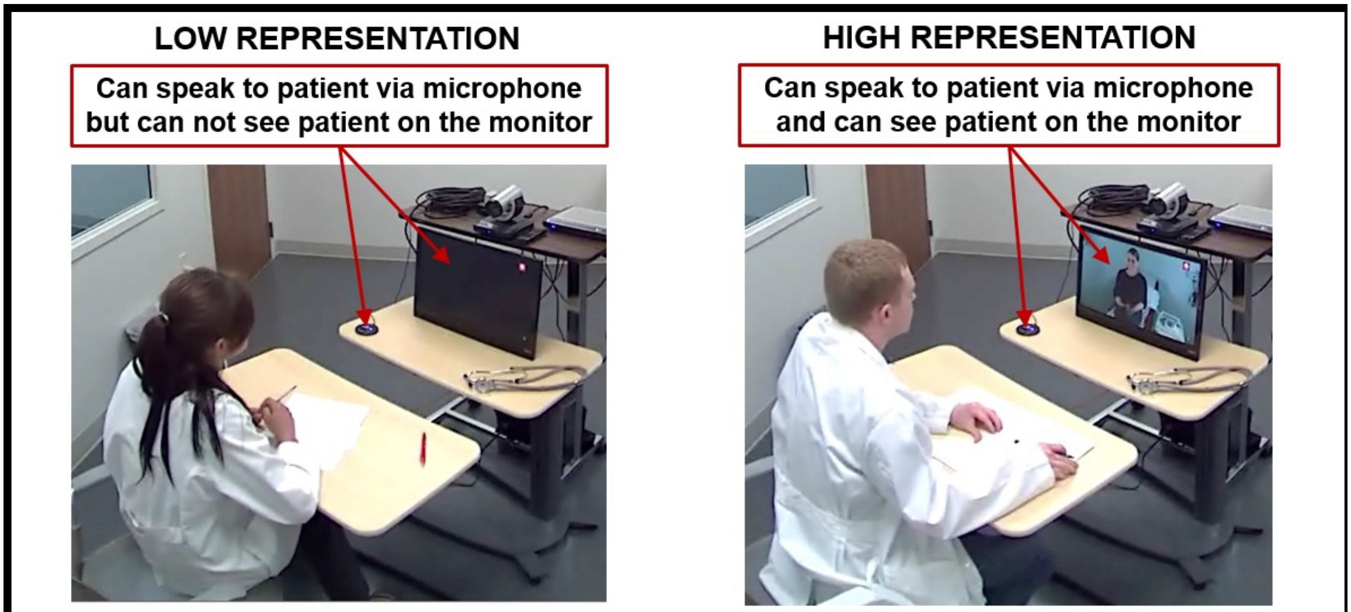

Figure 4. Low and High Representation Conditions

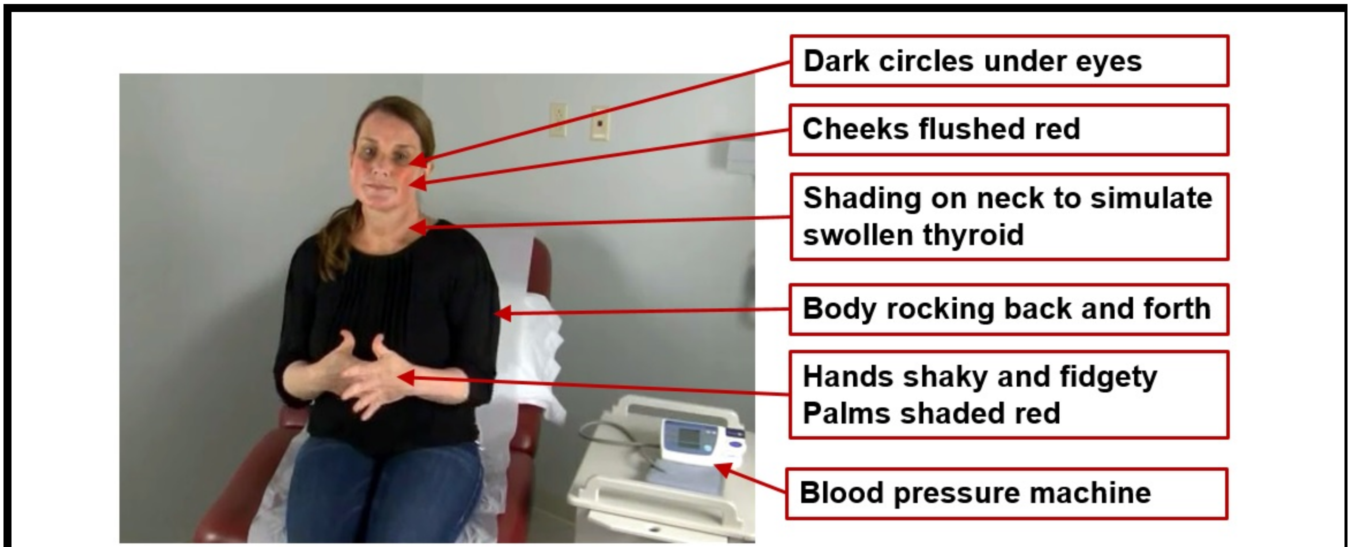

Figure 5. Physical Signs/Cues of the Patient Visible in the High Representation Condition

when asked questions and she limited her answers to responding only to the specific question asked (e.g., in response to the question, "Are you taking any medications?," she would simply answer, "Yes"), whereas in the high presentation script, the confederate would not only answer questions asked by the subjects but also would volunteer additional relevant information (e.g., in response to the question, "Are you taking any medications?," she would answer, "Yes, I'm taking 500 milligrams of Tylenol daily for pain"). See Appendix I for more details regarding the two scripts.

Elicitation

To ensure variation in elicitation capabilities, our sample included both undergraduate and graduate students. For the purpose of *assigning* students to conditions, we categorized graduate (Master's level) students and graduating undergraduate seniors as experts with high elicitation capabilities (n = 46) and regarded junior level and first-semester senior undergraduate students as novices with low elicitation capabilities (n = 47). This was done to ensure an approximately equivalent number of students in each cell. However, the *measure* of elicitation used in the analysis was based on the elicitation skills displayed by each subject during the consultation. Two nursing faculty judges observed all recorded telemedicine interactions separately and scored subjects on their elicitation capabilities (see Appendix J for the scale items used by the judges to rate elicitation; inter-rater reliability was .911, as measured by a two-way mixed, absolute agreement intraclass correlation coefficient (Shrout and Fleiss 1979)). The judges' scores were averaged for a composite elicitation score (Cronbach's alpha = .94) and dichotomized based on a median split (1–3 as "low" and 3.1–5 as "high") to be included as a factor in ANOVA.[7]

E-Consultation Diagnosticity (Task Performance)

The dependent variable, e-consultation diagnosticity (task performance), was captured by the subjects' responses to an open-ended question on the survey that asked them to list and describe the most probable medical diagnoses for the patient based on the telemedicine assessment. Their responses were evaluated by two nursing faculty judges who met initially to jointly develop a rubric for scoring the subjects' answers and then applied the rubric to score the subjects' task performance. The rubric applied a Likert scale of 0 to 10, with 10 representing the most accurate response (i.e., hyperthyroidism) and 0 representing the most inaccurate response. For responses in which subjects recorded several possible diagnoses, each diagnosis was assigned a score based on the rubric, and a final score was calculated by computing the mean. There was full consensus in the judges' application of the rubric and assessment of the subjects' responses. Examples of responses and their scoring are provided in Table 3.

Control Variables

Though in Study 1 we controlled for the task, in the experiment, the health assessment task remained constant (same health condition and patient) across subjects. Thus, we included controls for individual differences. The demographic variables of age and gender were self-reported. Grade point average for all subjects was obtained from the university's registrar office.

[7]As a result of the judges' scoring of elicitation capabilities, 20 of the 46 students assigned to the high elicitation condition received scores that placed them in the low elicitation condition, and 21 of the 47 students assigned to the low elicitation condition received scores that placed them in the high elicitation condition, for a resulting total of 46 students in the low elicitation condition and 47 students in the high elicitation condition.

Data Analysis and Results: Study 2

Table 4 shows sample characteristics and the dependent variable means across treatments. The subjects' average age was 28 years, with 86 percent (n = 80/93) being female and 14 percent (n = 13/93) being male (at least one male was represented in each cell). The average telemedicine session time across all subjects was 9.29 minutes. The judges' overall mean score for e-consultation diagnosticity was 6.2 with a standard deviation of 2.94. Additional construct means and reliabilities can be found in Table J2 of Appendix J.

Manipulation Checks

Both subjects and expert judges answered questions to test the manipulations. The questions used for the manipulation checks were largely adopted from Study 1 to maintain consistency across the two studies (see Appendix J). Mean differences across treatments were statistically significant (see Table J3 in Appendix J), confirming that the manipulations were successful.

Hypothesis Testing

A three-way ANOVA (presentation × elicitation × representation) was conducted on e-consultation diagnosticity (see Table 5). Results show that both presentation and elicitation have a significant positive effect on e-consultation diagnosticity ($p < .001$), supporting H2 and H3, but the effect of representation is not significant; thus, H1 is not supported. Both interactions (between representation and presentation and between representation and elicitation) have significant impacts on e-consultation diagnosticity ($p < 0.05$). Controls are nonsignificant.

To explore the significant interaction effects, we used interaction plots and surface response graphs (see Figures E3–E4 in Appendix E). Results show that at low levels of representation, there is a stronger relationship between presentation and e-consultation diagnosticity than at high levels of representation. Furthermore, results show a stronger relationship between representation and e-consultation diagnosticity at low levels of presentation versus high levels of presentation. Collectively, these results suggest that technology capabilities are able to compensate for weaknesses in presentation capa-

Table 3. Examples of E-Consultation Diagnosticity Scoring

Subject's Response	Judges' Score(s)	Mean Overall Score
Ebola, lupus	Ebola = 0, lupus = 1	0.5
Arthritis, tumor, or osteoporosis	Arthritis = 4, tumor = 1, osteoporosis = 4	3
Anxiety, restless leg syndrome	Anxiety = 6, restless leg syndrome = 4	5
Diabetes mellitus II, thyroid condition	Diabetes = 8, thyroid condition = 9	8.5
Hyperthyroidism	Hyperthyroidism = 10	10

Table 4. Sample Characteristics by Cell

			Low Presentation	High Presentation
Low Elicitation	**Low Rep. (Audio-Only)**		**Mean (St. Dev.)**	**Mean (St. Dev.)**
		Sample Size	12	13
		Grade Point Average (GPA)	3.46 (0.27)	3.47 (0.40)
		E-Consultation Diagnosticity	2.28 (1.44)	6.40 (2.56)
	High Rep. (Video and Audio)		**Low Presentation**	**High Presentation**
			Mean (St. Dev.)	**Mean (St. Dev.)**
		Sample Size	11	10
		Grade Point Average (GPA)	3.29 (0.52)	3.53 (0.27)
		E-Consultation Diagnosticity	4.97 (2.42)	5.81 (3.05)
High Elicitation	**Low Rep. (Audio-Only)**		**Low Presentation**	**High Presentation**
			Mean (St. Dev.)	**Mean (St. Dev.)**
		Sample Size	11	15
		Grade Point Average (GPA)	3.28 (0.28)	3.60 (0.39)
		E-Consultation Diagnosticity	6.14 (2.12)	9.42 (0.92)
	High Rep. (Video and Audio)		**Low Presentation**	**High Presentation**
			Mean (St. Dev.)	**Mean (St. Dev.)**
		Sample Size	10	11
		Grade Point Average (GPA)	3.54 (0.50)	3.46 (0.43)
		E-Consultation Diagnosticity	6.13 (2.22)	7.54 (2.64)

Table 5. ANOVA Results (DV = E-Consultation Diagnosticity)

Variable	Mean Square	F-Statistic	P-Value
Covariates			
Grade Point Ave.	2.116	0.427	0.515
Gender	7.120	1.438	0.234
Age	1.828	0.369	0.545
Main Effects			
Presentation	**133.605**	**26.987**	**0.000**
Elicitation	**129.733**	**26.205**	**0.000**
Representation	0.089	0.018	0.894
Interaction Effects*			
Rep × Pres	**32.927**	**6.651**	**0.012**
Rep × Elic	**24.588**	**4.966**	**0.029**

*The three way interaction (representation × elicitation × presentation) was tested and found to be nonsignificant.

bilities and vice-versa, supporting H4. We see similar results for H5. Results indicate that the relationship between elicitation and e-consultation diagnosticity is stronger at low levels of representation than at high levels of representation. Additionally, the relationship between representation and e-consultation diagnosticity is stronger at low levels of elicitation than at high levels of elicitation. Collectively, these results suggest that technology capabilities can compensate for poor elicitation capabilities and vice versa, supporting H5.

Discussion and Conclusions

Summary of Findings

Findings from both studies suggest that the task-specific user capabilities of presentation and elicitation are indeed important determinants of e-consultation diagnosticity in technology-mediated expert consultations, providing consistent support for H2 and H3. Thus, in e-consultations, the communication competence of the users, in terms of information giving (presentation) and information seeking (elicitation), plays a pivotal role in determining successful diagnostic task performance.

Mixed results are found for the impact of representation. In the field study, representation has a significant main effect on e-consultation diagnosticity, supporting H1, but not in the experimental study. In the field study, telemedicine clinicians perceive the representational capabilities of telemedicine technology to be an important predictor of e-consultation diagnosticity, which is consistent with both existing research (e.g., Edison et al. 2008; High et al. 2000) and practice. For example, the Centers for Medicare and Medicaid Services (CMS) define telemedicine in terms of interactive communication between the patient and clinician that includes both audio and video equipment, at a minimum; as such, with few exceptions, CMS mainly reimburses providers for interactive video telemedicine services, as this mode of communication comes closest to traditional, face-to-face visits (Telemedicine 2013). However, results from our experiment suggest that the representational capabilities of the telemedicine technology do not have a significant main effect on e-consultation diagnosticity. Rather, as we discuss below, representation matters when user elicitation or presentation capabilities are low.

The hypotheses of interaction effects, H4 and H5, posit that user capabilities can compensate for representational weaknesses in the technology, and vice versa, in determining e-consultation diagnosticity. Findings from the experimental study support H4 and H5. Although statistical power limitations in Study 1 likely precluded us from detecting significant interaction effects when both interactions were included in the regression, results from our *post hoc* analysis, the regressions with each interaction entered separately, Chow tests, and interview comments provided by respondents in our qualitative study all support these interaction effects. Hence, results from the experimental study triangulate with qualitative and *post hoc* analysis findings from the field study, collectively providing support for H4 and H5.

The fact that the two-way interaction plots (Appendix E) indicate ordinal interactions for Study 1 (Figure E2) and disordinal (or crossover) interactions for Study 2 (Figure E4), when representation is the moderator, merits additional discussion. A likely reason for the difference is that representation is measured differently in each study. In Study 1, all respondents reported experiences based on using interactive video to perform a telemedicine consultation. In Study 2, subjects used either interactive video or audio-only to perform the consultation. Therefore, there is a difference in the range of representation that was captured in each study. In Study 1, we captured a technology that does indeed suppress certain face-to-face communication cues (e.g., touch, certain nonverbal cues) but also simulates many aspects of face-to-face interaction (e.g., visual cues, synchronous interaction). However, in Study 2, we were able to manipulate a *greater range* of representation in that the audio-only interaction suppresses face-to-face cues to a larger degree than interactive video. This is also reflected in the construct mean for the subjective measure of representation in Study 1 (mean = 5.51, SD = 1.33) which is higher than the construct mean for the subjective measure of representation in Study 2 (mean = 4.05, SD = 1.42). Thus, in Study 1, we observed relationships that may not capture the full range of representation effects.

In both studies, the response surface graphs and interaction plots suggest that presentation has no significant effect on e-diagnosticity (at $p < 0.05$) when representation is high. However, when presentation is the moderator, the relationship between representation and e-consultation diagnosticity differs across the two studies. In Study 1, at all levels of presentation, high representation is associated with higher e-consultation diagnosticity, but in Study 2, this is not the case. In Study 2, when presentation is high, *low* representation is associated with higher e-consultation diagnosticity. A possible explanation is that at very low levels of representation, the lack of visual cues *focuses* the expert consultant on the client's oral presentation and eliminates distractions of other visual cues that may lead the consultant down a different diagnostic path.

Limitations

As with all research, this study is not without limitations. Although each study (qualitative, survey, experiment) has its inherent limitations, we believe the mixed methods approach and convergence of our results across the three studies strengthen the conclusions of the study.

In our survey field study, we employed purposive sampling techniques because we targeted a population (physicians) that is difficult to recruit for research purposes. Furthermore, although respondents represent 37 different states in the United States, approximately 36 percent of the respondents reside either in Georgia or Missouri because we were able to obtain complete lists of e-mail addresses for telemedicine clinicians in these two states. Thus, responses from our survey may not generalize to a national sample of telemedicine clinicians. Additionally, data were collected from a single source in a cross-sectional survey; thus, respondents may have shown positive bias in rating their own elicitation skills and performance. For this reason, we combined the field study with an experimental study, in which we collected data from multiple sources and had external judges evaluate task performance. Also in Study 1, respondents were asked to recall a recent telemedicine consultation experience and report answers based on that one experience. One potential threat to this approach is memory errors of the respondents, that is, the possibility that respondents recall inaccurate and/or incomplete information from their past experiences (Krosnick 1999; Tourangeau 2000). The most common reason for memory errors is failure to retrieve the stored memory, which is most prevalent for unaided recall tasks and when there has been a significant passage of time since the memory was encoded (Tourangeau 2000). When there is greater assistance given to the memory retrieval process and greater recency in which the memory was encoded, the recalled information is more complete and accurate (Tourangeau 2000). Hence, to mitigate memory errors, we initially aided respondents in their recall task by probing them to carefully think about their most *recent* telemedicine consultation experience and answer open-ended questions in which they had to detail their telemedicine experience.

In our lab experiment, the subjects were undergraduate and graduate students of nursing. One critique of using student subjects is that they are not representative of the practitioner population (Shen et al. 2011). However, in our sample of student subjects, 60 of the 93 subjects (64.5%) had over one year of experience in performing face-to-face patient health assessments in a clinical setting. Approximately 13 percent of our student subjects had more than five years of experience working in the nursing field and performing patient health assessments. Thus, while a certain degree of realism is compromised in lab experiments, the majority of the subjects we recruited had at least one year of practitioner experience relevant to our context.

Another potential limitation of the experiment is that we used a single health condition, hyperthyroidism. We chose this condition for many reasons: its combination of physical signs and cues, which could be seen as well as described, and coverage in the nursing curriculum so that subjects would be familiar with it. Use of telemedicine for other types of health conditions may have yielded different results, but triangulation of our results with those of the qualitative and quantitative field studies enhances generalizability of our findings across health conditions.

Furthermore, a more granular operationalization of representation capability would entail manipulations beyond the two we chose to employ (audio-only versus video-and-audio). Different effects might be observed from using additional manipulations, such as still photos or prerecorded video versus interactive video, especially considering the many visual cues required for the evaluation task. The choice to eliminate visual cues in the low representation condition (audio-only) was intentional because it is a medium that offers greater suppression of face-to-face cues (which would provide a better test for compensatory adaptation behaviors). In addition, among the possible manipulations, the audio-only versus video-and-audio allowed us to capture two extremes of the representation spectrum. Moreover, many e-consultations are performed by phone (audio-only), so some realism can be captured by using this medium. Even so, it is possible that the elimination of visual images entirely in the low representation condition could have introduced confounds in the study. For example, the physical appearance and mannerisms of the confederate (not visible in the audio only condition) may have introduced confounds by manipulating more than just the technology. Likewise, the use of interactive video in the high representation condition may have created a confound in that it is nearly impossible to hold the confederate's behavior constant in each of the presentation conditions. To mitigate this threat, the confederate engaged in multiple script rehearsals with the primary researcher of this study as well as through two pretests and two pilot tests. During the administration of the experiment, the confederate also had the benefit of a live teleprompter who coached her to remain on script, including maintaining her general appearance and behaviors (see Appendix I).

Finally, our findings were derived in a telemedicine context and, thus, may not generalize to other expert consultation contexts. Future research should test the research model in other e-consultation contexts to assess the generalizability of the model.

Contributions to Theory

While perceptions of technology characteristics and their impact on task performance have been studied extensively in individual-level IS research, few studies have explored the role of task-specific user capabilities (as opposed to technology-specific user characteristics such as computer self-efficacy) and how they interact with technology capabilities in shaping successful system performance outcomes. The basic premise of our research is that users and technology combine in a compensatory manner such that limitations of technology can be compensated by human capabilities, and limitations in human capabilities can be overcome through technology. As such, in line with Burton-Jones and Grange (2012), we take a systemic view of effective system use and performance that takes into account both the users as well as the technology in successfully performing a task. Although Burton-Jones and Grange propose a tripartite conceptualization of effective system use, in which the user, technology, and task are integral elements that define the essence of system use, they emphasize the user's interactions with the technology in executing tasks. Our research suggests an expanded notion of effective system use within the context of technology-mediated communication to highlight the importance of users' interactions *with each other* in addition to their interactions with the technology in determining task performance. We further propose that users' *task-specific* capabilities, in addition to users' technology-specific characteristics (e.g., computer self-efficacy) and individual traits (e.g., demographics), are important factors that shape a holistic conceptualization of system use.

Moreover, we contribute to compensatory adaptation theory by identifying task-specific user capabilities as a key individual ability that enables compensatory behaviors in system use. Previous research has suggested that IS technologies can be designed in ways to facilitate compensatory adaptation (Kock 2008). Our research extends this insight by suggesting that *user* capabilities can be developed to achieve this same end. The extent of compensatory adaptation that can be achieved, in part, is contingent on the degree of user capabilities that are present.

While we have identified the task-specific user capabilities of presentation and elicitation as important in the context of e-consultations, our approach generalizes to examining system performance outcomes in general. Just as applications of TTF theory identify specific technology characteristics that are important in different contexts—interoperability in the context of managerial information systems (Goodhue and Thompson 1995), interactivity and vividness in the context of presentation media on websites (Jiang and Benbasat 2007b), and transmission velocity in the context of communications media (Dennis et al. 2008)—we suggest that relevant user capabilities will also need to be identified in different contexts.

While we posit that user capabilities can compensate for limitations in technology capabilities and vice versa, future research could explore user and technology capabilities that work synergistically toward task performance (rather than in a compensatory fashion) such that the total effect is greater than the sum of the parts. In addition, future research can examine adaptations in offline user capabilities that may be necessary for successful system use outcomes and the effects of these adaptations on performance. For example, our interviews indicate that although elicitation skills are important for both face-to-face and e-consultations, in many cases, consultants needed to adapt their elicitation skills to compensate for limitations in technology.

Specific to e-consultations, we identify the user capabilities of presentation and elicitation that entail knowledge and skills related to communication and problem solving. There are many popular communication media theories in IS, such as media richness (Daft and Lengel 1986; Daft et al. 1987) and media synchronicity (Dennis et al. 2008), yet studies leveraging these theories mainly focus on features of the communication media and tasks (e.g., El-Shinnawy and Markus 1997; Kahai and Cooper 2003; Muhren et al. 2009) and do not consider the abilities of the user, their adaptations, and interactions with technology in shaping successful communication outcomes. Our study addresses this important gap by theorizing, in an e-consultation context, the specific user communication capabilities of presentation and elicitation, the compensatory adaptive capabilities of users, and how these impact diagnostic decision making. These user capabilities not only influence e-consultation success directly but also as moderators that compensate for the communication obstacles posed by technology-mediated interaction. By leveraging compensatory adaptation theory, we are able to enrich conventional media theories, such as media richness theory, to provide an explanation for how use of communication media that lack richness in communication cues and symbol sets, and are thus considered a poor fit for problem solving tasks, can still result in successful task performance.

Contributions to Practice

Our study has important practical implications as well. While many system implementations involve user training, oftentimes a focus of the training is to teach users how to use the technology. While this aspect of user training is essential to successful system implementations, it is just as important to train users on task-specific strategies and best practices and how these need to be adapted to compensate for technology limitations because these skills will facilitate performance outcomes as well. For technology-mediated communication, the focal task relates to the information exchange between the participants; hence, specific training geared toward improving information exchange skills adapted for technology-mediated communications in the specific context (in addition to how to use the technology) will likely yield better performance.

Within the context of telemedicine, clinicians are typically well trained on how to conduct a medical interview; however, they may find that doing so over telemedicine requires a refinement of their interviewing strategies as well as learning how to provide instruction to clients at the remote site. For example, LeRouge and her colleagues (LeRouge, Garfield, and Hevner 2005; LeRouge, Hevner, and Collins 2007) suggest that telemedicine clinicians should receive "patient interaction" training to better prepare for telemedicine use. Likewise, clients can receive training on how to give a proper presentation of the clients' case problem; for example, the National School of Applied Telehealth recently began offering a certified telemedicine clinical presenter course for clinicians who participate in telemedicine consultations in the client role. Furthermore, studies have indicated that patients are poorly prepared in optimizing communication strategies during medical consultations and, thus, would benefit from communication training as well (Cegala, McClure, et al. 2000; Post et al. 2002). In other e-consultation domains, enhanced training for both consultants and clients on how to adapt their skills to compensate for limitations in technology or, conversely, to take into account superior functionality in the technology that reduces reliance on user capabilities is equally important.

Our study points to particular communication and behavioral adaptation skills that should be conveyed when training clients and consultants to use e-consultation systems. Thus, results of our study suggest that systems implementations should focus on a system-centric view (Burton-Jones and Straub 2006) of training (technology plus users plus task) rather than solely a technology-centric view of training. Finally, results of our study suggest adopting a system-centric view in implementing such systems. For example, when consultants and clients have strong presentation and elicitation skills, it becomes less important to invest in sophisticated representation technology. However, such technology becomes critical if presentation or elicitation skills are lacking. Therefore, practitioners can make trade-off decisions between user and technology capabilities when implementing e-consultation systems.

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RESEARCH ARTICLE

The Compensatory Interaction Between User Capabilities and Technology Capabilities in Influencing Task Performance: An Empirical Assessment in Telemedicine Consultations

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Appendix A

Qualitative Study Data Collection and Analysis

Methodology

We conducted a qualitative field study incorporating semi-structured interviews for the developmental purpose of mixed methods research; in other words, we initially engaged in qualitative research in order to develop the theoretical constructs and hypotheses of our research model, which we subsequently tested using quantitative methods (Venkatesh et al. 2013).

At the outset of our qualitative inquiry, our research questions guided the development of the interview protocol, which targeted factors that contributed to successful and unsuccessful e-consultations, asking respondents to share personal or observed experiences. Following a widely accepted framework for building theories using qualitative research (Carroll and Swatman 2000; Eisenhardt 1989), we iterated between the steps of data collection, data analysis, and enfolding literature until we reached theoretical saturation in the development of the constructs and hypotheses that formed our research model.

Data Collection

In order to investigate e-consultations, we grounded our data collection within a telemedicine context because users in this context are motivated to perform their focal e-consultation task (evaluation and diagnosis of patients), and the context allows for data collection from multiple types of stakeholders, providing the opportunity to triangulate emergent concepts across the stakeholders. The main stakeholder types were consulting providers, who assumed the role of consultant and used telemedicine to elicit the relevant information needed to evaluate and diagnose patients; presenting providers, who filled the role of presenter and used telemedicine to communicate the patient's problems to the consulting provider; healthcare administrators, who coordinated the implementation of the telemedicine systems and scheduling of telemedicine consultations at their respective sites; and telemedicine consultants, who were responsible for the telemedicine system implementations, training, and maintenance. In total, we conducted 39 semi-structured interviews with 14 consulting providers, 10 presenting providers, 8 healthcare administrators, and 7 telemedicine consultants (see Table A1). The telemedicine consultants worked for the same organization, and the remaining respondents represented 22 different healthcare organizations.

Table A1. List of Interviews for Qualitative Study				
Consulting Providers				
Title	**Mode**	**Length**	**Interview ID**	**Number of Interviewers**
Primary Care Physician	FTF	1:23:12	1	2
Pediatrician / Clinical Geneticist	FTF	1:06:54	2	2
Endocrinologist	FTF	2:20:19	3	2
Primary Care Physician/ Medical Director	Phone	0:41:18	5	1
	FTF	1:26:22	21	1
Mental Health Professional	FTF	1:04:37	7	1
Emergency Physician	FTF	0:54:45	9	1
	FTF	0:48:06	27	2
Primary Care Physician/ Medical Director	FTF	0:56:50	11	1
	FTF	0:54:13	28	2
Primary Care Physician/ Medical Director	Phone	0:31:34	32	1
Primary Care Physician/ Medical Director	Phone	0:42:16	34	2
Pediatric Psychiatrist	FTF	1:01:20	35	1
Primary Care Physician	FTF	0:45:59	36	1
Adult/Geriatric Psychiatrist	Phone	0:30:00	37	1
Optometrist	Phone	0:45:43	38	1
Obstetrician/Gynecologist	Phone	0:17:27	39	1
Presenting Providers				
Title	**Mode**	**Length**	**Interview ID**	**Number of Interviewers**
Primary Care Physician	Phone	0:48:51	6	1
Nursing Director	FTF	1:29:01	18	3
Nursing Director	FTF	1:08:38	19	3
	FTF	0:22:23	25	2
	Phone	0:29:12	33	2
Nursing Director	FTF	1:36:11	20	3
Nursing Director	FTF	0:54:11	24	3
Nursing Director	FTF	0:27:18	29	1
Social Worker	FTF	0:54:11	24	3
Nurse	FTF	0:41:31	20	3
Nurse	FTF	0:41:31	20	3
Nurse	FTF	0:40:27	30	1

Table A1. List of Interviews for Qualitative Study (Continued)

Title	Mode	Length	Interview ID	Number of Interviewers
Healthcare Administrators				
Parent Organization Administrator	Phone	0:39:29	4	2
	FTF	0:59:42	31	2
Telemedicine Coordinator	FTF	0:39:26	10	1
Healthcare Administrator	FTF	1:29:01	18	3
Healthcare Administrator	FTF	1:08:38	19	3
	FTF	0:22:23	25	2
	Phone	0:29:12	33	2
Healthcare Administrator	FTF	1:36:11	20	2
Healthcare Administrator	FTF	1:00:00	22	2
Healthcare Administrator	FTF	0:41:37	23	2
Healthcare Administrator	FTF	0:54:11	24	3
Telemedicine Consultants				
Title	**Mode**	**Length**	**Interview ID**	**Number of Interviewers**
Executive Director	FTF	0:21:49	15	1
Scheduling Coordinator	FTF	0:47:34	16	1
IT Administrator	FTF	0:43:20	14	1
Telemedicine Liaison	FTF	0:44:16	8	1
	FTF	1:08:38	19	3
	FTF	0:22:23	26	2
Telemedicine Liaison	Phone	0:44:10	12	1
	FTF	1:29:01	18	3
Telemedicine Liaison	Phone	0:37:21	13	1
Telemedicine Liaison	Phone	0:32:49	17	1

FTF = Face to Face
Length is presented in H:MM:SS

Data Analysis

All interviews were transcribed, and the interview transcripts were coded using the qualitative data analysis software MAXQDA. Our coding process was structured into first-order informant-driven concepts, second-order researcher-induced themes, and aggregate analytical dimensions, which adheres to a bottom-up, inductive analysis of the data (Van Maanen 1979). First-order concepts are derived from the insights expressed by the respondents, and second-order themes are the theoretical concepts that the researchers apply to explain the patterns in the first-order data (Van Maanen 1979). During the coding and analysis process, our research team met continuously to discuss the emergent findings, revise the interview protocol, and integrate theoretical concepts found in the literature. Any disagreement in the coding and analysis process was resolved to consensus. Data collection, data analysis, and literature integration ensued in this iterative process until no new concepts emerged (Eisenhardt 1989). Figure A1 portrays the data structure of our findings. These results shaped the theoretical development of the core constructs and hypotheses of our research model.

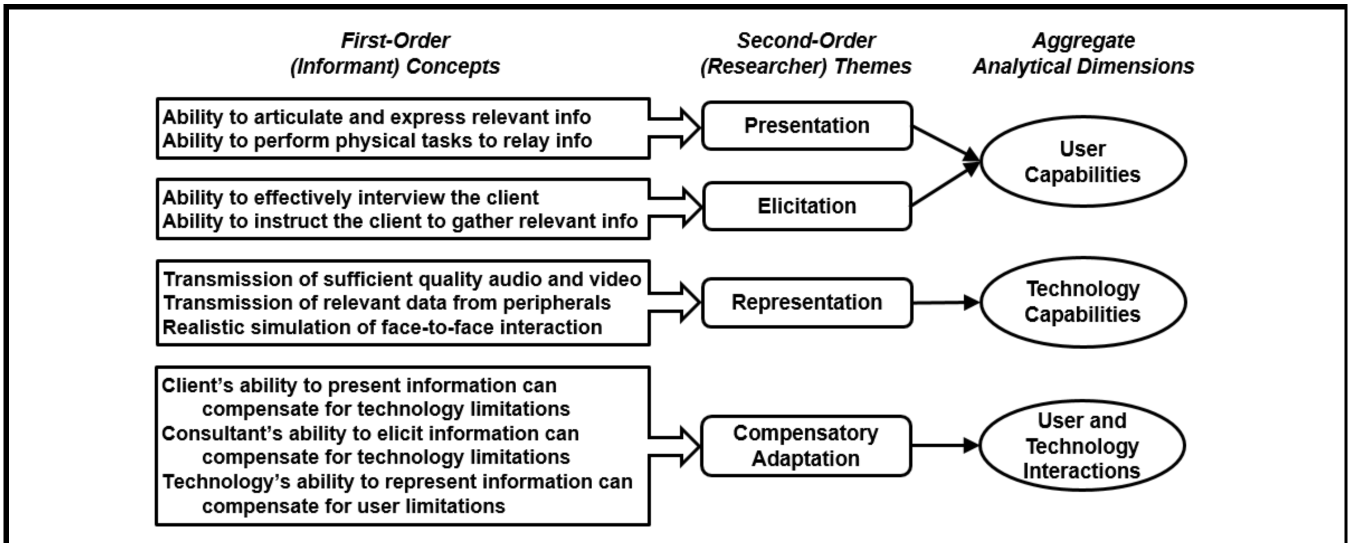

Figure A1. Data Structure of Findings

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Appendix B

Study 1 (Field Survey) Instrument Development

We followed established guidelines to develop scales for constructs in our research model (Mackenzie et al. 2011; Netemeyer et al. 2003; Straub 1989). A complete list of items for this study can be found in Table B1. All constructs were measured using a seven-point Likert scale where 1 = Strongly Disagree and 7 = Strongly Agree.

We measured the constructs using the medical consultation as our level of analysis and, thus, required respondents to recall one of their most recent telemedicine consultation experiences and respond to the survey questions based on that one particular telemedicine consultation experience. Prior to answering survey questions, the respondents were asked to describe (in open ended questions) the patient's medical condition and the particular telemedicine consultation experience, including interactions with the telemedicine participants and technology. This served as a validity check to ensure their telemedicine experience was valid for our research purpose (e.g., not a distance learning experience or other non-clinical application) and to facilitate the respondents' anchoring on that one particular experience when answering the remaining survey questions.

For most constructs in our study, we developed new scales because validated scales did not exist. There were no existing scales for presentation and elicitation, and existing scales for representation and perceived diagnosticity were deemed incomplete. Most of the existing items for perceived diagnosticity use language such as "judge" the quality or attribute of a product or "to get a real feel" for the product. Because we are focusing on the process of clinical evaluations of patients rather than products, this language did not seem appropriate and we opted to use wording such as *evaluate* and *assess*. Therefore, in reviewing existing scales for perceived diagnosticity, we chose to adapt one item from the literature that uses the language "carefully evaluate" in operationalizing diagnosticity (Kempf and Laczniak 2001; Pavlou and Fygenson 2006) and developed the remaining items. Similarly, when reviewing existing scales for representation, we found that this construct has been operationalized largely in terms of information completeness (Burton-Jones and Grange 2012; Overby and Konsynski 2010), which, in our context, only narrowly captures the construct's meaning according to our theoretical definition. Consequently, we adapted one information completeness item from Overby and Konsynski (2010) and developed additional items.

The item development process consisted of a prioritization exercise, item sorting, and two phases of pretest. We paid close attention to the content validity of the constructs by first ensuring that items represented the full domain of the construct definitions. Content validity was further assessed using a prioritization exercise (Mackenzie et al. 2011; Netemeyer et al. 2003) completed by four judges (doctoral students) who rated the extent to which each item was representative of the overall construct based on the construct's definition. We next employed item sorting by eight judges (faculty, doctoral students, and an IT professional) to provide a qualitative assessment of construct validity for the scales we created (Mackenzie et al. 2011; Netemeyer et al. 2003). Problematic items were reworded or dropped.

The survey was then pretested in two phases. First, we administered a pen-and-paper version at a practitioner telemedicine conference, where five telemedicine clinicians completed the survey and provided feedback. Based on their feedback, we shortened the survey and made modifications to the wording of some items. Second, we presented the revised instrument to two physicians and specifically requested suggestions concerning both the survey design and item wording. As a result of their review, we clarified survey instructions and modified the wording for some additional items.

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Table B1. Construct Definitions and Item Measures
Perceived e-consultation Diagnosticity: *the perceived ability of the telemedicine system (including technology and users) to enable consulting clinicians to understand and evaluate the health conditions of remote patients* During this particular telemedicine consultation, the ***telemedicine consultation***[a] allowed me to: DIAG1: Carefully evaluate the health condition of the patient DIAG2: Thoroughly assess the health condition of the patient DIAG3: Accurately evaluate the patient's health condition
Representation: *the perceived capacity of the telemedicine technology to present information relevant to the clinical evaluation process, including simulations of actors and objects within the physical setting, their properties and characteristics, and how process participants interact with them.* During this particular telemedicine consultation, the ***telemedicine technology***[b]: REP1: Transmitted audio and video feedback that was adequate for the clinical evaluation REP2: Transmitted all of the relevant information I needed for the clinical evaluation REP3: Allowed me to see everything that I needed to see for the clinical evaluation
Presentation: *perception of the presenters' capacity to relay information relevant to the clinical evaluation process, based on their ability to articulate pertinent information and execute actions that inform the process* During this particular telemedicine consultation, the ***presenting provider and/or patient*** was able to: PRES1: Effectively articulate the information I needed to know PRES2: Disregard irrelevant information and communicate to me only what was important PRES3: Execute hands-on tasks in order to give me the clinical information I needed PRES4: Complete the tasks necessary to present me with the information I needed
Elicitation: *perception of the consultants' capacity to solicit information relevant to the clinical evaluation process, based on their ability to interview and instruct the presenter(s) in a manner that informs the process* During this particular telemedicine consultation, ***I*** was able to: ELIC1: Effectively ask questions to elicit important information about the patient's condition ELIC2: Ask questions that were clearly understood by the patient and/or presenting provider ELIC3: Provide clear instructions to the patient and/or presenting provider on observing any patient conditions that needed to be communicated to me
Trust Requirements: *the perceived need for the client (advice-seeker) to trust the consultant (advice-giver) in a medical consultation context*[c] In general, when conducting clinical evaluations for medical conditions such as this one, it is necessary that: TRU1: The patient believes he/she can have confidence in my abilities TRU2: The patient feels that he/she can trust me TRU3: There is a trusting relationship with the patient TRU4: The patient believes I am acting in his/her best interest
Sensory Requirements: *the perceived need for the process participants to be able to enjoy a full sensory experience of the process and other process participants and objects in a medical consultation context*[c] In general, when conducting clinical evaluations for medical conditions such as this one, it is necessary that: SEN1: I use auscultation techniques[d] to evaluate patient organ systems during the clinical evaluation SEN2: I physically examine the patient during the clinical evaluation SEN3: I employ the sense of touch during the clinical evaluation SEN4: I obtain tactile feedback concerning the patient's condition during the clinical evaluation SEN5: I employ palpation and percussion techniques[d] during the clinical evaluation

[a]Respondents were provided with the following definition: *telemedicine consultation refers to both the technology and the interactions with people via the technology*.

[b]Respondents were provided with the following definition: *telemedicine technology refers to the telemedicine equipment, software and network only.*

[xc]The control variables of trust requirements and sensory requirements refer to perceptions of the *need* for trust and sensory experience and not perceptions of whether these needs were met.

[d]The techniques of auscultation, palpation and percussion refer to physical examination techniques employed during medical consultations.

Appendix C

Study 1 (Field Survey) Sample Characteristics

Table C1. Sample Characteristics (n = 201)			
Variable	**Category**	**Freq.**	**Percent**
Gender	Male	121	60.2
	Female	80	39.8
Age	25–34 years	17	8.5
	35–44 years	61	30.3
	45–54 years	68	33.8
	55–64 years	37	18.4
	65+ years	18	9.0
Years of Telemedicine Experience	< 1 year	14	7.0
	1–3 years	76	37.8
	4–6 years	55	27.4
	7–9 years	22	10.9
	10+ years	34	16.9
Hours of Telemedicine Use Per Week	< 1 hour	35	17.4
	1–10 hours	141	70.1
	11–20 hours	15	7.5
	21–30 hours	6	3.0
	31–40 hours	1	0.5
	41–50 hours	2	1.0
	50+ hours	1	0.5
Number of Telemedicine Patients Per Week	< 1 patient	34	16.9
	1–10 patients	119	59.2
	11–20 patients	26	12.9
	21–30 patients	15	7.5
	31–40 patients	4	2.0
	41–50 patients	0	0.0
	50+ patients	3	1.5

Table C2. Geographic Location of Survey Respondents

State	Freq.	Percent	State	Freq.	Percent
Georgia	41	20.4	Washington	3	1.5
Missouri	31	15.4	Maryland	3	1.5
Arkansas	14	7.0	Nebraska	3	1.5
Virginia	11	5.5	Oklahoma	3	1.5
Kentucky	10	5.0	South Carolina	3	1.5
Massachusetts	8	4.0	Arizona	2	1.0
Kansas	6	3.0	Colorado	2	1.0
Texas	5	2.5	Florida	2	1.0
New York	5	2.5	Illinois	2	1.0
Louisiana	4	2.0	Pennsylvania	2	1.0
Michigan	4	2.0	Wyoming	2	1.0
Oregon	4	2.0	Iowa	1	0.5
California	4	2.0	Ohio	1	0.5
Hawaii	4	2.0	Rhode Island	1	0.5
New Mexico	4	2.0	South Dakota	1	0.5
Alaska	3	1.5	Utah	1	0.5
Indiana	3	1.5	West Virginia	1	0.5
Minnesota	3	1.5	Wisconsin	1	0.5
Tennessee	3	1.5			

Table C3. Respondents' Medical Specialties

Medical Specialty	Freq.	Perc.	Medical Specialty	Freq.	Perc.
Psychiatry	39	19.4	Pulmonology	3	1.5
Pediatrics	38	18.9	Genetics	3	1.5
Neurology	20	10.0	Nutrition	3	1.5
Clinical Psychology	10	5.0	Rheumatology	2	1.5
Obstetrics and Gynecology	9	4.5	Urology	3	1.5
Internal Medicine	9	4.5	Orthopedics	2	1.0
Surgery	8	4.0	Physical Medicine	2	1.0
Emergency Medicine	8	4.0	Speech-Language Pathology	2	1.0
Critical Care	8	4.0	Wound Care	2	1.0
Dermatology	7	3.5	Allergy-Immunology	1	0.5
Primary Care	6	3.0	Gastroenterology	1	0.5
Endocrinology	5	2.5	Hematology	1	0.5
Cardiology	4	2.0	Hepatology	1	0.5
Geriatrics	4	2.0	Oncology	1	0.5
Nephrology	4	2.0	Ophthalmology	1	0.5
Infectious Diseases	4	2.0			

Note: Some respondents reported more than one medical specialty. The frequencies reported in this table reflect all reported medical specialties.

Appendix D

Study 1 (Field Survey) Measurement Validation

Table D1. Inter-Construct Correlation Matrix and AVE

Construct	Mean (Std Dev)	DIAG	ELIC	PRES	REP	SENS	TRU
DIAG	5.54 (1.34)	0.94					
ELIC	5.94 (1.13)	0.72**	0.93				
PRES	5.57 (1.23)	0.64**	0.69**	0.82			
REP	5.51 (1.33)	0.69**	0.64**	0.55**	0.81		
SENS	3.79 (1.77)	-0.03	-0.10	-0.01	-0.09	0.78	
TRU	6.19 (1.05)	0.21**	0.14*	0.19**	0.16*	0.03	0.83

Legend: DIAG = e-consultation Diagnosticity; ELIC = Elicitation; PRES = Presentation; REP = Representation; SENS = Sensory Requirements; TRU = Trust Requirements

All constructs measured on a 1–7 Likert scale. The shaded diagonal is the square root of the AVE. **$p < 0.01$; *$p<0.05$.

Table D2. Results of CFA Measurement Model Analysis

Construct	Variable Name	Factor Loadings	Cronbach's Alpha	Composite Reliability	AVE
e-consultation Diagnosticity	DIAG1 DIAG2 DIAG3	0.94 0.95 0.94	0.96	0.97	0.89
Presentation	PRES1 PRES2 PRES3 PRES4	0.90 0.77 0.72 0.88	0.89	0.92	0.67
Elicitation	ELIC1 ELIC2 ELIC3	0.95 0.94 0.89	0.95	0.96	0.86
Representation	REP1 REP2 REP3	0.83 0.81 0.80	0.85	0.91	0.66
Sensory Requirements	SEN1 SEN2 SEN3 SEN4 SEN5	0.75 0.72 0.75 0.82 0.84	0.88	0.89	0.61
Trust Requirements	TRU1 TRU2 TRU3 TRU4	0.77 0.92 0.75 0.88	0.89	0.93	0.83

Appendix E

Interaction Effects for Study 1 and Study 2

Study 1: Field Survey

To further interpret the nature of the significant interactions, we employed partial derivative analysis, response surface graphs, and two-way interaction plots with simple slope tests.

Partial Derivative Approach

The partial derivative analysis is based on the analysis of the factored coefficients, or partial derivatives, of the latent variables involved in a significant interaction effect to examine the relationship between the dependent variable and each variable in the interaction effect separately while holding the other variables constant (Ping 2003). In other words, the partial derivative represents the slope of the regression line between one of the independent variables and the dependent variable, while holding constant all other independent variables. This allows us to examine the relationship between the dependent variable and the independent variable at all levels of the "other variable" in the interaction term. Using this method, we calculated the partial derivatives of our dependent variable, e-consultation diagnosticity, with respect to the independent variables involved in the significant interaction effects (presentation × representation and elicitation × representation).

Specifically, given the regression equation for H4, $Diag = \beta_0 + \beta_1 SensReq + \beta_2 TrustReq + \beta_3 Pres + \beta_4 Elic + \beta_5 Rep + \beta_6 (Rep \times Pres)$, the partial derivatives of e-consultation diagnosticity with respect to representation and presentation, respectively, are $\frac{\partial Diag}{\partial Rep} = (\beta_5 + \beta_6\ Pres)$ and $\frac{\partial Diag}{\partial Pres} = (\beta_3 + \beta_6\ Rep)$. Likewise, given the regression equation for H5, $Diag = \beta_0 + \beta_1 SensReq + \beta_2 TrustReq + \beta_3 Pres + \beta_4 Elic + \beta_5 Rep + \beta_6 (Rep \times Elic)$, the partial derivatives of e-consultation diagnosticity with respect to representation and elicitation, respectively, are $\frac{\partial Diag}{\partial Rep} = (\beta_5 + \beta_6\ Elic)$ and $\frac{\partial Diag}{\partial Elic} = (\beta_4 + \beta_6\ Rep)$. Results of the partial derivative analysis show that the relationship between presentation and e-consultation diagnosticity is strongest at low levels of representation (see Table E1; significant effects in bold) and nonsignificant at high levels of representation. Likewise, the relationship between representation and e-consultation diagnosticity is strongest at low levels of presentation and nonsignificant at high levels of presentation (see Table E2). In addition, elicitation has its strongest effect on e-consultation diagnosticity at low levels of representation and no significant effect at high levels of representation (see Table E3). Similarly, representation influences e-consultation diagnosticity the most at low levels of elicitation and has no significant impact at high levels of elicitation (see Table E4). Altogether, these results suggest that the user capabilities of presentation and elicitation matter most when representation is low, and vice versa, supporting H4 and H5.

Table E1. Presentation to Diagnosticity Relationship at Different Levels of Representation

Rep Levels (Scale 1–7)	$\frac{\partial Diag}{\partial Pres}$	Standard Error	T-Statistic
7	-0.02	0.24	-0.09
6	0.09	0.21	0.41
5.51 (Rep Mean)	0.14	0.20	0.70
5	0.19	0.18	1.06
4	0.30	0.16	1.92
3	0.41	0.13	**3.11**
2	0.51	0.11	**4.81**
1	0.62	0.09	**7.23**

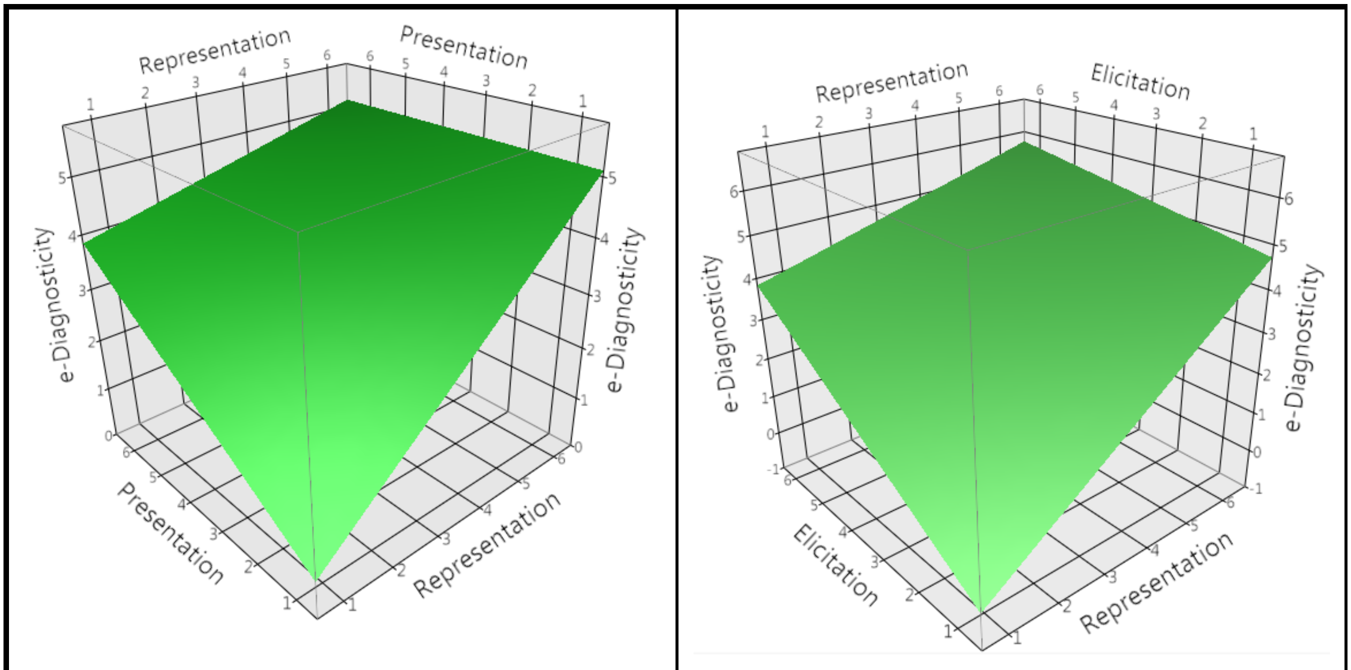
Table E2. Representation to Diagnosticity Relationship at Different Levels of Presentation			
Pres Levels (Scale 1–7)	**$\frac{\partial \text{Diag}}{\partial \text{Rep}}$**	**Standard Error**	**T-Statistic**
7	0.18	0.23	0.82
6	0.29	0.20	1.47
5.57 (Pres Mean)	0.34	0.19	1.81
5	0.40	0.17	**2.34**
4	0.50	0.14	**3.53**
3	0.61	0.12	**5.23**
2	0.72	0.09	**7.75**
1	0.83	0.07	**11.45**

Table E3. Elicitation to Diagnosticity Relationship at Different Levels of Representation			
Rep Levels (Scale 1–7)	**$\frac{\partial \text{Diag}}{\partial \text{Elic}}$**	**Standard Error**	**T-Statistic**
7	0.11	0.25	0.44
6	0.23	0.22	1.02
5.51 (Rep Mean)	0.29	0.21	1.36
5	0.35	0.20	1.77
4	0.46	0.17	**2.74**
3	0.58	0.14	**4.04**
2	0.70	0.12	**5.80**
1	0.82	0.10	**8.16**

Table E4. Representation to Diagnosticity Relationship at Different Levels of Elicitation			
Elic Levels (Scale 1–7)	**$\frac{\partial \text{Diag}}{\partial \text{Rep}}$**	**Standard Error**	**T-Statistic**
7	0.21	0.23	0.91
6	0.32	0.20	1.63
5.94 (Elic Mean)	0.33	0.20	1.68
5	0.44	0.17	**2.58**
4	0.56	0.14	**3.88**
3	0.68	0.12	**5.72**
2	0.80	0.09	**8.44**
1	0.91	0.07	**12.44**

Response Surface Methodology and Interaction Plots

The response surface methodology is an approach that enables three-dimensional visualization of the relationships between independent variables and dependent variables and is useful for interpreting interaction effects (Titah and Barki 2009). Regarding H4, under low levels of representation, there is a steeper slope for the relationship between presentation and e-consultation diagnosticity (lower left edge of the surface), whereas the slope for this relationship at high levels of representation is relatively flat (top right edge of the surface) (see Figure E1). This is



H4: Interaction Between Representation and Presentation

H5: Interaction Between Representation and Elicitation

Figure E1. Response Surface Visualization of Significant Interaction Effects for Study 1

also evident by the two way interaction plots (see Figure E2) and the simple slope tests, which reveal a strong positive relationship between presentation and e-consultation diagnosticity when representation is low ($t = 2.38$, $p < 0.05$) and a nonsignificant relationship between presentation and e-consultation diagnosticity when representation is high ($t = 1.16$, $p = 0.25$). This implies that user presentation capabilities can compensate for limitations in the technology such that when technology has low representation capabilities, user presentation skills become an important determinant of the diagnostic process.

In exploring the other side of this interaction, when presentation capabilities are low, the surface plot shows a steeper slope for the relationship between representation and e-consultation diagnosticity (lower right edge of the surface) compared to the slope at high presentation levels (top left edge of the surface) (Figure E1). Consistent with these results, the two-way interaction plots (Figure E2) and simple slope tests show that when presentation is low, there is a stronger relationship between representation and e-consultation diagnosticity ($t = 5.32$, $p < 0.001$) compared to when presentation is high ($t = 4.27$, $p < 0.001$). This indicates that representation capabilities are especially important when presentation capabilities are low and that the additional information provided by high levels of technology representation can compensate for information that a user fails to present or presents poorly. Collectively, these findings support H4.

Regarding H5, under low levels of representation, there is a steeper slope for the relationship between elicitation and e-consultation diagnosticity (lower left edge of the surface) compared to the slope for this relationship at high levels of representation (top right edge of the surface) (Figure E1). The two-way interaction plots (Figure E2) and simple slope tests reveal that the relationship between elicitation capabilities and e-consultation diagnosticity is stronger at low levels of representation ($t = 3.74$, $p < 0.001$) than at high levels of representation capability ($t = 3.20$, $p < 0.01$). These findings suggest that elicitation capabilities can compensate for lack of technology representation capabilities. Likewise, the surface plot shows that there is a steeper slope for the relationship between representation and e-consultation diagnosticity at low levels of elicitation (lower right edge of the surface) compared to high levels of elicitation (top left edge of the surface) (Figure E1). Consistent with these results, the two-way interaction plots (Figure E2) and the simple slope tests show that when elicitation is low, there is a stronger relationship between representation and e-consultation diagnosticity ($t=4.99$, $p<0.001$) compared to when elicitation is high ($t = 4.29$, $p < 0.001$). This suggests that representation capabilities matter most when user elicitation capabilities are low and can compensate for poor elicitation skills. In sum, these findings lend further support for H5.

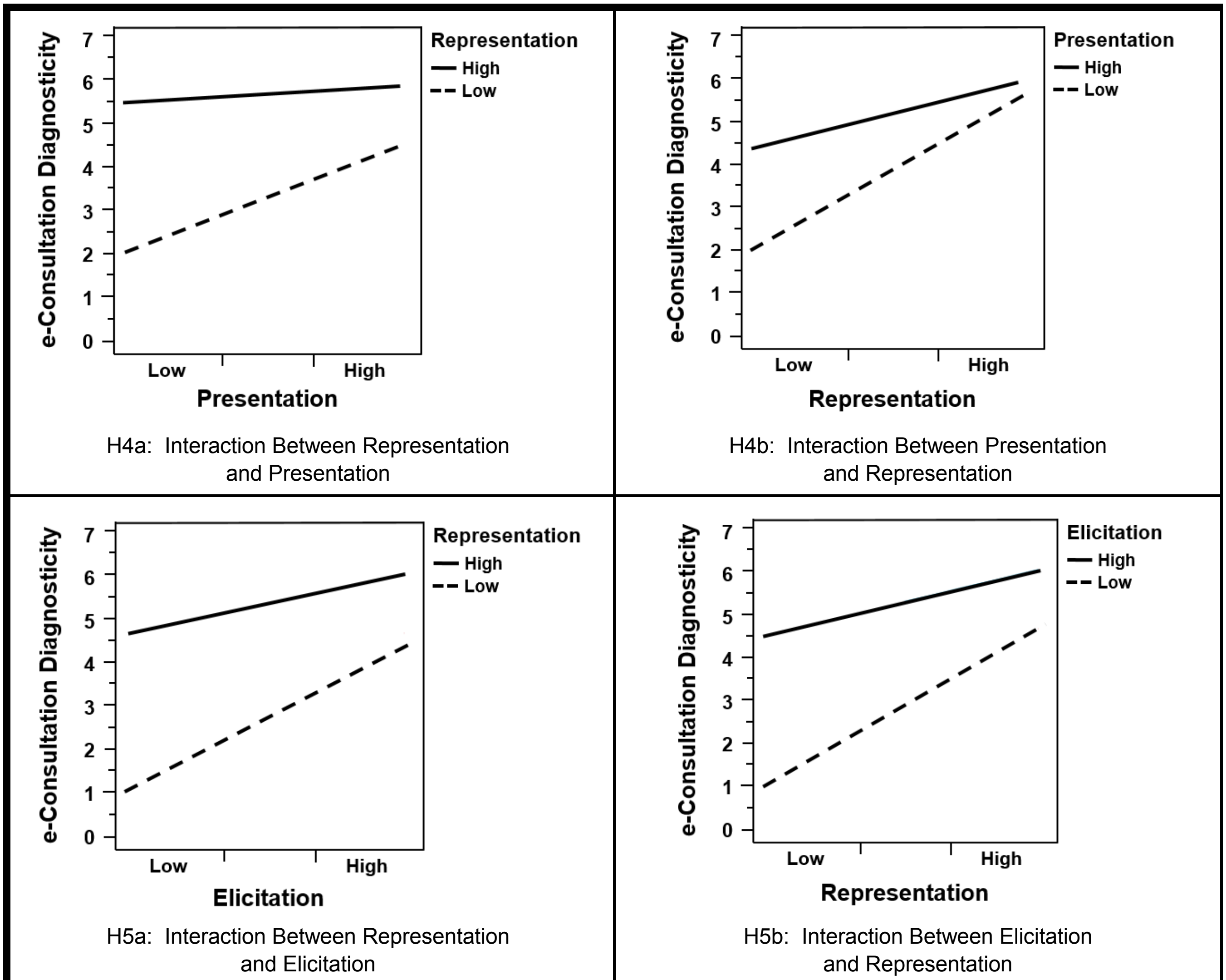
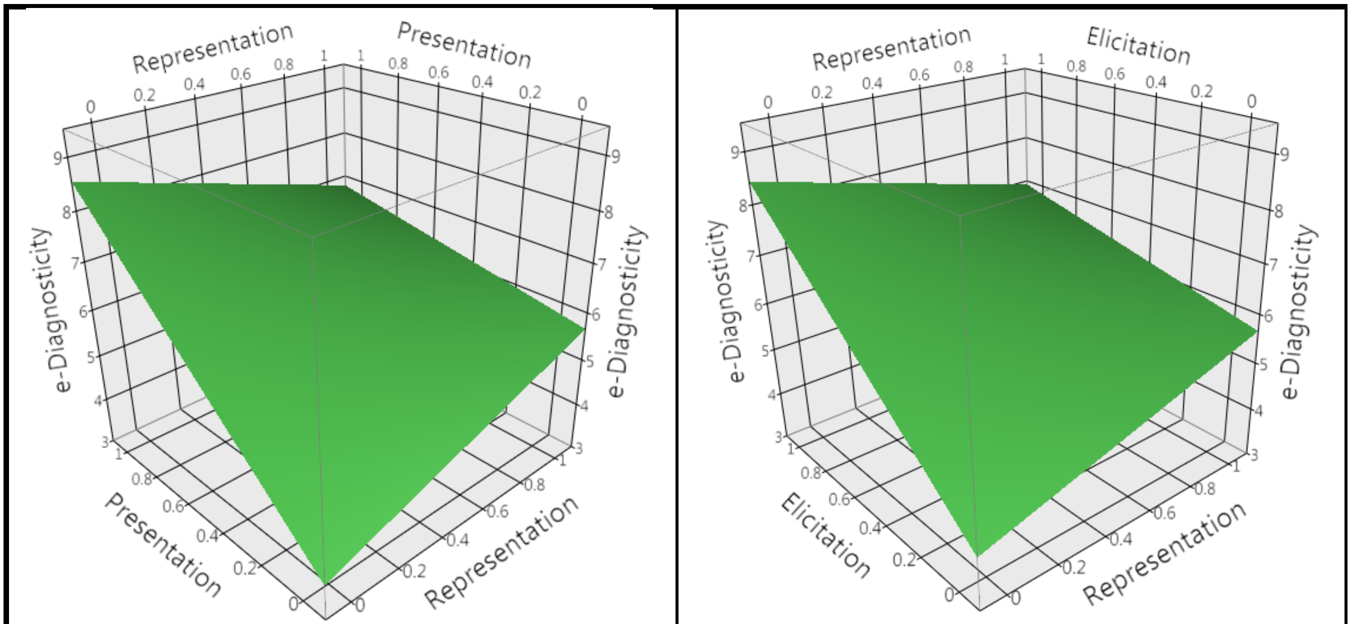


Figure E2. Interaction Plots: Field Survey (Study 1)

Study 2: Lab Experiment

To explore the nature of the significant interaction effects, we produced surface response graphs (Figure E3) and interaction plots (Figure E4) and performed simple slope tests. With regard to H4, the surface plot (Figure E3) shows that, under low levels of representation, there is a steeper slope for the relationship between presentation and e-consultation diagnosticity as compared to the slope for this relationship at high levels of representation. Supporting these results, the two-way interaction plots (Figure E4) and simple slope tests show that the relationship between presentation capability and e-consultation diagnosticity is stronger at low levels of representation ($t = 5.85$, $p < .001$) as compared to high levels of representation ($t = 1.67$, $p < 0.10$). Hence, when user presentation skills are poor, technology representation becomes an important informant in the e-consultation process, compensating for weaknesses in the user's problem presentation skills. Furthermore, the surface plot reveals a steeper slope for the relationship between representation and e-consultation diagnosticity at low levels of presentation compared to the slope for this relationship at high levels of presentation. The two-way interaction plots and simple slope tests are consistent with these results. When user presentation capabilities are low, there is a significant positive relationship between representation and e-consultation diagnosticity ($t = 2.11$, $p < 0.05$), and when presentation capabilities are high, there is a weaker and negative relationship between representation and e-consultation diagnosticity ($t = -1.88$, $p < 0.10$). This suggests that technology capabilities are able to compensate for weaknesses in user presentation skills. Altogether, these findings support H4.



H4: Interaction Between Representation and Presentation

H5: Interaction Between Representation and Elicitation

Figure E3. Response Surface Visualization of Significant Interaction Effects for Study 2

In terms of H5, the surface plot (Figure E3) illustrates similar results. The relationship between elicitation and e-consultation diagnosticity has a steeper slope at low levels of representation than at high levels of representation. Moreover, the two-way interaction plots (Figure E4) and simple slope tests show that there is a stronger positive relationship between elicitation and e-consultation diagnosticity when representation is low ($t=5.36$, $p<.001$) and a weaker relationship when representation is high ($t=1.78$, $p<0.10$). These results imply that strong user elicitation skills can compensate for weaknesses in technology representation capabilities. Additionally, the surface plot depicts a steeper slope for the relationship between representation and e-consultation diagnosticity at low levels of elicitation as compared to the slope for this relationship at high levels of elicitation. The two-way interaction plots and simple slope tests also reveal a stronger relationship between representation and e-consultation diagnosticity at low levels of elicitation ($t = 1.68$, $p < 0.10$) versus high levels of elicitation ($t = -1.58$, $p = 0.12$). Thus, technology capabilities can compensate for poor elicitation capabilities. Collectively, these findings provide support for H5.

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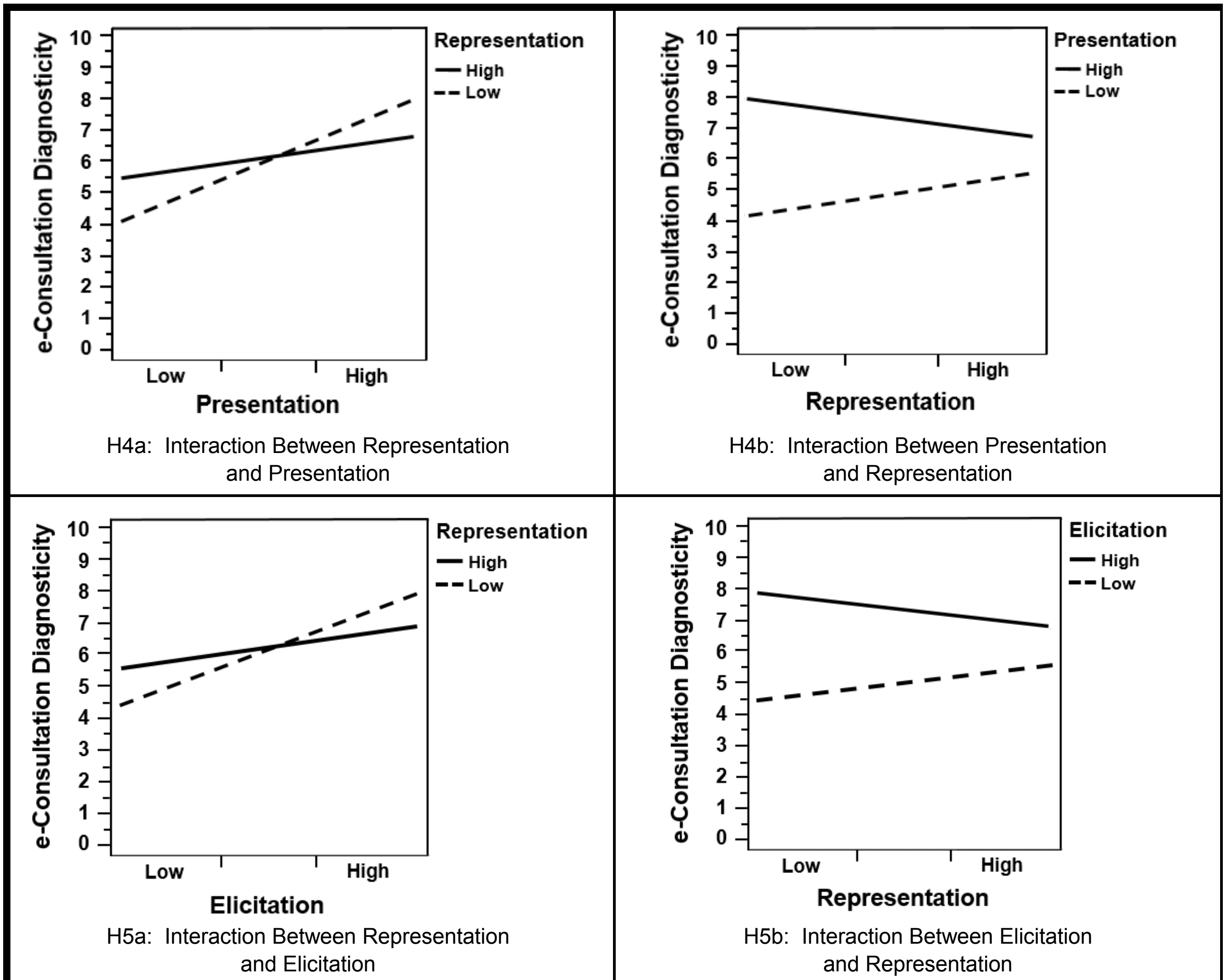

H4a: Interaction Between Representation and Presentation

H4b: Interaction Between Presentation and Representation

H5a: Interaction Between Representation and Elicitation

H5b: Interaction Between Elicitation and Representation

Figure 4. Interaction Plots: Lab Experiment (Study 2)

Appendix F

Post Hoc Analysis for Study 1

In Study 1, due to the possibility of multicollinearity between the interaction effects (correlation = .60) and the fact that the two interaction effects are non-significant when entered together in the regression, we combined the two user capabilities into a composite user capability construct and reran the regression analysis.

Table F1. Results of Post Hoc Hierarchical Regression Analysis (DV = E-Consultation Diagnosticity)

	Model 1		Model 2		Model 3	
Variable	**Beta**	**(S.E.)**	**Beta**	**(S.E.)**	**Beta**	**(S.E.)**
Controls						
Sens Req	-.039	(.070)	.028	(.044)	.034	(.043)
Trust Req	.205**	(.070)	.055	(.044)	.072	(.044)
Main Effects						
User Cap			.485***	(.062)	.439***	(.065)
Representation			.378***	(.057)	.334***	(.059)
Interaction Effects						
Rep × User					-.131*	(.038)
Sig. F Change	.013		.000		.016	
R^2	.043		.633		.643	
R^2 diff.	.043		.590***		.010*	

Standardized coefficients (standard errors), n = 201, ***p < 0.001, **p < 0.01, *p < 0.05

Results (see Table F1) indicate that both user capabilities and technology capabilities (i.e., representation) are significantly related to e-consultation diagnosticity ($p < .001$) and that the interaction between user capabilities and technology capabilities is significantly related to e-consultation diagnosticity ($p < .05$). The response surface and interaction plots reveal the same pattern of relationships as depicted in Appendix E, with a stronger positive relationship between composite user capabilities and e-consultation diagnosticity when representation capability is low ($t = 3.54$, $p < .001$) and a weaker relationship when representation capability is high ($t = 2.47$, $p < .05$). This suggests that user capabilities compensate for limitations in technology capabilities in determining task performance. Furthermore, the simple slope tests also reveal that there is a significant positive relationship between representation and e-consultation diagnosticity when composite user capabilities are low ($t = 2.51$, $p < 0.05$) and a weaker relationship when composite user capabilities are high ($t = 1.84$, $p < 0.10$). This indicates that technology capabilities can compensate for limitations in user capabilities in influencing task performance.

Appendix G

Description of Hyperthyroidism (Study 2)

Hyperthyroidism is a condition that results from overproduction of thyroid hormones. The thyroid is a gland located at the front of the neck below the voice box (larynx). The most common cause of hyperthyroidism is Graves disease, an autoimmune disorder that causes elevated activity in the thyroid gland. This disease is most common among women, with a peak onset of hyperthyroidism signs and symptoms occurring between the ages of 20 and 40 years. Evaluation and diagnosis of hyperthyroidism involve history taking, physical examination, and laboratory testing (Blackwell 2004; Singer et al. 1995; Skugor 2006). However, because the clinical interview only involves history taking and the physical examination, the experiment only includes these two diagnostic tasks (see Table G1).

Table G1. Evaluation of Hyperthyroidism

Diagnostic Task	Description
History Taking	Patients often present with the following medical history and symptoms: nervousness, irritability, sleep disturbance, fatigue, shortness of breath, heart palpitations, fine tremors of hands, heat intolerance (often with flushed cheeks and hands), increased perspiration, thinning hair, loose nails, weight loss, increased appetite and thirst, increased frequency of bowel movements, irregular menstrual cycle in women, joint swelling and pain, bulging eyes (exophthalmos), and enlarged thyroid (goiter).
Physical Exam	A physical exam to evaluate hyperthyroidism entails obtaining the patient's height, weight, heart rate*, and blood pressure*. Furthermore, the clinician should examine the patient's thyroid (e.g., palpate for enlargement), skin (for dryness and flushing), and eyes (for protrusion and vision impairment).

*Hyperthyroidism is associated with an accelerated heart rate and high blood pressure.

This condition was selected for a variety of reasons. From an experimental design perspective, we were interested in a health disorder that presents with visual signs that could be shown via the high representation treatment. However, we did not want the visual signs to be such obvious indicators of the health disorder that subjects would be able to discern the health condition upon first sight of the patient, thereby precluding the need for information gathering via an interview. Thus, of the two most conspicuous physical signs of hyperthyroidism, an enlarged thyroid and bulging eyes, we chose to represent only the enlarged thyroid and we displayed moderate swelling of the thyroid. This was deemed appropriate because not all patients with hyperthyroidism present with eye issues or severe enlargement of the thyroid. Furthermore, this condition was selected because all recruited subjects had completed a course on Adult Health and Illness, in which they learned about hyperthyroidism.

References

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Appendix H

Summary of Experiment Procedures (Study 2)

Of the 102 students scheduled to participate in the experiment, 9 cancelled, yielding a final sample size of 93 subjects. All subjects were scheduled to participate in the experiment over three consecutive days between semester sessions. This was to maintain consistency in the experiment procedures, the confederate's cosmetic makeup in the high representation condition, and the confederate's performance of the two scripts. Furthermore, because the experiment took place when no classes were in session, we were able to minimize in-class student interactions, which could potentially threaten the internal validity of the study.

When each subject arrived, he/she was checked in by the same research assistant and debriefed on the experimental task of conducting a telemedicine-based interview followed by completing a survey. All subjects were required to sign a confidentiality agreement stating that they would not discuss any details concerning the experiment to any outsiders to prevent contamination of the study. Each subject received a folder that contained a cover story explaining his/her role as a nurse who would perform a telemedicine-based assessment of a patient with a health problem located at a rural clinic who was contacting him/her via a nursing hotline to obtain triage advice. The subjects were provided with a patient assessment form, which listed basic information about the patient (name: Julie Smith, age: 35 years, gender: female, height: 5'3", and weight: 118 lbs.) and allowed them to take notes about the patient during the telemedicine session. Furthermore, the subjects were provided with a lab coat to wear during the telemedicine consultation. These steps were taken to mirror the typical procedures they would follow when conducting a face-to-face health assessment.

After the subjects completed the telemedicine patient assessment, they were directed to a computer where they completed the electronic survey and were distributed their cash incentive.

Appendix I

Presentation Scripts (Study 2)

Two nursing experts and the primary researchers of this study collaborated on writing the two scripts (high presentation and low presentation) for the confederate. Based on the signs and symptoms of hyperthyroidism, they chose the signs and symptoms the confederate would communicate in each script and the order in which she would present the symptoms. In addition, they constructed both a medical history and social history for the confederate and her fictional family members. See Table I1 for more details regarding the content of the two scripts.

Validity and Reliability of Presentation Scripts

To ensure validity and reliability of the scripts, the confederate engaged in multiple rehearsals with the first author and the nursing expert who co-wrote the script and also had opportunities to practice the script during two pretests (n = 5) and two pilot tests (n = 13). Furthermore, the experimental setup on the confederate's end was configured to facilitate her consistency in performing the two scripts. There was a printout of her script that was readable from where she sat on the patient exam table. Additionally, during breaks between subjects, she wrote extra details as needed on a large whiteboard visible to her. Finally, two monitors with a real-time instant messaging window were displayed to her. There was one monitor on each side of the camera, and the text was enlarged to be legible to her. The nursing expert who co-wrote the script was present during the three days of the experiment and observed all telemedicine interactions via a live stream on LifeSize UVC Video Center. This allowed her to use the instant messaging tool to send real-time messages to the confederate as a way of teleprompting the confederate to remain on script. This was especially important regarding the nonverbal communication and any unanticipated questions that arose to which there were no scripted answers. The nursing expert or confederate scripted answers to the new questions in real-time, and the nursing expert then recorded the newly scripted answers and instant messaged them to the confederate when the same questions were asked subsequently. Figure I1 depicts the experimental setup for the confederate.

Table I1. Script Content for Low and High Presentation

	Low Presentation	High Presentation
Baseline Signs & Symptoms Always Presented, by Order of Presentation	"I'm just not feeling myself."	"For the past three months, I just have not been feeling myself."
	"I have a hard time settling down most of the day but I'm also really sleepy. My eyes look tired."	"I'm shaky and trembling most of the day. I'm always fidgeting and can't sit still, even now as I'm talking to you. I'm also really sleepy. I have these dark circles under my eyes because I only sleep about three hours per night."
		"My face and hands are red and flushed. I'm just sweaty and hot all the time."
	"My hair feels different."	"My hair has gotten dry and brittle. In the shower, when I wash my hair, there is a whole gob of hair that ends up in my drain."
		"I'm losing weight. You'd think that's a good thing, but I'm not trying to lose weight."
		"Every time I swallow, I feel like there is a lump in my throat, like something is caught in my throat. It doesn't hurt or anything, and I can still eat fine, but if I touch it, it feels kind of swollen."
Additional Signs & Symptoms Presented Only if Elicited	Presented with minimum details: Heat intolerance, weight loss, swelling on front of neck, increased appetite and thirst, shortness of breath, heart palpitations, joint pain in legs, loose stools, irregular menstruation	Presented in great detail: Increased appetite and thirst, shortness of breath, heart palpitations, joint pain in legs, loose stools, irregular menstruation
Physical Execution of Tasks	Does not know how to take her own blood pressure or read output (132 over 94) from the blood pressure machine, needs explicit instructions Does not know how to take her own pulse (112/min.), needs explicit instructions	Knows how to take her own blood pressure (132 over 94) and read output from the blood pressure machine, little instruction needed Knows how to take her own pulse (112/min.), little instruction needed
Medical History Presented Only if Elicited	Takes 500 mg of Tylenol daily for pain in legs. Takes no vitamins or supplements. Delivered a baby (son named John) three months prior. Healthy pregnancy and vaginal delivery. Baby sleeps through the night and is healthy. Did not breast feed. Attended six week postpartum visit to OB/GYN physician. No reports from the physician of anything out of the ordinary medically at this visit. Father is deceased from a car accident. Mother is alive and healthy. No siblings. No medical history of chronic illnesses from mother's or father's side of the family.	
Social History Presented Only if Elicited	Moved in with her mother who lives in a rural town 1½ months ago. Single mother but father of baby is involved in the baby's life. Used to work as a full-time accountant but is currently unemployed by choice to spend time with her baby.	

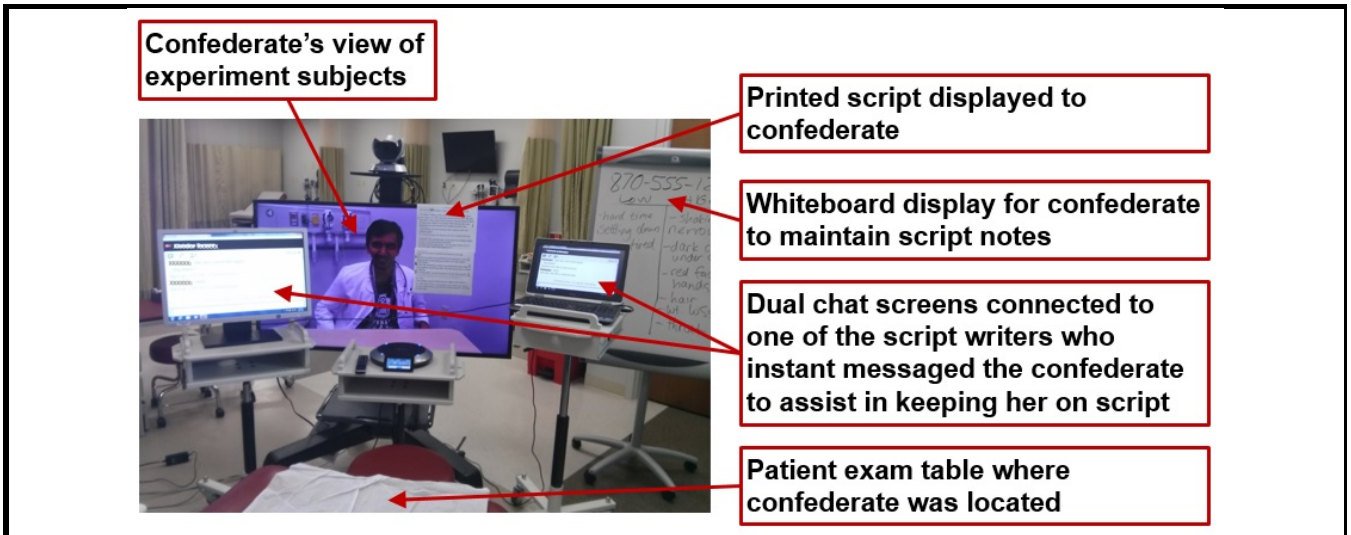

Figure I1. Experimental Setup for the Confederate/Patient

Appendix J

Experiment Manipulation Checks (Study 2)

Questions in Table J1 were used to test the manipulations. Responses from both subjects and expert judges were utilized for the manipulation checks. For subjects, responses were recorded on a seven-point Likert scale, with 1 representing "strongly disagree" and 7 indicating "strongly agree." For expert judges, responses were recorded on a five-point Likert scale, with 1 representing "strongly disagree" and 5 indicating "strongly agree." Construct means and reliabilities are presented in Table J2. Results of manipulation tests are shown in Table J3.

Table J1. Construct Definitions and Item Measures for Manipulation Checks		
	SOURCE	
Construct and Items[a, b]	**SUB**	**JUD**
Representation: *the perceived capacity of the telemedicine technology to present information relevant to the clinical evaluation process, including simulations of actors and objects within the physical setting, their properties and characteristics, and how process participants interact with them.* During this particular telemedicine consultation, the telemedicine technology:		
REP1: Transmitted audio and video feedback that was adequate for the clinical evaluation[c]	✓	✓
REP2: Allowed me to see everything that I needed to see for the clinical evaluation[c]	✓	
REP3: Provided a realistic representation of a traditional face-to-face health assessment	✓	✓
Presentation: *perception of the presenters' capacity to relay information relevant to the clinical evaluation process, based on their ability to articulate pertinent information and execute actions that inform the process* During this particular telemedicine consultation, the patient was able to:		
PRES1: Effectively articulate the information I needed to know[c]	✓	✓
PRES2: Execute hands-on tasks in order to give me the clinical information I needed[c]	✓	
PRES3: Complete the tasks necessary to present me with the information I needed[c]	✓	✓
RES4: Disregard irrelevant information and communicate to me only what was important[c]	✓	
PRES4: Clearly articulate her symptoms and concerns to me	✓	✓
PRES5: Volunteer relevant clinical information without being prompted		✓
Elicitation: *perception of the consultants' capacity to solicit information relevant to the clinical evaluation process, based on their ability to interview and instruct the presenter(s) in a manner that informs the process* During this particular telemedicine consultation, the subject (student) was able to:		
ELIC1: Effectively ask questions to elicit important information about the patient's condition[c]		✓
ELIC2: Provide clear instructions to the patient on observing any patient conditions that needed to be communicated to him/her[c]		✓
ELIC3: Conduct an effective focused assessment interview based on presenting symptoms		✓
ELIC4: Elicit from the patient all essential information about the patient's condition		✓
ELIC5: Conduct an effective patient interview, overall		✓

Legend: SUB = Experiment Subject; JUD = Expert Judge
[a]Subjects' survey items used first person perspective (I and me). This wording was changed to "the subject" in the expert judges' survey items.
[b]Operationalization of the dependent variable, e-consultation diagnosticity, is described in the methodology section of Study 2 in the manuscript.
[c]Survey items that are included in both Study 1 and Study 2.

Table J2. Construct Means and Reliabilities						
	Subjects (7-pt Likert Scale)			**Expert Judges (5-pt Likert Scale)**		
Construct	**Mean**	**Std. Dev.**	**Cronbach's Alpha**	**Mean**	**Std. Dev.**	**Cronbach's Alpha**
Representation	4.05	1.42	0.75	2.84	1.75	0.97
Presentation	4.87	1.19	0.87	2.91	1.67	0.98
Elicitation[a]				3.09	0.88	0.94

[a]Only expert judges' evaluation of subjects' elicitation skills were included in the analysis.

Table J3. Manipulation Test Results								
	Subjects (Seven-Point Likert Scale)				**Expert Judges (Five-Point Likert Scale)**			
	Low Mean (Std. Dev.)	**High Mean (Std. Dev.)**	**F**	**Sig**	**Low Mean (Std. Dev.)**	**High Mean (Std. Dev.)**	**F**	**Sig**
REP	3.42 (1.33)	4.82 (1.11)	29.40	.000	1.26 (0.17)	4.75 (0.20)	4168.82	.000
PRES	4.24 (1.21)	5.43 (0.85)	30.65	.000	1.18 (0.25)	4.47 (0.26)	3919.82	.000
ELIC[a]					2.34 (0.45)	3.83 (0.49)	236.93	.000

Legend: ELIC = Elicitation; PRES = Presentation; REP = Representation

[a]Only expert judges' evaluation of subjects' elicitation skills were included in the analysis.