CHAPTER 1. INTRODUCTION

A physician is attending the birth of woman who is diagnosed as having a healthy and normal childbirth when the electronic fetal monitor indicates that there may be fetal distress. The physician knows that this device is prone to false positives (physician distrusts technology) and is not designed to be a diagnostic tool, yet s/he also knows that failure to respond to the technology's diagnosis could result in an accusation of malpractice. If the physician relies on the technology, the appropriate decision would be to perform a cesarean section. Cesarean sections are not only expensive (increasing cost of care), but are also risky for the mother (increases in recovery time and infection). If the physician trusts their judgment and does not perform a cesarean section and the child is born with neurological damage the parents could sue the obstetrician ("Jackson v. Cohen," 2006). In Jackson v. Cohen, which is representative of a typical obstetric malpractice cases, the parents used the fetal monitor output as evidence of the obstetrician's negligence, (indicating high patient trust in the technology). In another hospital a pregnant Pittsburgh Steelers fan asks her doctor to induce labor early so she can watch the Super Bowl (Cassidy, 2006). In this case, the patient trusts the technology so much that she is willing to increase her risks of needing a major surgery (cesarean section), fetal distress or a rupturing her uterus in order to watch a football game. Elective induction can represent 30% of hospitals inductions (Cassidy, 2006). These cases exemplify the complexity of trust in medical technology relationships in obstetric work systems.

Purpose

The purpose of this research was to contribute knowledge to trust in technology models for health care workers and patients using a mixed methods research design. The results were a model of trust in medical technology that defined the construct and incorporated the roles of patients and health care workers. Trust in medical technology was defined as: ***A person's belief that electronic or mechanical devices used to replace or augment human labor in medical contexts will perform effectively*** (Sheridan, 1988).

For the purposes of this research, the terms automation and technology were used synonymously. To properly define trust in technology, an understanding of these terms is necessary.

Automation, like technology has a variety of accepted definitions in the minds of researchers and the public. Automation is defined in this research as the use of electronic or mechanical apparatuses to replace or augment human effort (Sheridan, 2002). Parasuraman (1997) similarly defined automation as using a machine to perform a function that was previously carried out by a human (Parasuraman, 1997). In other studies automation may be defined as the automatic control of the production of a product through a number of consecutive phases (Sheridan, 2002). This definition is only applicable in product manufacturing and does not encompass the potential use of automation in a variety of settings. Like automation, the definition of technology comes from the use of a "thing" to improve human capability.

The definition of technology has evolved from the traditional definition that evokes a human's use of a tool (like a wheel), to a more modern definition of the use of knowledge, invention, ideas and processes (JIN, 2005). The expanded definition would encompass such disparate concepts as biology, NutraSweet, or Six Sigma. In this research, technology was defined in the more explicit sense of hard technology (tools, machines, and equipment) as opposed to the modern concept of soft technology (processes, techniques, approaches) (JIN, 2005). More specifically, technology is the use of a hard technology by a human to replace or extend human capabilities. Therefore, to trust a technology or automation is to believe that a tool, machine or equipment will not fail (Sheridan, 2002).

Trust in technology is an important factor in system performance where humans interact with technology (Sheridan, 2002). Sheridan (2002) argued that trust in technology is important because it is both a cause and an effect of system performance. As a cause, trust in technology causes operators (people using the technology) to use it, or not, if they do not trust it. As an effect, trust in technology is an operator's perception that the technology is reliable, robust, familiar, understandable, explicates its intent, or useful (Sheridan, 2002). Current models argue that trust in technology is important because of the relationship between operator trust and the outcome of technology's correct use, misuse, disuse, or abuse (Parasuraman, 1997). If an operator trusts a technology appropriately and uses it the way a designer intended, the system should have high performance, efficiency and effectiveness. Technology misuse occurs when an operator uses a technology in a way the designer did not intend (Dzindolet, Peterson, Pomranky, Pierceb, & Beckc, 2003; Parasuraman, 1997). When an operator distrusts a technology, s/he will choose not to use the technology, which equates to under-trust in technology (Dzindolet et al., 2003; Muir & Moray, 1996b). If an operator over-trusts the technology, s/he will overuse the technology, which equates abuse (Bisantz & Seong, 2001; Parasuraman & Miller, 2004; Sheridan, 1988). An example of over-trust occurred in 1994 when a jet running under the control of an autopilot function crashed. The pilot assumed the autopilot function controlled his airspeed and failed to make changes, thus losing altitude and crashing (Sheridan, 2002). The delicate relationship between over-trust and under-trust dictates a negotiation between sufficient trust to influence usage of the technology and sufficient distrust to allow operators to be skeptical of the technology. This relationship is particularly important in settings where the costs of under or over-trust in technology are high, such as health care systems.

Innovation and invention have allowed health care systems to increase the use of electronic and mechanical devices to replace or augment human ability. For example, anesthesiologists now program machines to give patients the proper analgesic, in the proper dose, at the proper time (Sheridan, 2002). This allows the anesthesiologist to act as a supervisory controller of the machine and the patient. Supervisory control means the operator is encoding and receiving information from a source such as a machine, computer or human (Sheridan, 2002). The relationship between the anesthesiologist and the machine is subject to use, misuse, disuse and abuse. Leaving the technology to regulate the patient without monitoring in order to take a nap would constitute abuse. In this case, the doctor over-trusts the technology to function properly without monitoring. The patient can die if the technology malfunctions and administers too much medication or be subject to a great deal of pain if the technology administers too little medication. On a larger scale, most hospitals use computers to keep and retrieve patient records, and to pass information between health care workers (Perry, Wears, Chozos, Johnson, & Smith, 2006). In this case, a doctor can under-trust the technology and refuse to use it. Refusing to use the technology can increase the potential occurrence of errors in communication and record keeping. The effects of trust in technology in health care scenarios appear comparable to those in other work systems. Both systems involve an operator’s relationship with a technology and decision regarding usage. However, the difference between trust in technology and trust in medical technology in health care work systems is the presence of patients.

Patients are important stakeholders in the trust in technology model; because patients may not directly manipulate medical technology it is difficult for patients to observe factors that predict trust in technology such as reliability and predictability (Muir & Moray, 1996b). The majority of trust in technology research looks at trust in technology from the standpoint of the operator, which in a medical setting would be the physician, nurse or technician (Jian, Bisantz, & Drury, 1998a; Parasuraman, 1997; Parasuraman & Miller, 2004).

A given patient’s trust in medical technology may influence other aspects of the health care work system. It is arguable that medical technology becomes a key stakeholder in the doctor-patient relationship. Either it becomes the doctor by taking on the roles, practices and responsibilities that would normally be the province of the doctor, or, in other cases; it becomes a tool of the doctor. For example, patients who have a high level of trust in medical technology may request more technology and expect a large amount of technological interventions. They may also have false expectations about what the technology can provide. Highly trusting patients may not view technology as a physician’s tool, but as an authority of their well-being that rivals their physician’s say-so. Patients with low levels of trust in medical technology may feel as if they are receiving sub-standard care, because the physician is focusing on the technology instead of the patient. Failing to meet expectations of how technology is used may be cause for some patients to seek malpractice litigation.

Health care scholarship and policy has recently accepted the notion that a patient’s trust in his or her physician may be an important factor in predicting malpractice litigation and other factors such as health care system use, adoption, and adherence to advice (Hall, 2001; Hall, Camacho, Dugan, & Balkrishnan, 2002; Kao, Green, Davis, Koplan, & Cleary, 1998; Pearson & Raeke, 2000; Thom, Kravitz, Bell, Krupat, & Azari, 2002). Hall (2001) defined trust as a defining characteristic of the doctor-patient relationship; he argued that trust makes the patient physician relationship significant in itself, without consideration to any other function (Hall, 2001). If a patient displaces trust onto the technology rather than the physician, does the doctor patient relationship exist? If there is no relationship in the traditional sense, what does the role of the physician become? The unexplored relationship between medical technology and interpersonal trust in physician is an important topic for research.

A relationship exists between malpractice, medical errors and trust. In April 2000 the Institute of Medicine published a report entitled *To Err Is Human: Building a Safer Health System*. The report claimed that at least 44,000 people, and possibly as many as 98,000 people, die in hospitals each year because of preventable medical errors. Despite controversy regarding the legitimacy of the report's findings (Leape, 2000; McDonald, Weiner, & Hui, 2000), the report has resulted in changes in medical institutions (Leape & Berwick, 2005). Some of the major "solutions" to medical errors have been increases in care-giving technology and information systems (Bates et al., 2001; Berger & Kichak, 2004). Despite medical system efforts to reduce medical errors and increase patient safety, patient-prompted malpractice litigation is increasing (Zhao, 2005).

Problem statement

A person's trust in technology is an important construct to define in order to understand health care systems. While health care research advocates increases in interpersonal trust between patients and physicians, little is understood about the relationship between patient's trust in technology. More information about the relationship between patients and technology in medical work systems is needed to inform the design and implementation of new technologies in these systems.

Human factors design is defined as designing relationships between people and things (Sheridan, 2002). The goals of human factors engineering are to design systems that allow humans to interact in ways that 1) reduce error 2) increase productivity 3) enhance safety and 4) enhance comfort (Wickens, Gordon, & Liu, 1998). Designing automated systems that allow for appropriate levels of trust for operators and patients will 1) minimize errors resulting from mistrust, distrust and complacency 2) minimize loss of personnel and work hours due to malpractice 3) increase safety by reducing system disuse and abuse and 4) increase patient and operator comfort with technology.

Research questions and approach

The primary question directing this research was, **what is the construct trust in medical technology.** To begin to answer this question several other questions arose:

1) How is trust in medical technology related to trust in technology as it has been operationalized in previous studies (Bisantz & Seong, 2001; Jian, Bisantz, & Drury, 2000; Lee & Moray, 1992; Madsen & Gregor, 2000; Muir & Moray, 1996a; Taylor, Shadrake, & Haugh, 1995; Uggirala, Gramopadhye, Melloy, & Toler, 2004)?
2) How is trust in medical technology conceptualized in relation to distrust?

3) How do users construct trust in medical technology in a health care work system?
4) How can trust in medical technology be measured?

There were several goals for this research:

1) To define the construct trust in medical technology empirically, using methods developed by human factors researchers (Jian, Bisantz, & Drury, 1998c; Zhang, 1996).
2) To develop a model of how patients and care providers construct trust in a health care work system.
3) To develop and validate an instrument to measure trust in medical technology.

It was hoped that this research would lead to a better understanding of the role of technology in health care systems and would add to existing trust in automation literature.

Approach

The research is divided into three phases 1) Understanding trust in medical technology, 2) Constructing trust in medical technology, and 3) Measuring trust in medical technology.

<u>Phase I: Understanding trust in medical technology</u>

The goals of phase one were to understand the make-up of the construct trust in medical technology. Specifically, the following questions about the construct were answered:

1) Do users define trust and distrust in technology the same as they define trust and distrust in medical technology?
2) Is trust in medical technology the same as trust in technology?
3) Is trust in medical technology a theoretical opposite of distrust in medical technology or are they separate constructs?
4) What are the factors that form the construct trust in medical technology?

<u>Phase II: Constructing trust in medical technology</u>

Phase two was a qualitative study that explored how patients and physicians come to trust medical technology in an obstetric work system. The results from study were two models. Participatory methods were used to determine variances between patients' and care providers' experiences of obstetric technologies. Using the results of the study the following questions were answered:

1) How do patients characterize their user experience with medical technology?
2) How do patients come to trust medical technology?
3) How do providers come to trust medical technology?

Phase III: Measuring trust in medical technology

The goal of the research conducted in phase three was to create and validate a psychometric instrument of the measure trust in medical technology using the research results from phase I and phase II. A rigorous Rasch instrument development method was used (Wolfe & Smith, 2007a) to develop the instrument and evaluated it's psychometric qualities. The Messick (1995) validation framework was used to provide evidence of the instruments validity.

CHAPTER 2. REVIEW OF LITERATURE

Health care systems

Health care is "the prevention, treatment, and management of illness and the preservation of mental and physical well-being through the services offered by the medical and allied health professions" (The American Heritage® Dictionary of the English Language, 2000). The combination of care-providing services constitutes a health care system. The main goal of a health organization is to treat and to heal people and, in the worst case, decrease the pain of patients.

<u>US Health Care</u>

The U.S. government does not guarantee publicly-funded health care to its citizens. Health insurance is expensive and medical bills are the most common reason for personal bankruptcy in the United States (Himmelstein, Warren, Thorne, & Woolhandler, 2005). Health care organizations, specifically hospitals, in the United States are facing several key problems that can affect their ability to provide quality health care for the American public. On April 14, 2003 the *Health Insurance Portability and Accountability Act* was put into effect as a Federal Standard to protect the privacy rights of health care patients (Sultz & Young, 2006). This Act includes specific regulations to ensure the protection of identifiable patient health information. Hospitals and other health care organizations must abide by these regulations, implementing measures to protect all forms of personal health care information including paper-based, computerized or orally communicated patient medical record data (Services, 2003). While this Act was put into effect years ago, hospitals are still working to ensure that they fully uphold the laws, especially with regard to the electronic transfer of data for insurance claims (Sultz & Young, 2006). In order to meet the regulations, hospitals have had to make infrastructure changes, both technological and procedural, which have proven problematic in terms of training employees and maintaining 100% compliance with the law. Should a hospital fail to meet a HIPAA regulation they are subject to serious penalties, fines, and jail time for specific employees (Sultz & Young, 2006).

Hospitals also must pass an audit by the Joint Commission on Accreditation of Health Care Organizations (JCAHO) every three years in order to ensure that they are meeting standards designed to continually increase the wellbeing and quality of care given to the community (JCAHO, 2006). These standards include such things as specific rules for abbreviations in a patient's medical record, steps for identifying a patient before administering any drug or performing any procedure and the amount of training each employee must receive in infection control. Complying with these standards requires that hospitals make infrastructure changes including implementing new procedures, training policies, and technologies on a regular basis. Dealing with these changing expectations of accreditation and government stakeholders is a problem facing hospitals today.

Hospitals also face many problems related to insurance regulations and coverage policies. Government insurance programs, such as Medicare and Medicaid, and private insurance companies have different policies on how coverage payments are disbursed and what medical procedures are covered. In 1966, Medicare became the second federal insurance program in history. It has grown to become one of the largest financial resources for most hospitals and presents the largest problem to health care organizations due to its specific and complex billing regulations (Sultz & Young, 2006). Recently, Medicare has changed from a retrospective fee-for-service system to a prospective payment system (PPS) with regard to how it reimburses hospitals for rehabilitation care provided to patients (PPS, 2006). The PPS reimburses hospitals a set amount for care provided to an older patient with a specific diagnosis regardless of what care is provided to that patient and how long they stay in the hospital. This system potentially forces hospitals to trade-off between their goal to provide the best possible care to patients and the financial bottom line for providing that care.

The rising costs of malpractice lawsuits and insurance are leading to labor shortages in hospitals. Physicians are becoming overburdened with the costs of malpractice insurance and are sometimes forced to leave the field (Zhao, 2005). There is also a major shortage of nurses and other skilled clinical employees; many hospitals are being forced to use insufficiently trained and overworked nurses in order to remain open. Sultz (2006) attributes the labor shortage in healthcare to increases in frustration with labor reductions, too much work, and too little time to uphold quality patient care. This shortage places a cost burden on hospitals to both find and retain skilled employees and forces some hospitals to restructure their organization to shift responsibilities. Nursing may be an area that is especially vulnerable to medical errors due to task demands; medical errors are likely to become even more common as the number of overworked and poorly trained nurses continues to rise (Rowland, 2000).

Malpractice and Medical Error

It is estimated that 195,000 people die each year from preventable medical errors in hospitals in the United States, which is twice the number reported by the Institute of Medicine (IOM) in its landmark 1999 report, *To Err Is Human*,: which cited 98,000 preventable deaths each year. According to the report, hospital medical errors are the sixth leading cause of death in the United States, after diabetes, influenza, pneumonia, Alzheimer's disease and kidney disease. Due to changes in the hospital since 1999, IOM representatives acknowledge that the actual number of medical errors occurring in the nation's hospitals may be more than was reported in 1999. The study examined 37 million Medicare patient records.

From the viewpoint of a sociotechnical system, the characteristics of a health care system include humans, technology, organization and environment, which interact with and affect each other. A problem with any one of these variables may lead to malfunctions of the whole system or cause a medical error. An error in many systems may result in system disorder or a loss of production, while an error in a medical system can harm someone's health or even threaten their lives. Medical errors occur in many forms. Sometimes 'human error' or ‘technology error’ is blamed, e.g., the misuse of a drug is referred to by the saying, ‘someone took it by mistake’.

In May 2003, clinical psychiatry news published an article entitled “Malpractice Crisis Breeds Fear, Distrust of System.” The article claims that physicians’ lack of trust in the legal system is causing them to order more tests, refer patients to more specialists, and suggest more invasive procedures (Silverman, 2003). This is no new development, as every major newspaper has long chronicled the growing negative effects of malpractice litigation, the main ones being increased insurance rates for physicians and increased costs of medical care overall in the United States. Some journalists have even coined the phrase “defensive medicine,” a style of providing medical care that involves extensive testing and reliance on technology to avoid litigation, to exemplify changes in physicians’ care-giving styles. This article raises several important questions that are essential to the proposed research. The title of this article includes the phrase “malpractice crisis.” Malpractice is typically defined as improper care, conduct, or treatment by a physician, hospital, or other provider of health care. However, throughout the article other terms are used to define malpractice, such as medical error and lack of quality care. By the article’s end, it is not clear if these terms are the same. What appears to be most absent in this discussion is a relationship between the patient and malpractice; specifically what factors influenced the patient to seek litigation. Secondly, there does not seem to be a discussion about the response of the medical community, which is to increase technology. A final point that this article makes is that physicians’ fear of litigation, which results in using more technology, makes them less “genuine and sincere” (or less honest) with patients (Silverman, 2003), which likely affects the patients’ trust in the physician. This article exemplifies the relationship that interpersonal and technological trust may have with the current malpractice crisis.

Health disparities

Groups who are deprived of health care because of their capacity to pay for services or access care, or those who endure health disparities because of some other minority status, are labeled the underserved population. In the United States, health disparities have been reported and studied in minority populations such as African Americans, Native Americans, Asian Americans, and Hispanics. When judged against White Americans, the above groups have more chronic diseases, higher mortality, and poorer health outcomes.

- African Americans have a higher incident of cancer (Fennell, 2005).
- African Americans and Hispanics have a higher incidence of diabetes (Fennell, 2005).
- African Americans have a higher incidence of heart disease (Lurie et al.).
- African Americans and Hispanics have a higher infant mortality (Laditka, Laditka, & Probst, 2006).
- African Americans have a higher incidence of infertility (Laditka et al., 2006).

Laditka (2006) argues that research has generally attributed ethnic disparities to poor life outcomes, but there is evidence that disparities may be related to practice and policy. A system analysis of the healthcare system requires an exploration of policies and practices that take into consideration in effective health care experiences for certain populations.

In conclusion, the health care system is complex, dynamic, and has multiple goals for each subsystem. The success of a health care system depends on five sociotechnical system elements: technological and personal subsystems, internal and external environments and the organizational and managerial structure (Hendrick & Kleiner, 2001). The proposed research must consider each of the subsystems when developing a model of technology in healthcare in order to fully define the construct trust in medical technology.

Trust

Human-System Trust

Health Care systems have several smaller subsystems. Insurance providers represent a subsystem that can influence the type and quality of care a patient receives. Trust in insurance providers provides insight to the creation of trust between patients and the larger health care system. Zheng et al. (2002) developed a scale to measure patients' trust in health insurers. They developed a conceptual model of trust in insurers but concluded that more information is needed to define the factors that lead to patients' trust. They also recommended future research to identify how patient trust affects patient behaviors (Zheng, Hall, Dugan, Kidd, & Levine, 2002).

The health insurance system is a large part of the health care system. Balkrishnan et al. (2004) looked at the relationship between patients' trust in their managed care insurer, physician, and future care-finding behaviors over time. They found that patients' trust in their insurer increased over time, but the patients' trust in physicians did not change (Balkrishnan, Hall, Blackwelder, & Bradley, 2004). The researchers' result contradicted previous research that concluded that patients' trust in insurer is more open to change (Hall et al., 2002; Zheng et al., 2002). Balkrishnan et al. (2004) argue that patients had much more power over choosing their physician as opposed to their insurance provider. If patients didn't feel they could trust their physician, they were free to find one that they could trust. However, Balkrishnan et al. (2004) were not able to ascertain what contributed to patients' trust in their insurance provider. They theorize that patients' trust in their physician is rounded in a deeper psychology that predisposes individuals to seek and submit to care in a vulnerable situation, rather go by than actual experiences from treatment. In this theory, trust in insurers is affected by the structure or behavior of the health plan.

The authors of the *Health Care System Distrust Scale* believe that distrust in the health care system is a barrier to health care system adoption. The researchers use characteristics such as seeking care, adhering to preventative care, and participating in medical research (Rose et. al., 2004). The scale was developed from a conceptual model of distrust in health care and items were created from focus group sessions, literature, and expert opinions. Trust is defined in four domains: fidelity, competence, confidentiality, and honesty/ informed consent. The scale was given to 55 people randomly selected for jury duty. Item-item and item-total correlations were completed. Items were dropped that had incomplete data from pilot tests and item correlations below .20 (Rose et al., 2004). The authors found that distrust measures were higher among African Americans than whites, and among people with higher education (some college or more vs. high school). They didn't find any differences among gender and age. To assess concurrent validity, the survey was delivered to 400 participants and compared to the trust subscale from the primary care assessment survey for validity testing (Pearson, -.34, p<.0005). Unfortunately, this test was not validated with Asian, Native American and Hispanic populations.

Powerlessness is an internal factor of health-seeking behavior, health care system adoption and use (Dunn, 1998). Dunn (1998) defines powerlessness in relation to Miller's (1984) definition of powerlessness. They argue that "perceived powerlessness or perceived lack of control over health situation, will lead to apathy, withdrawal, diminished patient initiated interaction, and nonparticipation in care or decision-making," (Dunn, 1998 p. 136). Research has associated "the reduced utilization of health care services, behavioral inhibition, alienation and lower motivation" with the concept of powerlessness (Dunn, 1998 p.138). The concepts of locus of control and powerlessness (which are often used interchangeably) are seen as distinct entities on the scale of Powerlessness Regarding Health-Service Barriers. Miller (1984) asserts that powerlessness is situational and locus of control is a more permanent personality trait (Dunn, 1986). This model can be used to effectively measure real perceptions and experiences regarding health care, as opposed to an innate trait of powerlessness. The PHSB scale represents the construct of powerlessness as well as systematic and subjective perceived barriers to care (Dunn, 1998). The barriers identified in the measure are derived from literature related to college-aged students. The barriers of interpersonal relationships (Doescher et. al, 2000), economics, site-related impediments, fear and inconvenience (Dunn, 1998) are also represented in broader literature about barriers to health services.

Items were developed from a series of interviews with students on their experiences with care, literature on powerlessness, and health-care barriers (Dunn, 1998). Content validation for this measure occurred in several stages. First, 80 initial items were critiqued for face validity, readability, and clarity. Second, college-aged students reviewed the remaining items for clarity, redundancy, and meaningfulness. Third, nursing experts on powerlessness critiqued the remaining 48 items for content validity. Fourth, item-total correlations were derived with 98 participants. Inter-item correlations were also conducted to assess for redundancy. Lastly, matrix evaluations were performed to make sure each item met the initial inclusion criteria (Dunn, 1998). The scale was given to 33 students (who had not completed the scale before) to evaluate test-retest reliability and internal consistency (Dunn, 1998).

Automation

Automation is the “mechanical or electrical accomplishment of work,” which often replaces acts that humans are capable of performing, or that humans are incapable of performing (Wickens & Hollands, 2000 p. 538). Automation is defined by 1) its intentions, 2) the human functions it substitutes and 3) the advantages and disadvantages it demonstrates in the interaction between humans and automated apparatuses (Wickens & Hollands, 2000 p. 538).

Automation is not solely limited to replacing a complete task. Wickens (2000) defines four categories of automation purposes:

1. The first purpose is using automation to complete functions that the human is incapable of accomplishing due to human limitations or safety concerns. In this category automation is necessary and required. Examples of this type of automation would be robots that collect artifacts from extreme locations such as the deep sea. Another example would be computers that perform complex calculations.
2. The second purpose is using automation to carry out functions when humans would otherwise perform poorly. Examples in this category are autopilot control systems, complex monitoring systems (such as in health care), collision avoidance systems, and diagnosis and decision support systems (Wickens & Hollands, 2000).
3. The third purpose is supplementing or supporting performance when humans have limitations. Wickens defines this category as different from replacing fundamental features of the task because its goal is to aid supporting jobs that are needed in order to achieve the focal task. Examples in this group are functions such as digital information retrieval devices.
4. The last purpose is based in economic need. Wickens says that automation is introduced in these circumstances because it is more expensive for the organization to use humans as opposed to technology. An example of this is robots used in manufacturing plants and computerized customer assistants (Wickens & Hollands, 2000).

<u>Function Allocation</u>

Function allocation is the starting point for automation; it determines which system functions should be automated and to what degree the automation should occur. Function allocation is the design process that determines which system functions should be accomplished by humans, machines, or both. Function allocation is acknowledged as an important part of the system design life cycle, yet it is also a point of controversy amongst professionals (Chapanis, 1996; Fuld, 1997). A variety of human/machine taxonomies and allocation methodologies have been developed to aid in the allocation of functions between humans and machines. However, as new technologies are developed and knowledge about the importance of understanding socio-technical systems in design increases, these methodologies are evolving.

The early stages of the system development life cycle include front-end activities such as user-analysis, function-analysis, task-analysis, environment-analysis, user-requirements, and system-specification (Wickens et al., 1998).

The concept of design is broad; it can represent a variety of activities from designing a new system or product, to developing part of a new system, to applying human factors principles to an existing system. Examples of functions would be to detect, to maintain, to monitor; these are a basis for defining more detailed tasks that are needed to accomplish the function (Meister, 1985). Functional analysis, also called function determination, is the first part of the function allocation process. The goal of function analysis is to define system functions for the future allocation of responsibility to humans and machines. In function analysis, the system's functional design is defined in terms of actions that must be performed in order to meet system goals. Meister (1985) says a function is first neutral, because it can be performed by a human, machine, or both, on a scale that ranges between no machine intervention (manual) to no human intervention (automatic). He goes on to say that these decisions are based on "cost, performance, reliability, maintainability, logistics, and human considerations,"(Meister, 1985). A conceptual representation of functional analysis is the functional flow diagram (Meister, 1985; Sanders & McCormick, 1987; Sharit, 1997). In addition to the function analysis, other inputs are needed such as past experience with similar systems, performance capabilities of machines and software, and knowledge of known human capabilities and limitations (Chapanis, 1996).

Wickens says that the conceptual design stage is where human factors specialists use the system design approaches to analyze the human-machine system and determine the optimal configuration of characteristics (Wickens et al., 1998). He goes on to say that this configuration should have an appropriate balance between product, human and system; this can be achieved by function allocation (Wickens et al., 1998). Price says that allocation should occur continually through the design life cycle (Price, 1985). It is important that function allocation is included in the design process (Price, 1985). Function allocation is both a process and a theoretical concept (Fuld, 1997), in which functions are distributed between available resources (humans, machines (software, hardware etc.) or combinations) (Sanders & McCormick, 1987). Concept function allocation advocates that humans and machines have a variety of capabilities and the designer has a responsibility to allocate the functions of the system appropriately. In application, function allocation is not simple; there are a variety of complicated reasons why a function should be allocated to a machine or human.

Taxonomies

Paul Fitts (1951) developed a list that details which functions humans and machines are most capable of performing. One function allocation method involves assigning functions to the entity that is seen as most capable; however, this method can lead to a variety of design problems. Allocating functions without understanding system characteristics can lead to work system pitfalls, such as a technology-center design and the leftover approach to function allocation (Hendrick & Kleiner, 2001; Wickens et al., 1998). Fitts' list is criticized for being too general; however the theory of Fitts' list is useful to help direct attention to problems in human-machine systems and remind designers of the different human and machinecomponents of which the system is comprised (Fuld, 1997; Sanders & McCormick, 1987). A systematic approach for allocating functions has been an intangible goal of human factors specialists since its conception (Fuld, 1997); however, several systematic methodologies have been developed, but are not as widely used. Chapanis states that many allocations are forced on the designer because of high-tech capabilities or limitations or cost (Chapanis, 1996).

Saunders and McCormick (1987) provide a generalized list (Table 2.1) of the capabilities of humans versus machines, derived from a variety of sources (Chapanis, 1960, Fitts, 1951, 1962; Meister, 1971; Meister and Rabideau, 1965; and others). Mutual capabilities of humans and machines are excluded. Lists such as these have very little practical use because they are too generalized and qualitative (Price, 1985).

Table 2.1

Human and Machine Capabilities

Humans are better at	Machines are better at
Sensing low levels of certain stimuli	Sensing stimuli outside the normal range of human sensitivity (such as x-rays, radar wave lengths, and ultrasonic vibrations)
Detecting stimuli against high noise level background	Applying deductive reasoning
Recognizing patterns of complex stimuli	Monitoring for specific events, especially infrequent ones
Sense unusual and unexpected events	Store coded information quickly and in substantial quantity
Remember large amounts of information over long periods of time	Retrieve coded information quickly and accurately
Retrieve important information from storage	Process quantitative information following specified programs
Draw upon varied experience when making a decisions; adapt decisions to situational requirement; act in emergencies	Make rapid and consistent responses to input signals
Select alternative modes of operation if certain modes fail	Perform repetitive activities reliably
Reason inductively; generalize from observations	Exert considerable physical force in a highly controlled manner
Apply principles to solutions of varied problems	Maintain performance over extended periods
Make subjective estimates and evaluations	Count or measure physical quantities
Develop entirely new solutions	Perform several programmed activities simultaneously
Concentrate on the most important activities when overload condition require	Maintain efficient operations under conditions of heavy load
Adapt physical response to variation in operational requirements	Maintain efficient operation under distractions

Source: Saunders and McCormick (1987), derived from a variety of sources (Chapanis, 1960, Fitts, 1951, 1962; Meister, 1971; Meister and Rabideau, 1965; and others).

Meister introduced a model of alternate possibilities of classifying functions, emphasizing that there are multiple ways of carrying out a function (Meister, 1985). In his model he introduced alternatives of functions being carried out primarily by an operator, a mix between human and machine, and primarily machine. Kleiner (2001) discusses a model of five levels of automation beginning with human dominant (level 1) to technology dominant (level 5). In level one the technology use is minimal, the operator is in control of power and decision-making, and is coined a "direct performer." Levels two, three, and four represent a continuum of human and technology working together. Level five represents total automation, coined the "executive controller," the machine controls power, decision making, and there is no need for human monitoring (Kleiner & Shewchuck, 2001). Price developed a graphical model to exemplify that allocation decisions are not just human or machine, but should be determined at some point between on a "goodness" decision matrix (Price, 1985).

<u>Function allocation methodologies</u>

Price (1985) describes a function allocation process that relies on the notion of one system design team composed of an engineering team and a human factors team. Price defines five steps in his methodology, emphasizing the importance of defining functions initially, without predisposition to technocentric solutions. Price's method involves clarifying requirements, defining functions, proposing design solutions using MABA-MABA lists, evaluation and iterations of the process (Price, 1985). In step one the team prepares for design by clarifying requirements and developing a documentation foundation. Then, functions are identified in terms of inputs and outputs, while accessory functions are identified simultaneously. In the next step designers hypothesize solutions by proposing an engineering hypothesis for each function. If they cannot find a solution, functions are redefined. Decisions on human/machine allocation are based on the engineering hypothesis. If no allocation can be made, the hypothesis is revised. Next a human factors hypothesis is made, to determine appropriate function allocation. These steps are repeated until agreeable sets of hypotheses are developed for the function. Step four involves evaluating and testing the allocation hypothesis. Step five involves iterating the design process to locate errors, increase detail in design, and optimize (Price, 1985). Price's methodology emphasizes four rules 1) acknowledging when mandatory allocations need to be made 2) develop allocation hypotheses based on balance of value 3) consider the role of cost in allocation and 4) consider the role of affective and cognitive support in allocation (Price, 1985). The strategy first allocates functions that are required to be allocated to a human or machine because of system constraints (harsh environment, legal, safety), which appears in several methodologies (Chapanis, 1996; Price, 1985). While it important to secure the safety of humans, this strategy may hinder the development of creative design solutions because of the predisposition to certain "mandatory allocation," guidelines on how to perform mandatory allocation may be needed.

Meister (1985) proposes a quantitative five-step function allocation method that involves determining which functions have been allocated, describing functions and using functional flow diagrams, establishing a weighting criteria, comparing alternative designs, and selecting the most cost-effective design. In Chapanis' similar attempt to quantify function allocation, allocation criteria are assigned a weight based on the system being developed, and the criteria are compared and given quantitative values based on their significance; alternatives follow the same procedure and the alternative with the highest score is chosen (Chapanis, 1996).

Several system designers propose using teams instead of individuals for function allocation (Kleiner, 1998; Kleiner & Shewchuck, 2001; Price, 1985). Kleiner and Shewchuck (2001) found that teams using participatory function allocation methods correctly allocated lower levels of automation for decision making when compared to individuals in a manufacturing function allocation task.

The Sheffield method was developed in the context of naval control systems. Its five-step methodology is similar to other traditional methods: 1) macro system overview 2) mandatory allocations 3) trade-off mechanisms for provisional allocation 4) provisional allocation between humans of different roles and evaluation and 4) dynamic allocations considered for functions left-over functions (Johnson, Harrison, & Wright, 2001).

The problem of incorporating the broader system characteristics into function allocation practices has spawned the development of new methodologies. Dearden, Harrison, and Wright (1998) propose the use of scenarios in function allocation. Their process identifies functions; allocates necessary functions; defines the operator's role; develops scenarios; identifies contradictions in allocation; identifies candidates for dynamic allocation; and then it is reviewed and iterated. Scenarios may be particularly useful in the design of healthcare technological systems where stakeholders come from a variety of backgrounds (physicians, patients, technicians, nurses, administrators etc.).

Wright, Dearden and Fields (2000), advocate a function allocation method that considers context and work practices using methods such as contextual design. The York method also uses scenarios to allocate functions within its appropriate context (Johnson et al., 2001). Its methodology includes 1) mandatory allocation, total automation, partial allocation and resolving allocation conflicts. From their evaluation of the Sheffield and York function allocation methods Johnson et al. (2001) propose a new function allocation method that supports the "designer in allocating function across an organizational structure and in determining what level of automation to provide," (Johnson et al., 2001).

One example of automation in obstetrics is the inclusion of the electronic fetal monitor. For simplicity, this device is a tool for monitoring heart rate and making decisions about abnormalities. It can be assumed that the existing (non-automated) system does not use an electronic fetal heart monitor; instead caregivers use a fetal stethoscope to monitor fetal heart rate and contractions. It can also be assumed that this information is recorded using paper and pencil instead of by a computer such as those attached to most fetal heart monitors (Cartwright, 1998).

<u>Advantages and potential disadvantages of automation</u>

Automation can offer many advantages such as decreasing costs, increased efficiency, productivity, and performance (Wickens & Hollands, 2000). Wickens (2000) outlines potential human factors problems with automation. Wickens (2000) says that many of the problems with automation devices result from the lack of concern for human factors in the design on the system interfaces. Complete automation eliminates the probability of human error, but increases the probability of system error (Wickens & Hollands, 2000). As the automation levels increase, the automation complexity increases, which leads to a higher probability that something somewhere will malfunction (Wickens & Hollands, 2000). An example of this is the reliance on software. The more automated a system is, the more code is needed to run the system, which also increases the probability of code errors and bugs (Landaur, 1995 as cited in Wickens & Hollands, 2000).

Automated systems can become so complex that the system accomplishes tasks in ways that are entirely different than the way a human would accomplish the same task. In these cases, the human operator may become suspicious of the automation systems operation and be surprised when the system does things that the human does not expect (Wickens & Hollands, 2000). Examples of this are found in literature about autopilot systems. Suspicion and surprise can lead human operators to believe that the automation has failed. Wickens (2000) says that reliable automated devices can give the perception that they are unreliable. The perception of a technology's reliability or unreliability directly relates to issues of trust. A failure of trust calibration occurs when the operator trusts the automation less than is reasonable as a result of the automation's complexity or because of its true level of unreliability (Wickens & Hollands, 2000).

Feminist history of obstetrics

Feminist scholars have studied the construction of modern obstetric systems by examining the history of childbirth. Two major models of childbirth practice are discussed historically in feminist literature named the midwifery work system and the obstetric work system. Differences between the obstetric and midwife model of childbirth are often described as a conflict between natural and unnatural. The midwifery model of childbirth has been mischaracterized as essentially "natural" currently and historically. Understanding the systems in terms of natural versus unnatural, delegitimizes the skill and knowledge midwives had and have, and assumes that they are not competent users of technology. The difference between the two models of care is contrasting ideologies about the use of technology. The midwifery work system is characterized as childbirth activities that rely on shared knowledge, specifically focusing on the mother as the source of knowledge about her body and the process. The midwifery work system is flexible in that it uses different levels of technology depending on necessity and relies on a variety of knowledge structures and diverse locations. The obstetric work system is located in the hospital and is characterized as childbirth processes controlled by obstetricians and managed with technology.

Female-attended non-interventionist births are represented as the exclusive model of childbirth historically across cultures and social classes until the 18th century (Duden, 1993; Leavitt, 1988; Oakley, 1986; Roberts, 1997; Ulrich, 1999). In this model, women's births are attended by family, friends and a midwife, who is an experienced and respected woman care provider. Feminists generally believe women were empowered in the midwife model (Leavitt, 1988). Midwives were often well-paid for their services; mothers were encouraged to make decisions about how they wanted to give birth and who they wanted to attend their births; friends and family were acknowledged as possessing useful skills and knowledge. This model relied on the women's personal experience with her body and birth attendants trusted their patients' experiences to make decisions about their care (Duden, 1993).

In the 18th century physicians were invited to attend to women's childbearing, because patients felt that they had a higher chance of survival if the physician were present (Leavitt, 1988). At first the physician was merely a bystander, but later physician developed obstetrical techniques dominated the birth process. The obstetrician's role in the midwife / obstetrician model evolved over time to eventually create the obstetric model of childbirth. While the obstetric model of care has changed in terms of details, it remains consistent in that it is characterized by childbirth occurring in a hospital, the obstetrician as being the primary authority in the birth process, and the obstetricians reliance on technology to manage the process, rather than the mothers insight.

Depictions of the midwifery model in feminist literature include themes of value in women's work and women's knowledge. However, at some point in history positive regard of midwives work and knowledge disappear and are replaced with a general devaluation of women's work and knowledge. Wendy Lutrell's (1998) analysis of the different ways of knowing provides an excellent framework for analyzing the different perceptions and experiences women from different class and ethnic backgrounds may have. In her study she describes how African American and White working-class women define and claim knowledge. Through ethnographic research she found that women have a variety of definitions of intelligence, but they make distinctions between common-sense knowledge (life experience) and intelligence (schooling). In her interviews, Lutrell noted that when White working class women are asked to describe people they thought of as intelligent, they only named men. The women describe intelligence to represent activities that men perform, such as skilled manual labor, and self-learned activities (playing instruments), but they did not associate women's labor or self-learned activities with intelligence. Both African American and White women associated women's common sense with instinct and care giving (affective, intuitive), and men's common-sense with learning (cognitive). Two important contributions come from Luttrell's study that relate to childbirth; the first is that gender-biased construction of knowledge contributes to the devaluation of women's work. Midwifery is considered an instinctual, care-giving act, until it is represented as a legitimate skill in the hands of men. The representation of midwifery as an instinctual care-giving act is prominent in feminist perspectives of midwifery; however, it devalues the actual skill and technology that midwives have, to simply describe their contributions in terms of common-sense care-giving activities. The second contribution is that Lutrell demonstrates that gender- and class-based concepts of intelligence and skill may influence the perceptions women have of themselves and of others. It is useful to understand that women's knowledge became devalued at some point historically across professional and private spectrums, when examining the de-valuation of women's knowledge about the childbirth activities of other women and the de-valuation of women's knowledge about their own bodies and childbirth.

The midwife depicts her role in the birth process not as a bringer of a natural process but as manager of the process. In many accounts from early midwives, most notably, *A Midwife's Tale: The Life of Martha Ballard, Based on Her Diary, 1785-1812*, the fact that midwives did use tools and technologies is neglected in the later feminist interpretations. The process of becoming a midwife is much like an apprenticeship to become a skilled worker like a blacksmith or a tailor. The midwives' tools may be described as "natural" medicines and herbs; however, these were advanced technologies for the time. They were also the same technologies that physicians of the time possessed. Technologies became more advanced, and the historical depiction is not that the midwives rejected these practices, but that they were denied access to these technologies (it is not known if they would have used them if they had access). It is probably true that the male-dominated system rejected the attendance of women at the birth process and prevented them from having access to the technology, which forced women to use physicians. Nevertheless, it is not accurate to claim that because midwives did not use the technologies of the time, they embraced a model of "nature" in birth. In understanding the work process of the midwife, it is important to note that the midwife had the authority to tell the pregnant woman what she should or should not be doing in relation to her pregnancy. Modern midwifery also uses many technologies and often understands the importance of the existence of technologies to intervene when there are complications. Currently, the culture in the United States embraces technology and feels that citizens are entitled to technological interventions, and these interventions are equated with better quality care. This process of valuing industrialization is historical, and around the time when women were being kicked out of the birth rooms, society was in the midst of exalting technology and equating it with better quality.

There are several themes that come from feminist literature that characterize modern obstetric work systems: 1) Using more technology makes one a better mother (whereas less technology can be defined as denying the child appropriate treatment and is labeled child abuse in some cases). 2) More technology is an indicator of better quality of medical care. 3) Technology makes it easier to plan and manage childbirth (i.e. induction, planned caesarean, ultrasound), the way men would. The result of conversations regarding technology as a "masculine" form of childbirth, have created the opposing "feminine" notions of natural childbirth.

Like midwives, women who esteem midwifery models of childbirth are not necessarily always holding "nature" in the highest regard. In fact the feminist rhetoric of natural in relation to childbirth is probably more harmful to women's self-esteem and identity than it is positive. First, it contributes to essentialized notions of motherhood by equating women's worth and self esteem with their biology and their ability to conceive naturally. Second, it is a mythological ideal in modern society: the idea of "natural" cannot be truly realized with technologies such as antibiotics or vitamins. The goals are confusing under this rhetoric, and it can be argued that they move the attention of feminist scholars away from the important issues women are facing in pregnancy, childbirth, and reproduction. Is the goal to have safe babies and mothers? Is the goal to allow women to have empowered decision-making and choices? However, even the concept of empowered decision-making and choice is complicated in childbirth and pregnancy. Complete empowerment and control over the reproductive technology might mean that women would be able to have babies at age 83 and schedule caesarean births around their favorite television shows. Finally, the concept of the natural in pregnancy and childbirth misrepresents the role of midwives in childbirth. Their role is not to provide women with natural birth experiences that are merely gimmicks. Their role is to understand the appropriate use of intervention and technology in the birth process, not to reject its necessity in certain circumstances. Modern and historical midwives have extensive training, expertise, and knowledge of the usage and implementation of technology, and arguably understand a larger spectrum of technologies than physicians (from holistic techniques to fetal monitors and forceps). These skills, coupled with an ideology that value women's authority and decision-making, create a different environment than that of the modern obstetrical environment. When broken down and modeled in terms of work processes and decision-making processes, it will be shown that the midwife model of childbirth is as complex as the obstetrical model. However, the differences do not lie in the technologies used, but in the appropriate use of technology.

African American women had little to no reproductive freedom and therefore the representation of pregnancy before the 1800s as a female-empowered event does not apply to African American women, despite the use of slave midwives (who attended the births of slaves and white women) (Kenyon, 2000). In this period African American women were the property of their masters, as were their children. To complicate this model, slave owners not only had a monetary interest in the physical labor female slaves could provide, but also in the female slaves' reproductive capabilities. The more healthy children a woman could have, the more profit a slave owner could make from their labor or sale (Roberts, 1997).

The decision to marry and/or have children often did not belong to the mother, but belonged to the slave owner. The lack of maternal decision-making represented itself in several ways: first, slaves were matched with other slaves to produce desirable characteristics (slave breeding) and second, female slaves were subjected to sexual assault by their masters (Roberts, 1997). Even during these early years slave owners understood the importance of protecting the fetus from harm which is indicated in accounts that state that they beat female slaves, they dug a hole in the ground for the pregnant woman's stomach and then beat her (Roberts, 1997). African American women also experienced a much higher rate of infant mortality than white women during this time which can probably be attributed to the poor care women received, their diet, and the strenuous work they were required to do often into the late months of pregnancy (Roberts, 1997).

Obstetricians are also characterized differently through occurrences in the subjugation of African American women that began during slavery and continued into the 20th century, such as experimentation without consent. For example, physicians experimented on slave women before practicing new surgical procedures on white women; gynecological surgery was developed by J. Marion Sims, by performing operations on slaves who were purchased for the experiments (Roberts, 1997; Sartin, 2004). Slaves' owners had most of the power in the childbirth model during slavery; nevertheless, women were able to become empowered with technologies such as abortions and birth control (Kenyon, 2000; Roberts, 1997). Women could choose to abort their pregnancies or kill their children to prevent them from growing up as slaves. Even the smallest amount of knowledge about the history of African American women and reproduction exemplify that African American women have always been, and currently are, socialized differently with regard to reproduction as an institution.

The dichotomy that has evolved that differentiates the midwife model of care from the obstetric model of care has evolved through a historical combination of devaluation of women's work and ideas, and capitalism. The two systems remain separate through different beliefs about the role of technology in childbirth. The obstetric model is characterized by managing birth through notions of complete control and awareness through technology. As a result this model can only exist inside the technological and financial establishment of the hospital system. The obstetric system (like other health care sub-systems) is subject to a variety of environmental impacts from the legal system, medical standards of care, medical research, cultural changes, and insurance systems. The midwife model is characterized by appropriate use of technology. This is why the midwife model of birth can move from the home to the birth center and to the hospital, when necessary. It relies on a direct relationship between the patient and provider, and can therefore disassociate itself from complicated financial structures that seek to define women's birth options in terms of the cost of hospital time and space.

CHAPTER 3. PHASE I EMPIRICALLY DEFINING TRUST IN MEDICAL TECHNOLOGY

Overview

Researchers in a variety of fields are interested in the role of trust in systems and have developed measures of interpersonal trust, system trust, and trust in technology (DeFuria, 1996; Dirks, 1999; Framer, 1999; Goold, Fessler, & Moyer, 2006; Hall, 2001; Jøsang & Presti, 2004; Pearson & Raeke, 2000; Siegrist, Cvetkovich, & Roth, 2000; Wickens & Xu, 2002). Most measures of trust in technology are developed from theoretical definitions of trust and were designed for specific populations. Jian et. al (1998) sought to determine if measures of trust in technology should use the same trust constructs as interpersonal trust measures. They found that trust and distrust are considered opposites, negating the need for two separate measures to be developed. They also found that participants rate concepts of generalized trust, interpersonal trust, system trust, and trust in technology similarly. Jian et al's (1998) research provides a framework for the development of a trust in medical technology theory and measure. It is not apparent if trust in medical technology is the same as trust in general technology. If the two constructs are different, existing trust in technology models may not be useful in discussions about medical technology. The studies involved in the development of a framework of trust in medical technology will determine if trust in medical technology is empirically the same as trust in technology. The methods described in studies one through three were based on research methods used to empirically define the constructs trust (Bisantz & Seong, 2001; Jian et al., 2000) and comfort (Zhang, 1996). These methods were chosen in order to offer an extension of previous trust in technology models and for their ability to compare and validate findings in the studies.

Study one: Factor generation

The factor generation study obtained a collection of words associated with trust and distrust of technology and medical technology. The goal of this study was to provide evidence towards understanding trust in medical technology as the same or different from trust in technology.

Participants. Participants were recruited through a Psychology research website and a linguistics listserv. Forty eight participants volunteered to participate. Of the 48 participants who started the study, 21 dropped out before completing the study. Participants who had professions or majors that exhibited an expertise with reading and writing remained in the sample. The 14 participants that were included in the sample were students or held degrees in English, sociology, psychology, linguistics, applied linguistics, sociolinguistics, and publishing.

- Participants ages ranged from 18-44 with M=26 SD= 7.97

- Seventy four percent self-identified as White/ Caucasian, 4 percent as African American/ Black, 4 percent as Hispanic, and 11 percent as Asian/ Pacific Islander.
- Education in years ranged from 12-21 with *M*=15 *SD*=2.44

Procedure. Participants first provided an open-ended definition of their understanding of trust and distrust in technology and another of medical technology. Second, participants were given a list of 160 trust-related words obtained from Jian et al.'s (1998) study to rate on a three-point Likert-type scale ranging from "positively related to trust in medical technology" to "not at all related to trust in medical technology" to "negatively related to trust in medical technology." The procedure was repeated with the same list of words for trust in technology.

Analysis. Participant open-ended definitions were coded with Atlas.ti® version 5.0 software under the themes trust in medical technology, distrust in medical technology, trust in technology and distrust in medical technology. Units of analysis were at the word level. The 27 participant responses were coded and included in the analysis.

Positively and negatively related words were included as study two variables. Words rated as "not at all related" to trust by 25% or more of the group were dropped from the word pool. Words that received conflicting ratings were also dropped (i.e. rated both positively and negatively). New words defined in the open ended definitions of trust/ distrust in technology and medical technology were included in study two.

Results. Thirty-nine additional trust and distrust related words were included in the final set of factors for the next study. Conceptually different definitions were provided for trust and distrust related to medical technology as opposed to a non-specified type of technology.

For Trust in Technology, Likert responses out of 160 words, 40 met Criterion 1 (not at all related by 25% or more) and 91 met Criterion 2 (conflicting ratings). For Trust in Medical Technology, out of 160 words, 56 met Criterion 1(not at all related by 25% or more) and 89 met Criterion 2 (conflicting ratings). Twenty seven words met both criteria for trust in technology and 37 words met both criteria for trust in medical technology (see Table 3.1).

Table 3.1

Words to be Included in the Study

	Trust in Technology	Trust in Medical Technology
1		Absolute
2		Anger
3	Assurance	Assurance
4		Attack
5	Can_be_relied_upon	Can_be_relied_upon
6	Certain	Certain
7	Certainty	Certainty
8		Competence
9	Confidence	Confidence
10	Constancy	Constancy
11	Cooperation	Cooperation
12	Count_on	Count_on
13		Cruel
14	Deception	Deception
15		Definite
16	Distrust	Distrust
17	Doubt	Doubt
18	Error	
19		Entrust
20	Failure	Failure
21		Falsity
22	Harm	Harm
23	Hesitation	
24	Honesty	Honesty
25	Integrity	Integrity
26	Misleading	Misleading
27	Mistake	Mistake
28	Mistrust	Mistrust
29		Overtrust
30	Positive	Positive
31	Reliability	Reliability
32	Reliable	Reliable
33	Secure	Secure
34	Security	Security
35		Security_in_caring
36		Trustworthy

37		Understandability
38	Usefulness	Usefulness
39	Wrong	Wrong

**Shading indicates a word that appears in one set and not the other.*

Discussion. It was expected that participants would provide similar definitions of trust in technology as with trust in medical technology, however the results show that participants provided mostly similar responses but not similar enough to indicate that participants view trust in technology the same as trust in medical technology. In the rating portion of the study, more words met both criteria for trust in medical technology than trust in technology, which may indicate that trust in medical technology encompasses more dimensions than trust in technology. The words that differentiate trust in medical technology from trust in technology according to the results are; Absolute, Anger, Competence, Attack, Cruel, Definite, Entrust, Falsity, Overtrust, Understandability, Trustworthy, Security_in_caring. The words that differentiate Trust in Technology from Trust in Medical Technology are Error and Hesitation.

It was also expected that new words would be added to the list of words that differentiate trust in medical technology from trust in an unspecified type of technology. Themes that arose in the analysis of trust in medical technology open-ended responses included notions of trust in physician, ideas about technological advancement or innovation, research, and trust in medical systems. The theme of technological advancement was included in analysis of trust in technology, but was represented more as a desire to try or own advanced technology (i.e. “Trusting technology and its advancements allows you to move ahead of the old ways,” p1) as opposed to a suspicion of new advances (i.e. “doubting new advances in medicine,” p17).

In open-ended responses, participants described trust in technology in three different categories:

1. Actions that a person performs when they trust a technology. Examples include: using a technology, consenting to use, purchasing, trusting it with important information or safety.
2. Feelings about the technology. Examples include: having faith, believing in the technology, and feeling comfortable.
3. Actions that the technology performs to lead to trust or distrust. Examples include: being accurate, being reliable, being understandable, being easy to use, and matching assumptions.

Thinking of trust in technology along these categories may provide insight into various ways of measuring trust (i.e. based on actions a trusting person performs). This information may also distinguish between trust as a belief system and trust as a product of a technology’s performance.

Limitations. Mortality was a threat to validity. Many participants dropped out of the study before completing which could be an indication of the study being too long and/or tedious. These drop-outs are likely related to the study being conducted online.

Study two: Comparing trust across contexts

The goal of study two was to identify a smaller set of words strongly related to trust and distrust in medical technology. The results of this study provided evidence to answer the research questions:

- *Question one: What is the relationship between trust across the conditions trust in medical technology and trust and technology?*
- *Question two: How is trust conceptualized with relation to distrust?*

Participants. Two hundred and nine participants were recruited from a major university's student community. Sixty eight participant responses were excluded from the final data set because they failed to complete the questionnaire, (two small studies were conducted to evaluate this phenomena, complete response rates remained higher in lab and paper questionnaire conditions as opposed to the online condition, while initiation rates were higher in the online condition). Of the remaining 141 respondents, 37 were dropped because of missing responses. A total of 104 responses were evaluated.

- Participants ages ranged from 18-40 with M=19.90 SD= 2.38.
- Eighty one percent self-identified as White/ Caucasian, 9 percent as Asian/ Pacific Islander, 6 percent as African American/ Black, 1 percent Hispanic, 1 percent multi ethnic, and 2 percent declined to respond.
- Education in years ranged from 12-15 with M=13.7 SD=1.19
- Participants were all native English speakers.

Apparatus. An online questionnaire was developed with each of the words generated from study one. The questionnaire contained a five point Likert-type scale with levels ranging from positively to negatively related to trust (see Table 3.2).

Table 3.2

Questionnaire Conditions

Questionnaire number	Construct Evaluated	Likert type Range
Questionnaire one:	Medical Technology.	positively related to trust-negatively related to trust
Questionnaire two:	Medical Technology.	positively related to distrust-negatively related to distrust
Questionnaire three:	General Technology	positively related to trust-negatively related to trust
Questionnaire four:	General Technology.	positively related to distrust-negatively related to distrust

Procedure. After providing consent, participants were asked to complete the four questionnaires. In each questionnaire participants were asked to rate words, from the list derived in study 1, as ranging from positively to negatively related to trust in medical technology or trust in technology. It took participants from 20 to 40 minutes to complete the task.

Analysis. Three types of analyses were performed: 1) Correlation analysis (trust and distrust); 2) Regression analysis; 3) Union Sets and; 4) Principal Component Analysis.

Question one: Is distrust a theoretical opposite of trust across conditions or is distrust a different construct?

A Pearson correlation analysis was performed to determine if trust and distrust words were highly positively and negatively correlated to identify them as theoretical opposites. A factor analysis was conducted to determine if the model matched the theoretical model. These factors were used as a blueprint for study three.

Question two: Is trust the same across the conditions, trust in medical technology and trust and technology?

Regression analyses were performed for each group's trust in medical technology and general trust in technology. The slopes of the lines indicate whether participants view trust in medical technology and general trust in technology the same. For each group the highest rated words were grouped and included in the paired comparison study.

Expected Results. High negative and positive correlations of trust in medical technology were expected to distinguish trust and distrust as theoretical opposites. It was expected that regression lines for trust in medical technology and trust in technology would produce similar slopes, indicating convergent and discriminate validity. It was also expected that the union sets and principal components analysis would produce similar factors for trust in medical technology and trust in technology, which would match the proposed internal model of the construct.

Results

Correlation. Average ratings for each word were calculated for all four conditions: trust in medical technology; distrust in medical technology; trust in technology; and distrust in technology. A multivariate Pearson correlation analysis for each word for rating of trust versus distrust were conducted for trust in medical technology and trust in technology in JMP. Ratings of trust were highly, negatively correlated with ratings of distrust (r (187)= -.99, p <.0001 and r (187)= -.99 p<.0001 respectively) (Table 3.3). Words with high positive ratings for trust also had high, negative ratings for distrust (Figure 3.1). This indicated that concepts for trust and distrust are opposites rather than containing different factors.

Table 3.3

Correlations of Trust by Distrust

Variable	by Variable	r	Signif Prob
medtech_distrust	medtech_trust	-0.9896	<.0001
tech_trust	medtech_trust	0.9906	<.0001
tech_trust	medtech_distrust	-0.9889	<.0001
tech_distrust	medtech_trust	-0.9843	<.0001
tech_distrust	medtech_distrust	0.9876	<.0001
tech_distrust	tech_trust	-0.9936	<.0001

Pairwise pearson correlations were also calculated (see Figure 3.1). The Pearson correlation between all variables pair was .99 $p<.0001$, with a count of 188 used for the computation. Only complete data was used for the analysis.

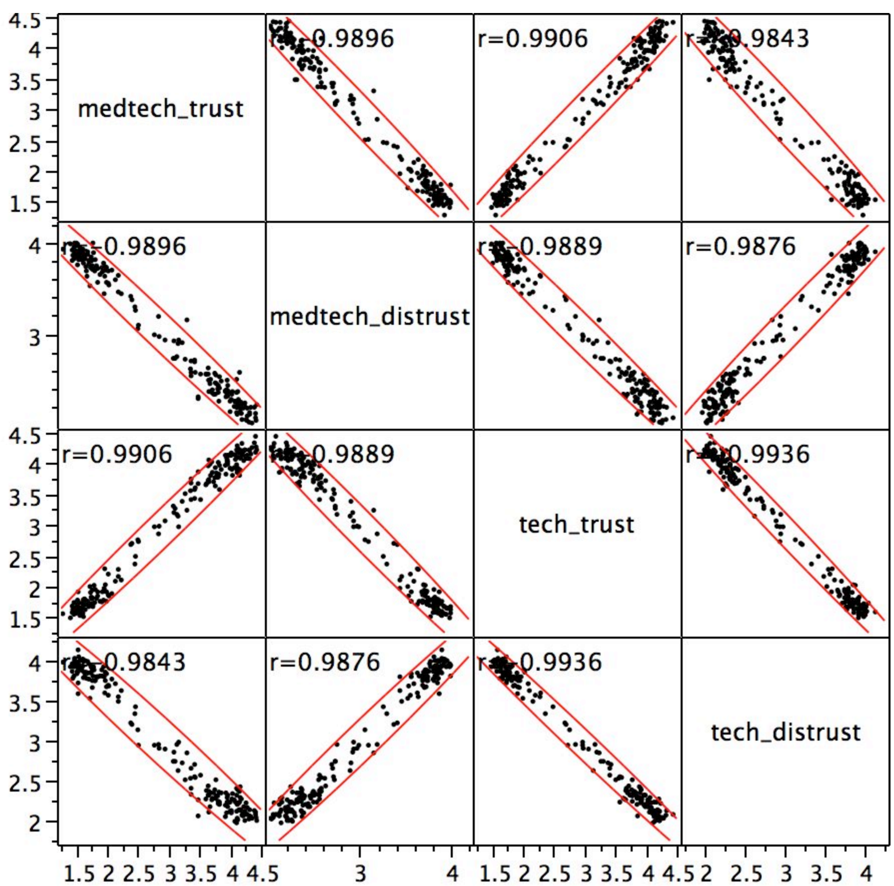


Figure 3.1 Pearson correlation between all variables

Regression. Results were analyzed using bivariate correlation and simple linear regression. Means, standard deviations and Pearson correlations appear in Table 3.4. Distrust scores were regressed on the trust scores separately for the conditions technology and medical technology. The variation in distrust in medical technology account for 98% of the variance in trust in medial technology (R^2= .979) and 99% for trust in technology (R^2= 0.987), which are close to one indicating a good fit with the data. All conditions were significant at p< 0.0001. Regression equations estimated as follows based on the parameter estimate (Table 3.5):

- medtech_trust = 7.5099965 - 1.5302135 medtech_distrust
- tech_trust = 6.992093 - 1.3572625 tech_distrust

Table 3.4

Summary of Fit

Trust in Medical Technology	RSquare	0.979338
	RSquare Adj	0.979227
	Root Mean Square Error	0.15871
	Mean of Response	2.900573
	Observations (or Sum Wgts)	188
Trust in Technology	RSquare	0.979338
	RSquare Adj	0.979227
	Root Mean Square Error	0.15871
	Mean of Response	2.900573
	Observations (or Sum Wgts)	188

Table 3.5

Parameter Estimates

		Estimate	**Std Error**	**t Ratio**	***p***
Trust Med Tech	Intercept	7.5099965	0.050438	148.90	<.0001
	medtech_distrust	-1.530213	0.016297	-93.89	<.0001
Trust Tech	Intercept	6.992093	0.034861	200.57	<.0001
	tech_distrust	-1.357262	0.011309	-120.0	<.0001

Regression lines were plotted for Trust in Technology and Trust in Medical Technology (See Figure 3.2).

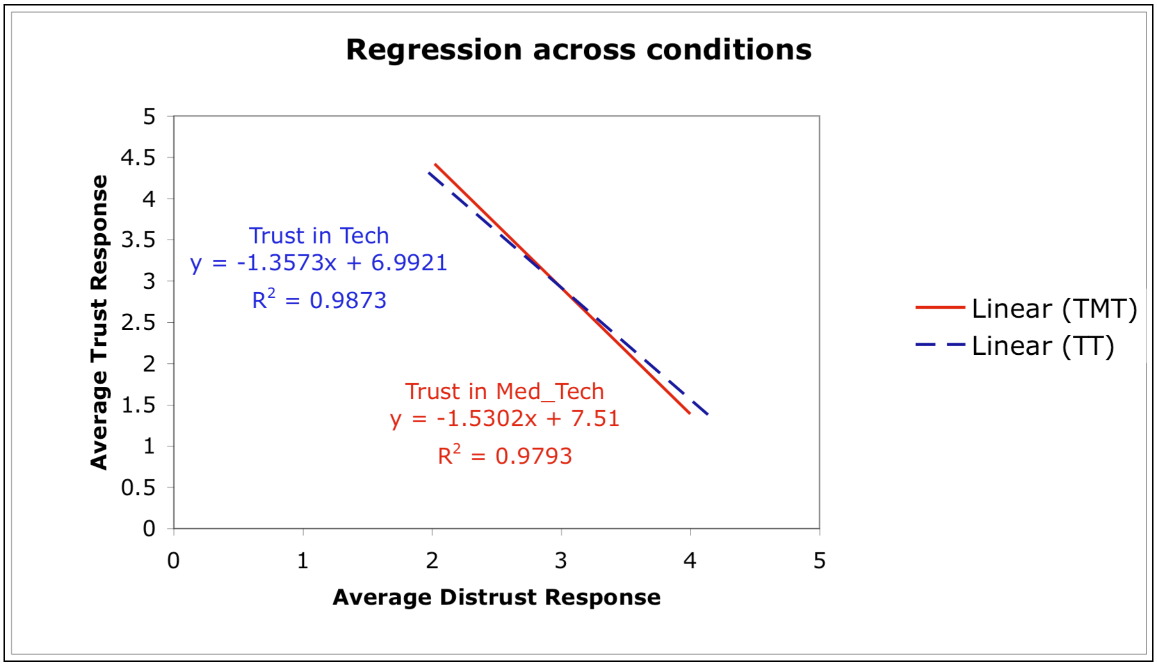


Figure 3.2 Regression lines plotted for Trust in Technology and Trust in Medical

Results were analyzed using a paired-samples t test. This analysis revealed a significant difference between mean levels of trust in technology and trust in medical technology, $t(187)= 3.903$; $p < 0.0001$. The sample means show that mean trust scores appear significantly higher in the trust in technology condition (M=2.94) than in the trust in medical technology condition (M= 2.90), the observed difference between the scores was .0435, and the 95% confidence interval for the difference extended from .0215 to .0655. The effect size was computed as d= .2847. According to guidelines for t tests, this represents a small effect (Cohen, 1992).

Union sets. Union sets were created from 5 - 30 words, to assess the overlap between the highest responses on variables trust and distrust, for the conditions technology and medical technology. Ranging from 5-30 allows for a clear representation of the points at which the sets merge or deviate based on the representativeness of the group. For example, of the five words that received the highest ratings of words related to trust for the variables technology and medical technology, three of the words trustworthy, reliability, and reliable are found in both trust in medical technology and trust in technology, to produce a 60% union match. The lowest percent of overlap between words associated with technology and medical technology was 0% at the distrust union set with five words. The highest percent of overlap was 70% at the distrust union set with 30 words (Table 3.6). Matched words and words included in the sets can be found in Figure 3.4. In the table the highlighted word indicate words found in the union set for both trust in technology (TT) and medical technology (TMT).

Table 3.6

Size and Percent Match of Union Sets

	Size of Union Set	Percent Match
Distrust	5	0%
Distrust	10	30%
Distrust	15	53%
Distrust	20	60%
Distrust	25	68%
Distrust	30	70%
Trust	30	67%
Trust	25	60%
Trust	20	60%
Trust	15	53%
Trust	10	50%
Trust	5	60%

										Lack_of_pro	3.91346154	Beneficial	4.11538462										
										Doubtful	3.92307692	Responsibly	4.125										
										FALSE	3.92307692	Advancements	4.13461538										
										Harmful	3.92307692	Confident	4.13461538										
										Lost_informa	3.92307692	Correct	4.13461538										
								Mistrust	3.92307692	Mistrust	3.92307692	Efficient	4.13461538	Efficient	4.13461538								
								System_cras	3.92307692	System_cras	3.92307692	Relied_on	4.13461538	Relied_on	4.13461538								
								Cause_harm	3.93269231	Cause_harm	3.93269231	Responsible	4.13461538	Responsible	4.13461538								
								Distrust	3.93269231	Distrust	3.93269231	Can_be_relied_upon	4.14423077	Can_be_relie	4.14423077								
								Errors	3.93269231	Errors	3.93269231	Knowledge	4.15384615	Knowledge	4.15384615								
						Mistakes	3.93269231	Mistakes	3.93269231	Mistakes	3.93269231	Dependable	4.17307692	Dependable	4.17307692	Dependable	4.17307692						
						Deceit	3.94230769	Deceit	3.94230769	Deceit	3.94230769	Security	4.17307692	Security	4.17307692	Security	4.17307692						
						Harm	3.94230769	Harm	3.94230769	Harm	3.94230769	Safe	4.18269231	Safe	4.18269231	Safe	4.18269231						
						Untrustworth	3.94230769	Untrustworth	3.94230769	Untrustworth	3.94230769	Ability	4.19230769	Ability	4.19230769	Ability	4.19230769						
						Error	3.96153846	Error	3.96153846	Error	3.96153846	Effective	4.19230769	Effective	4.19230769	Effective	4.19230769						
				Not_always_	3.96153846	Not_always_	3.96153846	Not_always_	3.96153846	Not_always_	3.96153846	Gives_real_results	4.19230769	Gives_real_r	4.19230769	Gives_real_r	4.19230769	Gives_real_r	4.19230769				
				Trickery	3.96153846	Trickery	3.96153846	Trickery	3.96153846	Trickery	3.96153846	Researched	4.21153846	Researched	4.21153846	Researched	4.21153846	Researched	4.21153846				
				Lying	3.98076923	Lying	3.98076923	Lying	3.98076923	Lying	3.98076923	Trusting	4.21153846	Trusting	4.21153846	Trusting	4.21153846	Trusting	4.21153846				
				Doubt	3.99038462	Doubt	3.99038462	Doubt	3.99038462	Doubt	3.99038462	Accurate	4.22115385	Accurate	4.22115385	Accurate	4.22115385	Accurate	4.22115385				
				Not_working	3.99038462	Not_working	3.99038462	Not_working	3.99038462	Not_working	3.99038462	Accurately	4.22115385	Accurately	4.22115385	Accurately	4.22115385	Accurately	4.22115385				
		Deception	4	Deception	4	Deception	4	Deception	4	Deception	4	Perform_correctly	4.22115385	Perform_cor	4.22115385	Perform_cor	4.22115385	Perform_cor	4.22115385	Perform_cor	4.22115385		
		Doesnt_func	4	Doesnt_func	4	Doesnt_func	4	Doesnt_func	4	Doesnt_func	4	Positive	4.22115385	Positive	4.22115385	Positive	4.22115385	Positive	4.22115385	Positive	4.22115385		
		Doesnt_worl	4	Doesnt_worl	4	Doesnt_worl	4	Doesnt_worl	4	Doesnt_worl	4	Secure	4.22115385	Secure	4.22115385	Secure	4.22115385	Secure	4.22115385	Secure	4.22115385		
		Misfunction	4	Misfunction	4	Misfunction	4	Misfunction	4	Misfunction	4	Reliance	4.24038462	Reliance	4.24038462	Reliance	4.24038462	Reliance	4.24038462	Reliance	4.24038462		
		Misleading	4	Misleading	4	Misleading	4	Misleading	4	Misleading	4	Precise	4.25961538	Precise	4.25961538	Precise	4.25961538	Precise	4.25961538	Precise	4.25961538		
Dangerous_s	4.00961538	Dangerous_s	4.00961538	Dangerous_s	4.00961538	Dangerous_s	4.00961538	Dangerous_s	4.00961538	Dangerous_s	4.00961538	Trustworthy	4.26923077	Trustworthy	4.26923077	Trustworthy	4.26923077	Trustworthy	4.26923077	Trustworthy	4.26923077	Trustworthy	4.26923077
Dont_work_i	4.01923077	Dont_work_i	4.01923077	Dont_work_i	4.01923077	Dont_work_i	4.01923077	Dont_work_i	4.01923077	Dont_work_i	4.01923077	Correct_results	4.28846154	Correct_resu	4.28846154	Correct_resu	4.28846154	Correct_resu	4.28846154	Correct_resu	4.28846154	Correct_resu	4.28846154
Failure	4.02884615	Failure	4.02884615	Failure	4.02884615	Failure	4.02884615	Failure	4.02884615	Failure	4.02884615	Give_correct_results	4.32692308	Give_correct	4.32692308	Give_correct	4.32692308	Give_correct	4.32692308	Give_correct	4.32692308	Give_correct	4.32692308
Fail_you	4.04807692	Fail_you	4.04807692	Fail_you	4.04807692	Fail_you	4.04807692	Fail_you	4.04807692	Fail_you	4.04807692	Reliability	4.33653846	Reliability	4.33653846	Reliability	4.33653846	Reliability	4.33653846	Reliability	4.33653846	Reliability	4.33653846
Failures	4.13461538	Failures	4.13461538	Failures	4.13461538	Failures	4.13461538	Failures	4.13461538	Failures	4.13461538	Reliable	4.44230769	Reliable	4.44230769	Reliable	4.44230769	Reliable	4.44230769	Reliable	4.44230769	Reliable	4.44230769
DT	DT	DT	DT	DT	DT	DT	DT	DT	DT	DT	DT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT	TT
5	5	10	10	15	15	20	20	25	25	30	30	30	30	25	25	20	20	15	15	10	10	5	5
DMT	DMT	DMT	DMT	DMT	DMT	DMT	DMT	DMT	DMT	DMT	DMT	TMT	TMT	TMT	TMT	TMT	TMT	TMT	TMT	TMT	TMT	TMT	TMT
Deceit	4	Deceit	4	Deceit	4	Deceit	4	Deceit	4	Deceit	4	Accurate	4.43269231	Accurate	4.43269231	Accurate	4.43269231	Accurate	4.43269231	Accurate	4.43269231	Accurate	4.43269231
Produced_ba	4	Produced_ba	4	Produced_ba	4	Produced_ba	4	Produced_ba	4	Produced_ba	4	Trustworthy	4.42307692	Trustworthy	4.42307692	Trustworthy	4.42307692	Trustworthy	4.42307692	Trustworthy	4.42307692	Trustworthy	4.42307692
Untrustworth	4	Untrustworth	4	Untrustworth	4	Untrustworth	4	Untrustworth	4	Untrustworth	4	Reliable	4.41346154	Reliable	4.41346154	Reliable	4.41346154	Reliable	4.41346154	Reliable	4.41346154	Reliable	4.41346154
Mistrust	3.99038462	Mistrust	3.99038462	Mistrust	3.99038462	Mistrust	3.99038462	Mistrust	3.99038462	Mistrust	3.99038462	Safe	4.41346154	Safe	4.41346154	Safe	4.41346154	Safe	4.41346154	Safe	4.41346154	Safe	4.41346154
Not_always_	3.99038462	Not_always_	3.99038462	Not_always_	3.99038462	Not_always_	3.99038462	Not_always_	3.99038462	Not_always_	3.99038462	Reliability	4.39423077	Reliability	4.39423077	Reliability	4.39423077	Reliability	4.39423077	Reliability	4.39423077	Reliability	4.39423077
		Mistakes	3.97115385	Mistakes	3.97115385	Mistakes	3.97115385	Mistakes	3.97115385	Mistakes	3.97115385	Precise	4.35576923	Precise	4.35576923	Precise	4.35576923	Precise	4.35576923	Precise	4.35576923		
		Misleading	3.96153846	Misleading	3.96153846	Misleading	3.96153846	Misleading	3.96153846	Misleading	3.96153846	Knowledge	4.33653846	Knowledge	4.33653846	Knowledge	4.33653846	Knowledge	4.33653846	Knowledge	4.33653846		
		Lost_informa	3.95192308	Lost_informa	3.95192308	Lost_informa	3.95192308	Lost_informa	3.95192308	Lost_informa	3.95192308	Honest	4.31730769	Honest	4.31730769	Honest	4.31730769	Honest	4.31730769	Honest	4.31730769		
		Misfunction	3.95192308	Misfunction	3.95192308	Misfunction	3.95192308	Misfunction	3.95192308	Misfunction	3.95192308	Trusting	4.31730769	Trusting	4.31730769	Trusting	4.31730769	Trusting	4.31730769	Trusting	4.31730769		
		Dont_work_i	3.93269231	Dont_work_i	3.93269231	Dont_work_i	3.93269231	Dont_work_i	3.93269231	Dont_work_i	3.93269231	Positive	4.30769231	Positive	4.30769231	Positive	4.30769231	Positive	4.30769231	Positive	4.30769231		
				Lying	3.93269231	Lying	3.93269231	Lying	3.93269231	Lying	3.93269231	Honesty	4.27884615	Honesty	4.27884615	Honesty	4.27884615	Honesty	4.27884615				
				Trickery	3.92307692	Trickery	3.92307692	Trickery	3.92307692	Trickery	3.92307692	Responsible	4.27884615	Responsible	4.27884615	Responsible	4.27884615	Responsible	4.27884615				
				Distrust	3.90384615	Distrust	3.90384615	Distrust	3.90384615	Distrust	3.90384615	Responsibly	4.26923077	Responsibly	4.26923077	Responsibly	4.26923077	Responsibly	4.26923077				
				Failure	3.90384615	Failure	3.90384615	Failure	3.90384615	Failure	3.90384615	Successful	4.25961539	Successful	4.25961539	Successful	4.25961539	Successful	4.25961539				
				Failures	3.90384615	Failures	3.90384615	Failures	3.90384615	Failures	3.90384615	Accurately	4.24038462	Accurately	4.24038462	Accurately	4.24038462	Accurately	4.24038462				
						Not_a_lot_o	3.90384615	Not_a_lot_o	3.90384615	Not_a_lot_o	3.90384615	Secure	4.24038462	Secure	4.24038462	Secure	4.24038462						
						Dangerous_s	3.89423077	Dangerous_s	3.89423077	Dangerous_s	3.89423077	Well_informed	4.22115385	Well_inform	4.22115385	Well_inform	4.22115385						
						Doubtful	3.89423077	Doubtful	3.89423077	Doubtful	3.89423077	Gives_real_results	4.21153846	Gives_real_r	4.21153846	Gives_real_r	4.21153846						
						Errors	3.89423077	Errors	3.89423077	Errors	3.89423077	Confident	4.20192308	Confident	4.20192308	Confident	4.20192308						
						Mistake	3.88461538	Mistake	3.88461538	Mistake	3.88461538	Give_correct_results	4.19230769	Give_correct	4.19230769	Give_correct	4.19230769						
								Doubt	3.875	Doubt	3.875	Researched	4.18269231	Researched	4.18269231								
								Uncaring	3.875	Uncaring	3.875	Confidence	4.17307692	Confidence	4.17307692								
								Doesnt_worl	3.86538462	Doesnt_worl	3.86538462	Helpful	4.16346154	Helpful	4.16346154								
								Harmful	3.86538462	Harmful	3.86538462	Integrity	4.16346154	Integrity	4.16346154								
								Misadvising	3.86538462	Misadvising	3.86538462	Security_in_caring_respon	4.16346154	Security_in_	4.16346154								
										No_confiden	3.86538462	Affect_lives	4.15384615										
										Doesnt_func	3.85576923	Security	4.15384615										
										No_faith	3.85576923	Effective	4.14423077										
										Not_disclosi	3.85576923	Healthy	4.13461539										
										Harm	3.84615385	Reliance	4.13461539										
0%		30%		53%		60%		68%		70%			67%	60%		60%		53%		50%		60%	

Figure 3.3 Union Sets with Means and Factors for Trust and Distrust across Conditions

Principal components analysis. Principal component analysis was applied to responses to the 188 item questionnaire. The principal axis method was used to extract the components, and this was followed by a varimax (orthogonal) rotation. Four criterion were explored to determine which components were meaningful.

1. **Criterion one:** components with eigenvalues greater than 1{Kaiser}.
2. **Criterion two:** Scree test to examine obvious breaks in the eigenvalues (Sall, Creighton, & Lehman, 2005).
3. **Criterion three:** Variance that was accounted for by individual components were examined at a criterion of 10% (Sall et al., 2005).
4. **Criterion four:** The combined variance was also examined for portions less than 80% (Sall et al., 2005).

Using criterion one, only 42 components from the trust in medical technology condition were retained for rotation and 37 from trust in technology. Combined, the components account for 87.2% and 87.5% of the variance (see Table 3.7).

Table 3.7

Eigenvalues and Percent Variance for TMT and TT

	TMT			TT		
	Eigenvalue	Percent	Cum Percent	Eigenvalue	Percent	Cum Percent
1	51.2132	27.2411	27.2411	73.9012	39.3091	39.3091
2	18.4046	9.7897	37.0308	13.9266	7.4078	46.7169
3	6.8288	3.6323	40.6631	5.7058	3.035	49.7519
4	5.3378	2.8393	43.5023	4.9029	2.6079	52.3598
5	4.7832	2.5443	46.0466	4.3588	2.3185	54.6783
6	4.4671	2.3761	48.4227	4.1673	2.2166	56.895
7	3.9983	2.1267	50.5495	3.5009	1.8622	58.7572
8	3.7271	1.9825	52.532	3.2556	1.7317	60.4888
9	3.5012	1.8624	54.3943	3.0753	1.6358	62.1246
10	3.4586	1.8397	56.234	2.8373	1.5092	63.6338
11	3.2372	1.7219	57.9559	2.7732	1.4751	65.1089
12	3.0402	1.6171	59.573	2.7162	1.4448	66.5537
13	2.9599	1.5744	61.1475	2.5654	1.3646	67.9183
14	2.8647	1.5238	62.6713	2.3537	1.252	69.1703
15	2.6875	1.4295	64.1008	2.3217	1.2349	70.4052
16	2.628	1.3979	65.4987	2.1877	1.1637	71.5689
17	2.4524	1.3045	66.8031	2.1017	1.1179	72.6868
18	2.3687	1.26	68.0631	1.9272	1.0251	73.7119
19	2.2365	1.1896	69.2527	1.8952	1.0081	74.72
20	2.1953	1.1677	70.4204	1.7812	0.9475	75.6675
21	2.122	1.1287	71.5491	1.7268	0.9185	76.5859
22	1.9196	1.0211	72.5702	1.6743	0.8906	77.4765
23	1.853	0.9856	73.5559	1.5944	0.8481	78.3246
24	1.8134	0.9646	74.5204	1.555	0.8272	79.1518
25	1.7164	0.913	75.4334	1.4869	0.7909	79.9427
26	1.6815	0.8944	76.3278	1.4085	0.7492	80.6919

27	1.626	0.8649	77.1927	1.3664	0.7268	81.4187
28	1.5712	0.8358	78.0284	1.3398	0.7127	82.1313
29	1.5404	0.8193	78.8478	1.2793	0.6805	82.8118
30	1.44	0.7659	79.6137	1.2405	0.6599	83.4716
31	1.4191	0.7549	80.3686	1.1667	0.6206	84.0922
32	1.3906	0.7397	81.1083	1.1373	0.605	84.6972
33	1.3327	0.7089	81.8172	1.1318	0.602	85.2992
34	1.2714	0.6763	82.4935	1.0893	0.5794	85.8786
35	1.2384	0.6587	83.1522	1.0763	0.5725	86.4511
36	1.1954	0.6359	83.788	1.0291	0.5474	86.9985
37	1.1724	0.6236	84.4116			
38	1.1472	0.6102	85.0218			
39	1.1111	0.591	85.6129			
40	1.0734	0.571	86.1838			
41	1.0427	0.5546	86.7385			
42	1.0038	0.5339	87.2724			

Questionnaire items and the corresponding factor loadings are presented in Table 3.7. In interpreting the rotated factor pattern, an item was said to load on a given component if the factor loading was .40 or greater for that component and less than .40 for the other. The first three factors were examined after rotation. For the first factor, 79 factors were produced for trust in technology and 76 for trust in medical technology. Ninety five percent of the factors overlapped between both conditions. For the second factor, 12 factors were produced for trust in technology and 33 for trust in medical technology. Zero percent of the factors overlapped between both conditions. For the third factor, 11 factors were produced for trust in technology and five for trust in medical technology. Zero percent of the factors overlapped between both conditions. Factor rotation summary and overlap can be found in Appendix A.4.

Discussion. The purpose of this study was to provide evidence for the following research questions:

- Question one: How is trust conceptualized in relation to distrust? Is distrust a theoretical opposite of trust across conditions or is distrust a different construct?
- Question two: What is the relationship of trust across the conditions trust in medical technology and trust in technology?

The correlation analysis provided evidence to support the hypothesis that trust and distrust are theoretical opposites across the conditions trust in technology and trust in medical technology. This means that distrust is not a separate construct from trust, indicating convergent validity, which matches findings in previous studies (Jian et al., 2000). This evidence allows for simplified considerations of trust in technology and medical technology recommendations as well as in the creation of measures of trust. For example, if the factor “easy to use” was considered a factor towards the trustworthiness of an interface or device. In order to make a technology more trustworthy a designer need only make it easier to use, in contrast making the technology less easy to use contributes to distrust in a device. The results of the correlation analysis also showed that trust across the conditions technology and medical technology behave in a similar bipolar way.

The regression analysis and subsequent paired t-test provided evidence that trust in medical technology and technology are perceived differently by research participants. This finding means that previous understandings of trust in technology may not be transferable to conversations about medical technology and medical systems.

Union sets analysis provided more evidence that trust in technology and medical technology are perceived differently between research participants. Of the top five words rated most related to trust in technology and medical technology, only 60% were the same across conditions (see Figure 3.4). This shows that participants were thinking of the two constructs differently. Principal component analysis additional provided evidence that trust in technology and trust in medical technology are different constructs with similar attributes.

Study three: Paired comparison

The goal of the paired comparison study was to assemble data from previous studies into a smaller set to support the development of items for the trust in medical technology instrument. The 30 words rated as most related to trust in medical technology were used as variables in the paired comparison study.

Participants. A new sample of Sixty four undergraduate students were recruited.

Apparatus. Paired comparison scenarios were built using software and implemented in a laboratory. Scenarios presented each word (identified in study two) with a 5-point likert-type scale ranging from “almost the same” to “totally different”. The point and click interface allowed the participant to select a rating and move to the next screen. The participants were asked to rate the relationship between the two words presented on the screen, they were also told that all of the words were related to trust between people and medical technology. Participants were not able to move backwards or change answers.

Procedure. Participants compared and rated the similarity of 435 pairs of words (defined in study two) as being positively and negatively related to each other. Words were randomized between subjects.

Analysis. A reliability analysis was conducted to determine the reliability of responses amongst participants. A cluster analysis grouped the factors that were rated as similar to each other into smaller groups.

Results. Estimates of internal consistency as measured by Cronbach’s alpha all exceeded .70 and are reported in the table in Appendix A.5. The recommended minimum coefficient is .70 (Nunnally, 1978). A hierarchical cluster analysis using Ward’s minimum variance method produced ten clusters (see Figure 3.4).

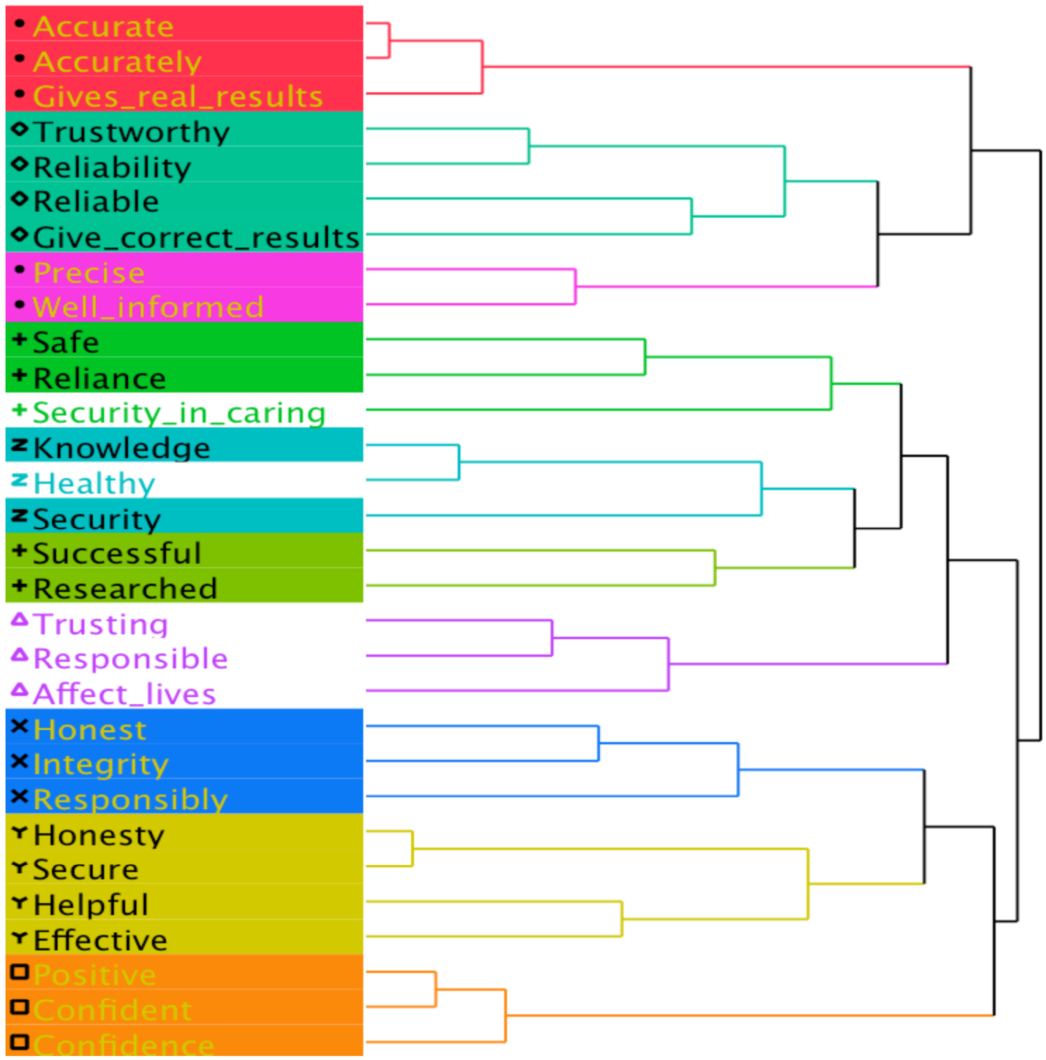
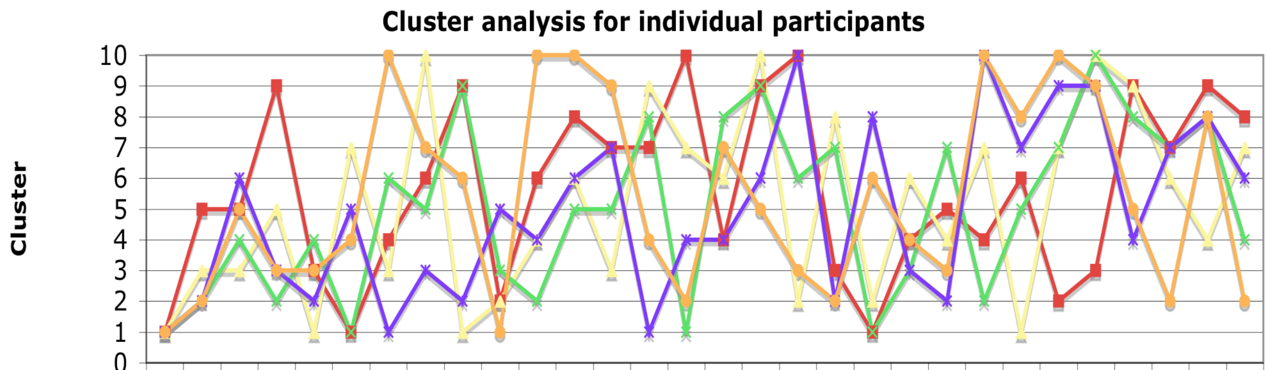


Figure 3.4 Hierarchal cluster analysis results
Note: colors and shapes indicate cluster membership.

To further assess the reliability of the results cluster analyses were performed on data from individual participants (see Figure 3.5). The table shows each of the 30 words by the cluster number (1-10) they were assigned to for a sample of the participants in the data set. The points show high variability in cluster memberships. If the results were reliable across participants, the lines would overlap.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
2301	1	5	5	9	3	1	4	6	9	2	6	8	7	7	10	4	9	10	3	1	4	5	4	6	2	3	9	7	9	8
2302	1	3	3	5	1	7	3	10	1	2	4	6	3	9	7	6	10	2	8	2	6	4	7	1	7	10	9	6	4	7
2303	1	2	4	2	4	1	6	5	9	3	2	5	5	8	1	8	9	6	7	1	3	7	2	5	7	10	8	7	8	4
2373	1	2	6	3	2	5	1	3	2	5	4	6	7	1	4	4	6	10	2	8	3	2	10	7	9	9	4	7	8	6
2372	1	2	5	3	3	4	10	7	6	1	10	10	9	4	2	7	5	3	2	6	4	3	10	8	10	9	5	2	8	2

Figure 3.5 Cluster analysis for individual participants

Next, a cluster analysis was performed on the participants. The cluster analysis might indicate similar internal rating scales or response patterns amongst participants. The results at the four cluster levels showed three major groups of participants (see Table 3.8).

Table 3.8

Number of Participants Per Cluster

Cluster	Number of participants
1	29
2	10
3	19
4	2

Given the results of these additional analyses, the results of the cluster analysis are considered unreliable. This may be because the hierarchical cluster analysis model forces each word into one cluster, while each word may fit into multiple clusters. New clustering algorithms have been proposed to allow cluster analysis to be performed on data that does not fit the hierarchal algorithm (Liu, Zhang, Wang, McMillan, & Prins, 2000).

Discussion.

The cluster analysis identified 10 clusters of factors regarding trust in medical technology (see Table 3.9). However, because of reliability issues with the cluster results, each of the original 30 factors was addressed individually (see Table 3.10).

Table 3.9

Cluster, Factors, and Guidelines for Trust in Medical Technology

	Cluster Name	Related Factors
1	Accuracy	Accurate Accurately Gives real results
2	Reliability	Trustworthy Reliable Reliability Gives correct results
3	Precision	Precise Well informed
4	Safety	Safe Reliance Security in caring
5	Security	Security Knowledge Healthy
6	Proof of Success	Successful Researched
7	Responsibility	Trusting Responsible Affect lives
8	Integrity	Honest Integrity Responsibly
9	Necessary	Effective Helpful Secure Honesty
10	Confidence	Positive Confident Confidence

Table 3.10

Design Guidelines for Trust in Medical Technology Based on Original 30 Factors

Factor	Guideline
Accurate	The technology must be accurate
Accurately	The technology must behave in an accurate manner
Gives real results	The technology must give real results
Trustworthy	The technology must be trustworthy
Reliable	The technology must be reliable
Reliability	The technology must portray reliability
Gives correct results	The technology must give correct results
Precise	The technology must be precise
Well informed	The technology must be well informed
Safe	The technology must be safe
Reliance	The user must be able to rely on the technology
Security in caring	The technology must show that it cares
Security	The technology must be secure
Knowledge	The user must have knowledge about the technology
Healthy	The technology must make the user healthy
Successful	The technology must be successful
Researched	The technology must researched
Trusting	The technology must be trusting
Responsible	The technology must be responsible
Affect lives	The technology must affect the life of the user
Honest	The technology must be honest
Integrity	The technology must have integrity
Responsibly	The technology must behave responsibly
Effective	The technology must be effective
Helpful	The technology must be helpful
Secure	The technology must be secure
Honesty	The technology must portray honesty
Positive	The technology must be positive
Confident	The technology must be confident
Confidence	The technology must portray confidence

Limitations. The paired comparison study was time consuming, taking anywhere from 30 minutes to 1.2 hours to complete. Even though participants were asked to take breaks, most never left the lab environment, which means fatigue may have caused participants to produce thoughtless responses to pairs, particularly towards the end of the task. Future studies may include distracter activities to stimulate participants at times when fatigue may set in.

Conclusion

Studies one through three provided insight into how people define trust in medical technology as a construct. Study one found that participants believed that 73% of the words for trust in technology and trust in medical technology were the same. Study two found trust and distrust to be theoretical opposites in both trust in medical technology and trust in technology. These findings are similar to Jian et. al's (1998) findings in which trust between people and trust between technology were found to be theoretical opposites. Study two also found that participants perceive trust between technology and trust in medical technology differently. However, there is a 67% overlap between the constructs at the 30 factor level (the 30 words most related to trust in technology and medical technology).

What is interesting about the results of each of the studies is 1) the greater than 50% overlap between trust factors in these studies (trust in technology and trust in medical technology) and previous studies (general trust, interpersonal trust, trust between people and automation) and 2) factors related to trust in technology closely resemble how one might describe a relationship between two people. These findings propose the questions: What is the relationship between the trust constructs and how are people thinking of trust in the various conditions? These findings can be explained using Eleanor Rosch's (1973) prototype theory, which explains how knowledge is organized in the cognitive mind. In prototype theory, people determine a concept's inclusion into a category by comparing it to a prototype (Rosch, 1973). In this case, interpersonal trust is a prototype of the category "trust".

What is prototype theory

Semantic memory is the type memory that is concerned with meanings. In relation to episodic memory, semantic memory is general knowledge that is not necessarily tied to an experience while episodic memory is the memory of events that happen to us. Semantic memory represents comprehensive knowledge such as "daffodils are flowers," and "trains are a type of vehicle" as well as conceptual knowledge (triangles have three sides). Semantic memory is necessary for problem solving, way finding and reading, and therefore affects many aspects of our cognitive functioning (Rosh, 1973).

Categories and concepts are the building blocks of semantic memory and are used as tools to organize a person's knowledge. A category is a grouping of objects that are linked together. For example, the category "pet" includes dogs, cats, hamsters and goldfish. A concept refers to the mental representation of a category. For example "dog" may be a person's mental representation of the category pet. Concepts can be divided into natural concepts and artifacts. Natural concepts are concepts that occur in nature such as a dog, a person, a tree, while people create artifacts.

There are four approaches to understanding how information in the semantic memory is organized, the feature comparison model, the prototype approach, the exemplar approach, and network models. Prototype theory is a useful framework for understanding how people define trust in different conditions.

Prototype theory was proposed by Eleanor Rosh in 1973. She argued that humans organize each category of knowledge based on a prototype that is the most representative of the category. In this theory, humans determine inclusion into a category through comparison with the category's prototype. The prototype of a category does not have to be real; it can be an abstract idealized illustration (Rosh, 1973). For example, the prototype for a flower may have a variety of attributes that do not match a flower that actually exists. The prototype approach does not pay attention to the details that distinguishes each member of a category. In this framework, trust between people and trust between people and technology are allowed to have dissimilar features. The members of a category differ with regards to their degree of prototypicalness (Rosh, 1973). Categories have graded structures, which begin with the most prototypical members and continue through to the category's nonprotoypical members (Rosh, 1973). With regards to trust, trust between a student and teacher, a couple, a patient and doctor are all more prototypical than trust between a person and an automated device or computer.

Trust between people as a prototype

Prototype theory has been used by researchers to explore how people understand and define constructs that are difficult to define such as love and discrimination (Biederman, Subranmaniam, Bar, Kalocsai, & Fiser, 1998; Colcombe & Jr., 2002; Fehr & Rossell, 1991; Harris, Lievens, & Hoye, 2004; Johansen & Palmeri, 2002; Lavner, Rosenhouse, & Gath, 2001; Rosh, 1999; Storms, Boek, & Ruts, 2001). Trust is de fined as a feeling of certainty that a person or thing will not fail. Trust implies a depth and assurance of feeling that is often based on inconclusive evidence[1]. There are a variety of trust relationships, such as a human's trust in another human (interpersonal trust), a human's trust in a system or institution (social trust or system trust) and a human's trust in a technology or device (trust in automation or trust in technology). Social trust, or trust in an institution, is influenced by factors such as the media and a generalized social confidence in the institution (Pearson & Raeke, 2000).

DeFuria (1996) developed interpersonal trust surveys from a behavioral model of interpersonal trust, which defines the behaviors that lead to increased or decreased trust between individuals. DeFuria argues that trust situations always involve vulnerability, risk, and expectations of the other person's trustworthy motivation and competence (DeFuria, 1996). DeFuria outlines trust-enhancing behaviors (see Table 3.11) and describes the behaviors mathematically as $TW=w_1SI+ w_2RC+ w_3AI+ w_4CE+ w_5ME$. In the equation SI

[1] : The American Heritage® Dictionary of the English Language, Fourth Edition Copyright © 2000 by Houghton Mifflin Company. Published by Houghton Mifflin Company.

equals sharing relevant information. The exception to this rule is self-disclosure behaviors that go against the anticipations of professionalism. RC refers to reducing controls which define the behaviors of reducing the means a person (1) creates and communicates the performance criterion or statutes for other people (2) observes the performance of a person (3) changes the circumstances a performance is accomplished, or (4) modifies the end results of performance by positive or negative reinforcement. AI stands for allowing for mutual influence, which means that both people have an egalitarian relationship in convincing the other and making decisions. CE equals clarifying mutual expectations, which involves disclosing information about their combined anticipations. ME refers to meeting expectations, which involves the behaviors associated with one person that meets the expectations of the other person. Meeting expectations is related to the feeling that an individual can be relied upon.

Table 3.11

Trust Enhancing and Reducing Behaviors

Trust Enhancing Behaviors	**Trust Reducing Behaviors**
Sharing relevant information	Distorting, withholding, or concealing real motives
Reducing controls	Falsifying relevant information
Allowing for mutual influence	Attempting to control or dominate
Clarifying mutual expectations	Obscuring, distorting, or avoiding the discussion of mutual expectations
Meeting expectations	Not meeting the trusting individuals expectations of performance or behavior
	Attempting to evade responsibility for behavior

Source: Defuria 1996

Ttrust between people is a prototype of all trust relationships. Trust in technology is a non-prototypical member of the category trust, meaning that it shares some characteristics with the prototype trust between people. People compare trust relationships between themselves and technology, medical technology, systems, and themselves (self-trust) to trust relationships between themselves and others.

How trust between people has characteristics of a prototype

Matlin (2002) describes how prototypes are different from the non-prototype members of a category. First, prototypes are the best example of the category. Because trust between people is a prototype of trust, when we ask people what they trust, in technology or medical technology, they evoke the example of trust between people. A study conducted by Mervis, Catlin, and Rosch (1976) looked at the notion of a prototype as a normative for a category. They asked participants to give examples of categories such as sports, birds fruit, and weapons. They then asked a different group of participants to select the prototypes for each of the provided examples. The researchers found that the items people supplied most often in the category norms were the same items rated as most prototypical . For example, for the category, “bird” people considered *robin* to be very prototypical, and *robin* was frequently listed as an example for the category “bird (Mervis, Catlin, & Rosch, 1976).

In Jian et al’s (2000) study, the researchers asked participants to provide open ended definitions of trust between people, general trust and trust between people and technology. The participants were essentially providing attributes of trust in the different conditions. They then combined the words with an existing list of words related to trust and asked participants to rate how related the words were to general trust, trust between people, and trust between people and technology. The five words most related to trust across the three conditions had a significant level of overlap (see Table 3.12). Additionally, the words that were provided, resembled relationships of interpersonal trust. The words trustworthy, loyalty, and honor are awkwardly applied to the definition of trust between people and technology, indicating trust between people as a prototype of trust relationships. In this study the top rated words for trust in technology more closely resemble characteristics of a machine with words such as: gives correct results and accurate. However, these terms are also closely related to the prototypical trust between people.

Table 3.12

Trust Factors Across Conditions

	General trust*	**Trust between people***	**Trust between human and automated systems***	**Trust between human and technology**	**Trust between human and medical technology**
Words	Trustworthy	Trustworthy	Trustworthy	Trustworthy	Trustworthy
	Honesty	Honesty			
	Loyalty	Loyalty	Loyalty		
	Reliability	Reliability	Reliability	Reliability	Reliability
	Honor		Honor		
		Integrity			
			Familiarity		
				Correct_results	
				Give_correct_results	
				Reliable	Reliable
					Safe
					Accurate

Source: * Jian, J. Y., Bisantz, A. M., & Drury, C. G. (1998). *Towards an empirically determined scale of trust in computerized systems: Distinguishing concepts and types of trust.* Paper presented at the Proceedings of the Human Factors and Ergonomics Society, Chicago.

Reeves and Nass (1996) argued that people treat computers, television and other media like they treat computers. People include trust between people and medical technology in their conceptions of trust relationships, which means that people may have the same expectations they have in trusting relationships between people as they have with trusting relationships with technology. The difference in these relationships may lie in the limits and capabilities of the interaction. To test their hypothesis, Reeves and Nass (2007) replicated communication and interpersonal research studies using a computer or technology in place of one of the people. They found through numerous studies, that when computers behave the way a person would expect a likeable person to behave, they were rated more favorably. These included behaviors such as being flattering, polite, maintaining appropriate interpersonal distance, and being team players (Reeves, Lewin, & Zwarenstein, 2006).

The primary definition of trust relies on a sense of vulnerability, thus when humans decide to trust other humans, there are limits to which factors can be evaluated to determine trustworthiness. With technology, humans are able to add additional metrics and different conceptions of the same metric. For example, reliability in trust between people may mean consistent affect, always being on time, or always being available. Where reliability between people and technology, may mean consistent performance, which can be measured. These studies reinforce the hypothesis that trust between people is the best example of the category trust, and therefore the means by which people use to assess the trustworthiness of technology. These studies also lay an additional framework for an expanded definition of trust where technology may be able to act out trustworthy behaviors in ways that humans can not. In a technological space, technology may be able to portray factors of trust such as caring, safety, and accuracy in ways that humans can not.

Rosch found that prototypes act as points by which other members of the category can be compared (Rosch, 1973). Rosch believed that people define terms in relation to other terms. For example, if a person asked “what is aqua?” the answer might be a “greenish-blue,” or “a blue with a little green.” The prototype would be blue, which is the point at which the color deviates to form another color, the non-prototype aqua. The context of trust between people isthe point at which people make decisions about non-prototypes. The question is how specific does the prototype get to inform those decisions. Future studies about trust in different conditions might have participants think aloud to determine how they make decision about what factors are related to trust between technology and medical technology. Are they using trust between themselves and another person as a reference? Does the person they are referencing change, for example, with trust in technology, are they imagining themselves and the customer rep for their computer? Perhaps they are thinking of their relationship with their physician when they think of trust in medical technology. While trust between people is the prototype for trust relationships, the domain of reference may produce different prototypes. It is understood that people expect different trust attributes from their physician than they might expect from a spouse or employee. Are these differences represented in understanding the trust relationships of the tools in those systems?

Prototypes are judged more quickly after priming (Rosch, 1973). The prototype priming effect could describe how specific relationships of trust behave in complex systems. In health care systems, the trust relationship with a stakeholder may prime a patient to feel trusting or distrusting in other moments in the system. For example, if the nurse at the front desk at a doctor's office leaves a person's personal medical history open, where other patients can see the details, the owner of the medical records may develop distrusting attitudes. This attitude may create a sense of skepticism that permeates throughout the rest of the patient's medical visit. The patient may wonder if they can trust the doctor to wash their hands or if the blood pressure machine is giving a correct reading? They may also question if the pharmacist is telling them all side effects that can result from the prescription.

Rosch's prototype theory (1973) also looks at how categories are structured in terms of different levels. Objects and concepts can be members of multiple, associated categories. For example, a category for what a person is wearing might be called; *clothing, pants, blue jeans, or Levi's.* Superordinate categories are more general, like the example terms *clothing* or *pants* (Rosh, 1973). Basic categories are neither too general nor too specific such as *blue jeans* in the example. Subordinate categories refer to more specific categories such as *Levi's*, in terms of trust. In terms of "trust" as a category "relationships" would be considered superordinate, while "trust relationships" would be basic and the specific relationships such as "trusting automatic teller machines" would be subordinate.

- *Superordinate- Relationships*
- *Basic- Trust Relationships*
- *Subordinate- Trust in Automatic Tellers*

Researchers argue that basic level categories are more useful than superordinate or subordinate categories (Biederman et al., 1998). This is because basic level categories are used to identify objects in social groups. For example, people are more likely to describe themselves as wearing jeans as opposed to clothing or Levi's, while experts are more likely to use the subordinate categories. Different levels of categorization activate different parts of the brain (Rosh, 1973). This understanding of trust as a prototype provides useful information towards discussions and measurement of the construct. Exploring trust may call for the use of different prototypes for different populations. Patients may respond better to basic categories, while physicians or developers of technologies may respond better to subordinate categories. Understanding the neurological differences in understanding relationships, as opposed to trust relationships, as opposed to trust in medical technology allows for scrutiny over the generalizability of the findings in trust research that represent different category levels.

How does trust between people as a prototype affect understandings of trust?

- It helps understand the personified definitions of trust between people and machines.
- Allows for the assumption that characteristics of trust between people may be effective in designing trust between people and machines.
- Shows that as the category becomes more specific, the attributes of it also become more specific.
- Allows for differing models of understanding of trust in technology based on culture and expertise.
- Accounts for the fuzzy boundaries between trust in different contexts and accounts for the overlapping factors of trust in those contexts.
- Provides guidelines for future discussion and measurement of the construct.

How is trust in medical technology and trust in technology different?

Examining the factors rated most related to trust in technology and trust in medical technology, show a 67% overlap (see Figure 3.6). The 23% that differentiates the constructs may provide a deeper understanding of what makes trust in medical technology a separate construct. The terms honest and honesty are both factors of trust in medical technology but not factors of trust in technology. These terms may allude to the importance of technology that affects health providing honest results or the importance of honesty to keeping health records and personal information secure. In a more abstract sense, honesty may be more important as a trust construct when the stakes are higher. For example, using trust between people as an analogy, honesty may be a more important factor when trusting people who have the power to inflict harm. Honesty is a factor that is quick to distinguish in situations where a person may not have long-term relationship with another person. For example, a background check on a person's resume provides evidence of their honesty or dishonesty. A person may trust a friend who lies about their age, because they have more information in their relationship to determine their trustworthiness in different situations. It is important for people to make appropriate decisions about the trustworthiness of individuals who have the power to affect ones life negatively. A dishonest babysitter may kidnap a child. A dishonest doctor could perform in ways that would jeopardize a patient's life and health.

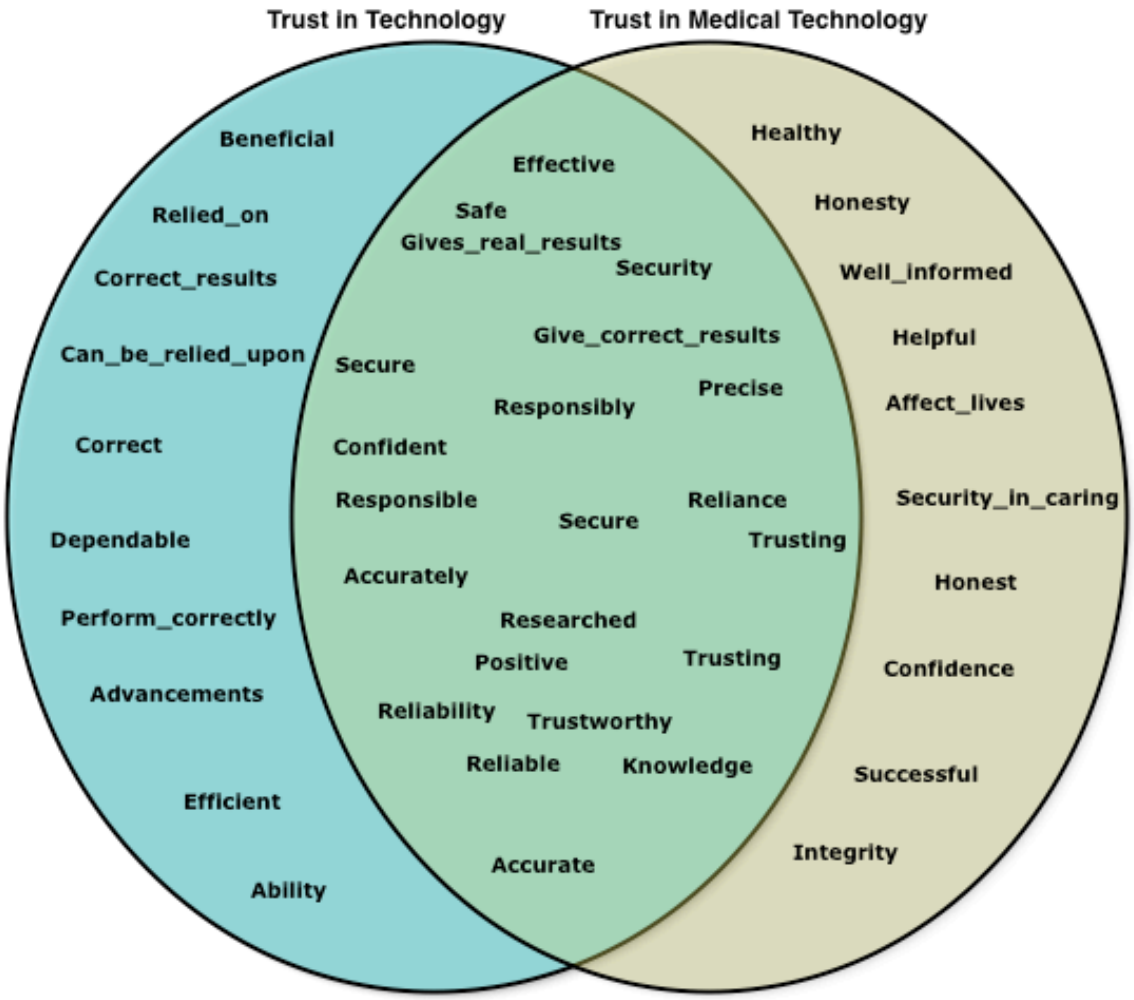


Figure 3.6 Overlap of factors of trust in technology and trust in medical technology

Healthy and affect-lives are two factors that characterized trust in medical technology and not trust in technology. These are both factors that represent bodily realties. It makes sense that one might trust a medical technology that makes them healthy and distrust one that makes them unhealthy. This is a particularly important issue in the treatment of diseases that have severe side effects. Chemotherapy as a technology may make some people very ill before it makes them better. In a letter to the editor of *Townsend Letter for Doctors and Patients* a patient described a personal experience with chemotherapy. The chemotherapy made the patient feel sick and weak. Concurrently, a member of the patient's support group discontinued chemotherapy and had begun to look healthy and vibrant again. This patient then stopped believing that the chemotherapy would even send cancer into remission. The unhealthy feeling the patient received because of the treatment caused the patient to distrust the technology as a whole. Whether these feelings develop as a psychological defense mechanism against pain or lack of just human weakness, designing technologies that make a person feel unhealthy may lead to distrust.

Another example, of the relationship of the factors unhealthy to the construct trust, lies in the development of painless glucose monitors. Frequent testing of glucose is important in maintaining health and controlling symptoms for diabetics. However, pain associated with frequent monitoring can be a deterrent to good health. The American Diabetes Services (2004) states:

> For many people living with diabetes, frequent testing of blood glucose levels can be the most valuable tool for maintaining control of symptoms and avoiding long term complications. New advances in pain free testing, including painless glucose monitors from many manufacturers, make pricked fingers and drawing blood a thing of the past. Alternative site monitors allow the patient to replace finger sticks with blood draws in less sensitive areas of the body such as the forearm and thigh. (American Diabetes Services, 2004)

American Diabetes Associations states that, “the painless testing supplies have been a breakthrough for diabetes monitoring. If patients aren't suffering they are more willing to test their blood sugar levels as frequently as their doctor recommends." This is another example of how pain or discomfort in design can lead to distrust in medical technology.

Inversely, technologies that make a person healthy may be worthy of trust simply because they worked. In obstetric work systems, trust in technology may simply be the result of having healthy babies and good outcomes. The factor “affects lives” can be described in two ways, it can describe the notion of unnecessary technology or it can describe a technology’s performance. For example, a person might say “I do not trust technologies that are not going to make my life better” or “I do not trust technology that simply does not have an effect on me.” An example of a technology that might not affect a person life are as weight loss pills that do not help them lose weight. In order to trust technology, it must have an affect on my life. This is also related to the factor “successful”.

Technology that affects lives positively can also be defined as successful. The term can also be described in terms of a cause; the more the technology is capable of affecting a person’s life, the more discriminate a person is in giving it trust. Genetic testing is a large part of prenatal care today. Many writers have discussed the phenomena of tests being used to terminate imperfect fetuses (Layne, 1999; Rapp, 2000). A person would want to have a high level of trust in the test, because the result of the test often determines whether or not a person carries a pregnancy to term. In another example, a treatment that has a 30% chance of killing a person would require higher trust than a treatment such as giving blood, which has a low likelihood of killing a person. Both the factors “healthy” and “affects lives” tie into the factor “helpful”.

Helpful, implies reluctance to participate in technologies that are not useful. It means that technologies that help a person, which could be defined as make a person healthy, are worthy of trust. Technologies that are not helpful may not be worthy of trust. For example, a person is likely to trust the antibiotics that cure their pneumonia. However, technologies that are a nuisance or unhelpful may be described as untrustworthy. For instance, if a person has two blood glucose monitors and one integrates well with his/her life, this monitor is usable, efficient, effective, and accurate. The other monitor is often inaccurate, requires multiple attempts, and is time consuming to operate. One technology may be described as helpful, while the other may be described as unhelpful.

Being well informed is not necessarily an expectation users have for the developers and support of regular technology. For example, the customer support for cellular phones are usually uninformed about the phone's functionality and design. Users generally do expect the people who make their printers to know the exact components of the ink it uses. However people trust these devices enough for their purposes. When the purpose changes to a person's body and health, additional criteria for trust are also introduced. Well informed, can mean that the technology must be well-informed, the users of the technology must be well-informed, and that the system must be well-informed. With health care in particular, a patient wants to know that the developers of the technology were well-informed. Specifically, that the technology was based on sound research and has proven success. A patient might also want the health care provider to be well-informed on the various technologies that exist in order to choose the best one for the best care. Last, the patient will want the physician to be well-informed on how to use the technology. The patient wants to know that the physician can use the technology effectively and without mistakes.

Integrity can be defined broadly as a sense of ethics, or a "steadfast adherence to a strict moral or ethical code (Integrity. (n.d.), 2008). Stedman's Medical Dictionary defines integrity as "a system characteristic that means that the system's functional, performance, physical, and enabling products are accurately documented by its requirements, design, and support specifications" (Integrity, 2000). Congruent with that definition, Evans et al. (2001) defined integrity in terms of product integrity, as "the ability of a product to meet or exceed a customer's expectations for performance, quality, and durability over the life of the product," (p. 3) (Evans, Evans, & Ryu, 2001). Integrity as a factor of trust in medical technology could mean a sense of adhering to the ethics of the medical system that the technology is being used in a just way and has been developed following the ethics of medicine. Integrity is illustrated in design by looking as if it performs well, is built with quality components, and durable.

CHAPTER 4: PHASE II Construction of Trust in Medical Technology by Patients and Health Care Providers in Obstetric Work Systems

Overview

The purpose of this study was to examine trust in medical technology in a health care environment to explore how trust is constructed by patients and care providers in this complex work system. This qualitative study investigated constructs of trust in medical technology from 25 women who had recently given birth and 12 obstetric health care providers. In-depth interviews were used. Over 169 factors of trust in medical technology were coded and analyzed, a theoretical model was developed describing:

1. Patients' user experience with medical technology.
2. Patients' and physicians' construction of trust in medical technology.

Subcategories of each component of the theoretical model were identified and are illustrated by narrative data. Implications for health care research and system design are addressed.

Introduction

A person's trust in medical technology is an important factor to understanding health care systems. The majority of trust in technology research looks at trust in technology from the standpoint of the operator, which in a medical setting would be the physician, nurse or technician (Jian et al., 1998a; Parasuraman, 1997; Parasuraman & Miller, 2004). The conceptual model for this research hypothesized relationships between the operator and the technology, the operator and the patient, and the patient and the technology (Figure 4.1). This model assumed that the patient's experience with the technology is be passive, meaning the machine does things to the patient without feedback. The machine monitors the patient's health status, controls the patient's bodily functions and presents feedback to the patient.

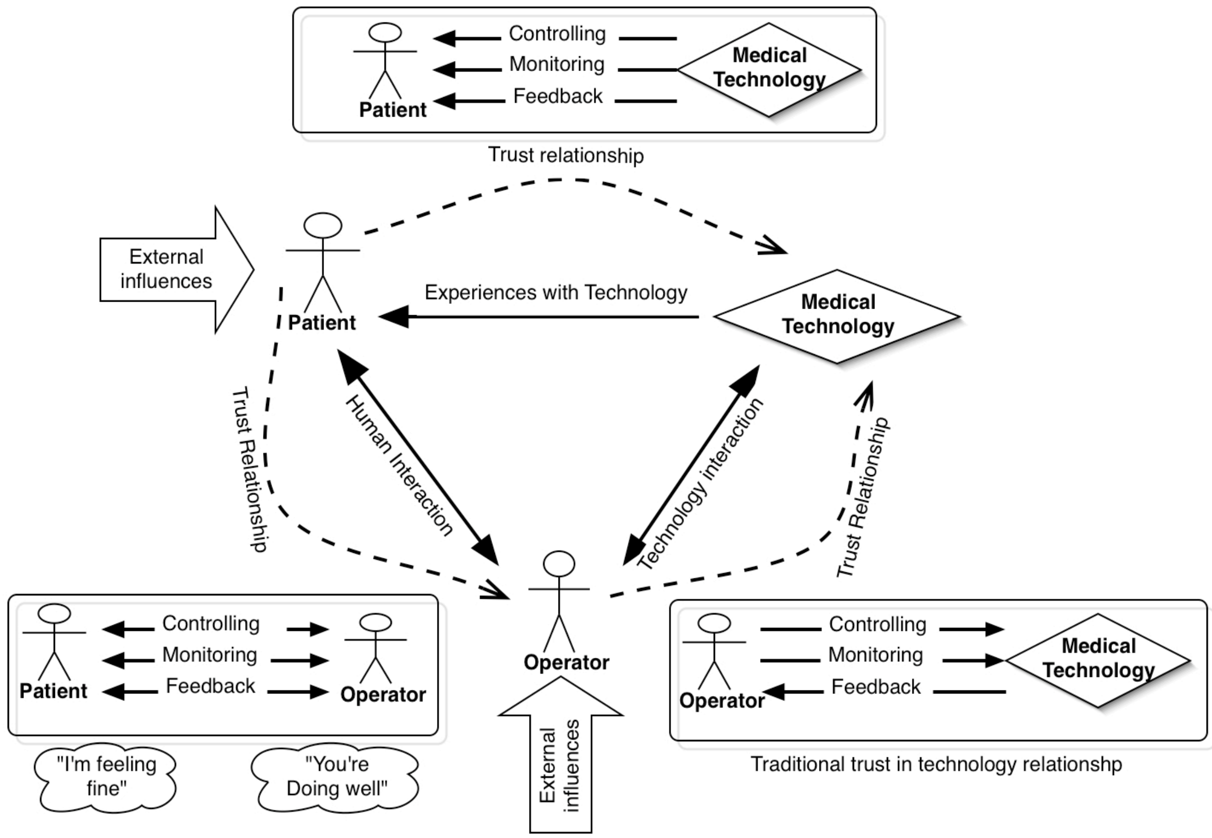


Figure 4.1 Relationship between patient, technology, and operator

This model also assumes that the patient and the operator had a reciprocal relationship, with the operator as a mediator between the patient and the technology allowing the patient to operate the technology through commands to the operator. For example, the patient can let the operator know if they want more medication from the machine and the operator can control the machine to administer the medication. As indicated in this model, it was expected that patients and operators experienced technology in different ways, given the different levels of control they had over the technology. Experience for this research was defined as relationship a person has with the technology and the translation of that relationship, into trusting or distrusting.

The care providing process in obstetrics is currently characterized as steadily increasing in physician usage and reliance on technology (Davis- Floyd, 1994; Davis-Floyd, 1993; Klein et al., 2006). In parallel, the malpractice crisis is affecting obstetricians more so than other health care systems thus causing obstetricians to either limit the care they provide or leave the field altogether (Zhao, 2005). The electronic fetal monitor is an excellent example of automation technology and has been a key technology with regards to malpractice litigation in obstetrics (Cartwright, 1998; Lent, 1999; McCartney, 2002). The fetal heart monitor measures fetal heartbeats during a mother’s labor to detect complications or abnormalities. In the past, a nurse or physician accomplished this monitoring manually with a fetal stethoscope. In recent years, a continuous electronic fetal heart-monitoring machine has replaced the manual method as a requirement of required standard care. The new automation allows for continuous monitoring and nurses' monitoring of multiple patients (Cartwright, 1998). This technology, like others, is subject to trust or distrust by the operator. However, it is unclear what happens when the patient trusts or distrusts a technology. Does the patient sue for malpractice if the operator's level of trust does not match her own? Will the patient influence the operator to trust the technology more or less to match her own level of trust? Understanding the relationship between the patients, the operators and the technology is necessary for understanding health system issues such as malpractice and medical error. Understanding the definition of trust in medical technology is a necessary first step for understanding health care systems and technological interventions in those systems. Characterizing trust in medical technology as it constructed by members of the obstetric work system will serve as a foundation for theories about the role of patients in health care systems.

Grounded Theory. Grounded theory studies a process, action or interaction involving many individuals and develops theory grounded in data from the field (Glaser, 1967). The difference between grounded theory and phenomenology is that grounded theory moves beyond descriptions of the experiences used generate or discover a theory (Glaser, 1967). The focus of grounded theory is to sort out the elements of an experience. From the examination of the components of the experience and their relationships, a theory is developed "that enables the researcher to understand the nature and meaning of an experience for a particular group of people in a particular setting," (p.5) (Moustakas, 1994). A key feature of grounded theory is the notion of constant comparison, which compares the data inductively, creates codes and then groups them into categories to ascertain importance. Data is then compared with other pieces of data with similar categories. As the pieces are compared, additional categories and relationships emerge (Schwandt, 2007). Categories are defined, described, and become the building blocks for the grounded theory (Schwandt, 2007).

There are two major approaches to grounded theory. The first type was "developed by Barney Glaser and Anselm Strauss, who felt that theories used in research were often inappropriate and ill-suited for the participants under study" (p.64) (Creswell, 2007). The second approach to grounded theory is Charmaz's (2006) constructivist approach. Constructivist grounded theory sought to reclaim grounded theory from its "positivist underpinnings" (Creswell, 2007). Another key figure in redefining grounded theory is Clarke (2005), who argues for a postmodern, poststructuralist approach to grounded theory with the goal of repositioning the researchers from an "all knowing analyst to an acknowledged participant," (Creswell, 2007). This research adopts a constructivist grounded theory framework. This research is concerned with the act of trusting medical technology and the process which leads to trust formation in an obstetric work system. It is an attempt to examine how trust in medical technology is formed and performed in an applied health care setting.

Method

Qualitative research methods are well suited to uncovering meanings people assign to their experiences (Hoshmand, 1989; Polkinghorne, 1991). To clarify participants' understandings of their experiences with medical technology the methods used in this study involved:

1. Developing codes, categories and themes inductively rather than imposing predetermined classifications on the data (Glaser & Strauss, 1967).
2. Generating working hypotheses or assertions (Erickson, 1985) from the data.
3. Analyzing narratives of participants' experiences with medical technology (Polkinghorne, 1991).

Participants. A maximum variation sampling framework was used in the theoretical sampling tradition. In this framework participants were not included because of their representativeness, but for their relevance to the research question (Patton, 2001). Participants represented two major groups of obstetric system users, patients and care providers. Twenty-five new mothers represented the patient group. All mothers had given birth in a hospital and were between the ages of 19 and 35. Seventeen participants self identified as White or Caucasian, one participant identified as Asian and one as Hispanic, five participants identified as Black or African American. The participant's number of children ranged from one to four, 12 mothers had one child, nine had two children, four had three children and two had four children. Participant profiles can be found in Appendix B.2. All names have been changed to respect participant privacy. Twelve obstetric health care workers participated in interviews to represent the provider group. Thirty-seven verbatim transcripts, 370 pages total, resulted from these sampling strategies to provide the data for the study.

Procedure.

Entry into the field. Participants were recruited in a large southeastern rural area in the United States through an obstetric resident who facilitated data collection. Interviews were conducted due to the infeasibility of recruiting participants for focus group sessions. Participants were told about the study from a physician stakeholder at a hospital in South Western Virginia or volunteered directly from advertisements for the study. Interviews took place in the patient's room, a private space, or over the phone. Before the interview participants were given an informed consent form. Once verbal consent was given (due to HIPPA regulations) participants were reminded that the interview would be audio recorded and that confidentiality would be kept. Participants from the provider group were told about the study from an obstetric resident and invited to participate. If they agreed to participate, interviews were scheduled by telephone.

Ethical Issues. The protocol was approved by the hospital and university ethics committees. The purpose of the study was explained verbally and in writing to each potential participant, consent was requested and each participant was informed of their right not to participate. Participants were all 18 years of age or older, so that consent could be given legally. Confidentiality between the participants and the researcher was assured. Additionally, in accordance with health insurance personal privacy act regulations any identifying information from patients was withheld from the researcher, therefore informed consent was only given verbally.

Data collection, analysis, and writing. Evidentiary adequacy is a concern for establishing rigor in qualitative research specifically, extensiveness of the group of evidence used for data and adequate time spent in the field and (Erickson, 1985; Morrow, 2005). The data consisted of over 37 hours of recorded interviews, field notes, and demographic questionnaires. Verbatim transcripts were created for each interview. During each interview, memos about salient themes and observations were taken during and after the interview by either the interviewer or a member of the research team.

The analytical process was based on engagement with participants and immersion in the data that was repeatedly sorted, coded, and compared using the constant comparative method (Morrow, 2005; Muhr, 2004). In accordance with the grounded theory method, analysis of data began as they were collected, and were then reanalyzed once data saturation had occurred (or no new themes began to arise). At the conclusion of analysis, categories had been identified and linked into a preliminary framework (Levy, 2006).

Each transcript was coded line-by-line in an initial open coding framework using Atlas.ti software (Charmaz, 2006; Muhr, 2004). Open codes were collected in-vivo or in the participants own words. During the open coding process, theoretical, methodological, self-reflective and analytical memos were written to bring meaning to the data. Theoretical memos consisted of explanations of the data using theoretical hypotheses or comparisons of the data to existing theories. Methodological memos consisted of documentation of the methods used to categorized (code) and sort the data. These documentations included definitions of codes and categories and rules for inclusion or exclusion. Self-reflective memos consisted of the researchers own reactions to participant accounts. Analytical memos consisted of thoughts, questions, reflections, and speculations about the data.

Open codes were then grouped with similar codes to form code families or focused codes. These codes were then systematically compared and contrasted to create progressively more complex and comprehensive categories. These codes were described as themes and reassembled using axial coding procedures. Axial coding is “a type of coding that treats a category as an axis around which the analyst delineates relationships and specifies the dimension of this category” (p. 60) (Charmaz, 2006). The purpose of axial coding was “to bring the data back together again into a coherent whole after the researcher has fractured them through line-by line coding” (p. 60) (Charmaz, 2006). Data was incorporated from memos and other portions of the study including demographic questionnaires and accounts of user experience to form theory.

Accountability was achieved through maintaining an audit trail that outlined the research process and evolutions of codes, categories and theory

(Miles & Hubberman, 1994; Wolf, 2003). The audit trail consisted of chronological narrative entries of research activities, including pre-entry conceptualizations, entry into the field, interviews, transcription, initial coding, analytical activities, and the evolution of the trust in medical technology model. The audit trail also included a complete list of the 169 in vivo codes for trust in medical technology that formed the basis of analysis.

Findings

The grounded theory model for trust in medical technology in obstetric work systems, that developed from the current study is presented in Figure 4.2. The first section describes patients' user experience with the technology. The second section describes the model of patients trust relationship with technology and the third section describes a model for physicians trust relationship with technology.

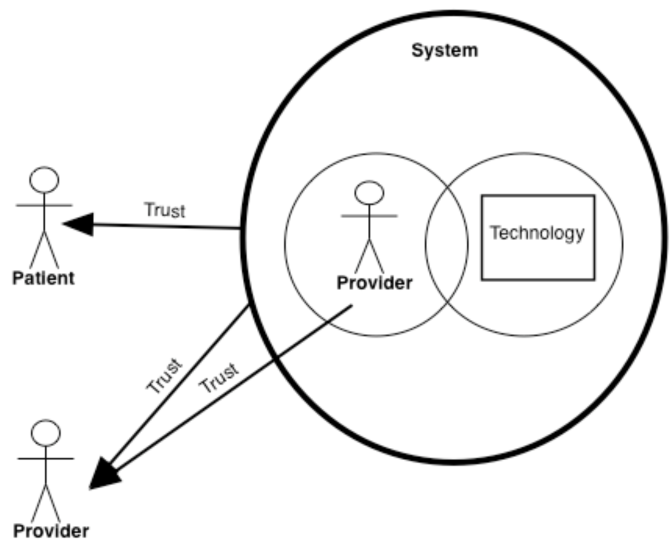


Figure 4.2 Model of patient and provider trust in medical technology

<u>Patients as Users.</u>

To explore patients' experiences with the technology they were asked what kinds of technology was used in their experience, what they noticed about the technology and how the technology made them feel. Patients' experiences were divided into positive and negative experiences with the technology. Patients reported the technologies that were used during the births of their children. These technologies were coded individually and then grouped into singular codes to describe technologies that were essentially the same. For example codes such as scalp electrode, vaginal fetal monitor, and internal fetal monitor were all coded as internal fetal monitor. These codes were then organized into larger categories. The codes fetal heart monitor, internal fetal monitor and external fetal monitor were labeled under the category fetal monitors. Larger categories labeled; low technologies, monitoring technologies and birth assistive technologies, were created to capture the purposes of the various technologies.

Low technologies were described as the sole technologies used in natural birth experiences. Examples of these technologies are adjustable beds and clamps. Monitoring technologies were divided into two categories, those that monitor the mother and those that monitor the baby. Maternal monitoring technologies included maternal heart monitor, blood pressure machines and contraction monitors, while fetal monitoring technologies included heart rate monitors and ultrasounds. Birth assistive technologies were those technologies that were used when natural birth did not occur. These technologies ranged in invasiveness from forceps, vacuums, epidurals, induction, and c-sections. Three patients reported not remembering or knowing what was used.

Participant's responses to what they noticed about the technology were divided into what they could see, hear and feel. Thirty-three codes were derived from sight, 14 codes were derived from feelings and 13 codes from hearing (see Figure 4.3).

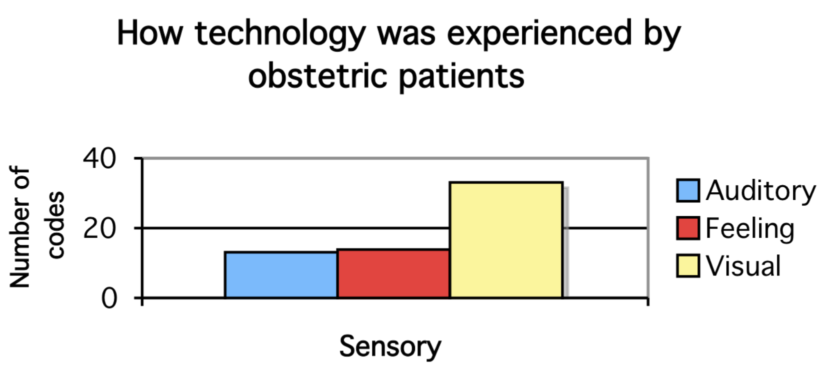


Figure 4.3 How technology was experienced by obstetric patients

After open coding, patient's experiences were categorized into positive experiences and negative experiences. There were ten positive experiences and twelve negative experiences (see Table 4.1).

Table 4.1

Code Families of Technology Attributes Associated with Positive and Negative Feelings

Positive feelings	Negative feelings
Technology was comforting	Immobility
Perceiving heart beat is comforting	Belt as the source of negativity
Having the technology equaled overall good feelings	More pain than necessary
Knowing when and how long contractions would be	Frustrated about IV
Monitors helped outsiders (partners and nurses)	Unreliability
Seeing and monitoring ones own blood pressure.	Machines were distracting
Keeping an eye on babies heart beat	Equipment didn't feel natural
Knowing more	Contraction monitor is unnecessary
Knowing that the mom and baby were being monitored	Depending on others
Knowing that the baby is ok	Dislike of blood pressure cuff
	Feeling like you're in a hospital
	Doctors pushing more medical interventions

These findings show that patients were having user experiences with the technologies that are present in the process and translating the feedback they receive into feelings.

Positive feelings were characterized as feelings that were welcome and comforting. These feelings were the result of what the patient noticed from the technology and how it made them feel comforted or positive about the technology and the process. Subcategories of positive experiences included:

a) Feeling that technology was comforting.
b) Perceiving the heartbeat as comforting was expressed by having comforting feelings associated with the simulated heartbeat that was heard from the fetal monitor.
c) Having the technology equaled overall good feelings for some mothers. The presence of the technology made them feel that they were receiving first class care and that the system would be prepared if anything were to go wrong.
d) Knowing when and how long contractions would be was also considered a positive feeling about the technology.

Erin expressed positive feelings when she said, "It made me feel I guess more comfortable and relaxed knowing that you know my baby's heart rate was being monitored and they knew what was going on as far as my contractions when they developed and… it was more comfortable." Kelly expressed positive feelings about the technology when she said "I'd say it was comforting, to be able to hear that the babies were doing fine, and you know, to be able to know when you were having a contraction too, and how much longer you were going to have to endure it. So I would definitely say it was comforting."

Negative feelings were characterized by expressions of negativity towards the technology and the feelings that resulted from the feedback from the technology. These negative feelings were:

a) Immobility
b) Belt as the source of negativity
c) More pain than necessary
d) Frustration about having to use the IV
e) Unreliability (i.e. "Is there something wrong with my baby or is it the machine?")
f) Machines were distracting
g) Equipment didn't feel natural
h) Contraction monitor is unnecessary
i) Depending on others
j) Dislike of blood pressure cuff
k) Feeling like you're in a hospital
l) Doctors pushing more medical interventions

Nicole expressed negative feelings about immobility and depending on others when she said "I didn't like having to wear the monitors. I mean they put them around and she… kind of… you're kind of on a leash, so if you are trying to turn around to get comfortable, you can't. You have to ask the nurse, to like, make sure everything is still hooked up when you go to turn on your side and stuff like that. And that was kind of a pain." Another expression of negative feelings came from Jennifer when she discussed unreliability:

> So yeah it's a little nerve wracking when they are like okay you know uh you know we are suppose to be able to monitor the baby's heart rate and we can't find it. Even the attitude of the nurses in the room, they were agitated when they couldn't find the heart rate so you know and then, you know, you hear the beeeeeep, the loud beeps of straight lines and things like that. So it is, you know, you know, having had a more consistent experience with my son, you know, having all that going on and having the nurses attitude be a little more agitated with the process you know it kind of it kind of sends you into a "okay what's going on? Why isn't this working? Is something wrong with the baby?" So it was a little, a little nerve wracking not knowing, you know, not knowing why alarms were going off or not knowing why their machines weren't working for me.

<u>Patient's Trust in Technology.</u>

Patients develop trust in the medical technology by enclosing the technology and those who use the technology into a system and then evaluating the system to determine whether the technology is trustworthy or not. Major components of the system are trust in care providers, how providers use the technology and characteristics of the technology (see Figure 4.4). Patients have direct relationships with the technology and the providers in the system, but it is how these two components work together that is a key component of trust formation. Mediating the decision to trust the system or not is a dynamic comparison with a person's mental model of how the system should function and ones personal beliefs. In the absence of mismatches, patients have "no reason to distrust the technology." A description of the key themes that formulate this relationship follows.

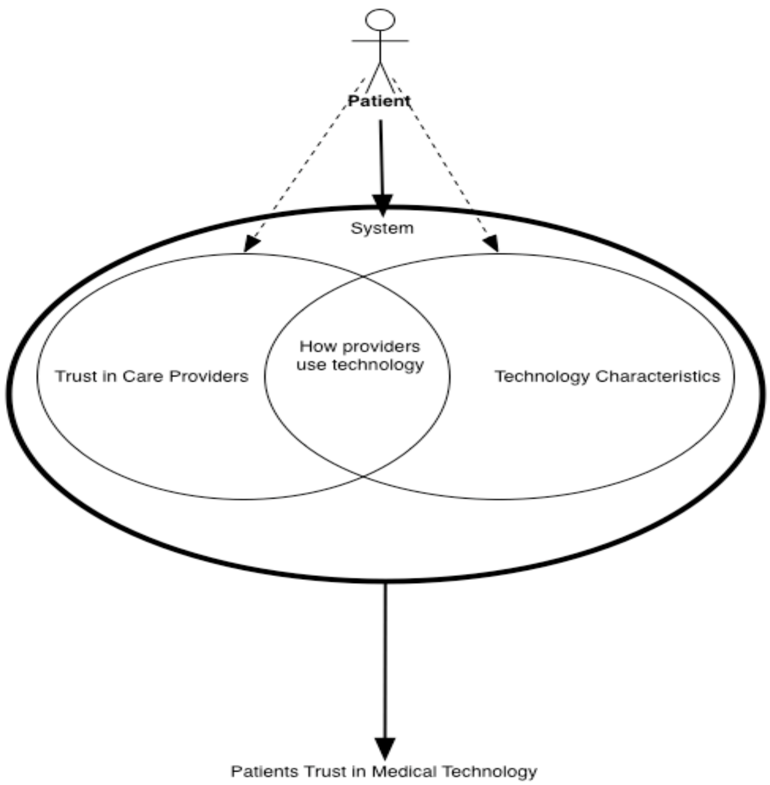


Figure 4.4 Patient's Trust in Medical Technology

Trust in care providers. Trusting care providers was the largest and most salient component of the trust in technology coding scheme. Participants expressed trust in providers as a component of trusting technology in a variety of ways. Trusting providers includes trusting that the provider is competent, capable, and knowledgeable enough to use the technology. Amanda expressed the doctor's personality as a way of her developing trust in the technology by saying, "It wasn't so much the equipment, it was the physician. Like, he was kind of a jerk, and he just wouldn't put up with anything inferior." She describes trust in care providers in terms of providers exhibiting behaviors worthy of trust. In her mind, her physician was a perfectionist that could not be bothered with bedside manner, which made him appear more competent as a physician. Specifically, she said "I didn't trust him to give me *laugh* um good advice like how to deal with the pregnancy or give me emotional support *laugh* or anything like that. But I trusted him to cut me open and take the baby out and sew me back up." In a similar example, Sarah described the physician's behavior in influencing her trust in the technology, she said it was "the doctor's confidence in what he was doing," and that "he seemed very knowledgeable about the technology." In another case, Tiffany "just kind of trusted the people that were using [the technology], that [they] were in charge of it." Tiffany trusted the providers to do their jobs and believed that part of their job was to be able to use the technology.

Technology characteristics. The technology characteristics that were related to patients' trust in medical technology were divided into a) the look of the technology, b) perceived reliability, c) consistency, and d) feedback from the technology. The look of the technology was described as the technology being perceived as modern or high-tech. Amy described her trust in the technology by saying "everything just looked so pristine, and new and modern and that just makes you feel like, okay, this is not going to break down on me and kill me." Maria also expressed her trust by saying "it appeared to be new, it was clean." Reliability was only experienced by a few mothers because of the nature of their pregnancies. Kelly had twins, and because she had "things tested twice," with each baby she felt trust towards the technology. Some mothers felt trust because the technology was consistent in its functioning and with their own bodily experience. Jennifer described consistency by saying,

> In trusting it to perform effectively I like to see that it's you know, that it's consistent, you know, you can, you can see that it's, for me monitors the contractions so I can see that yes, in deed when it was working you know, I could see that yes, it was you know peaking at the same time as my feeling of the contraction and you then coming back down after that, after the contraction subsides so you know when it was working, you know, that I guess that's a very, you feel that it was monitoring it correctly. When it wasn't working then you have that doubt that okay does that mean that something is wrong or does that mean that the machine is wrong…

Nicole expressed consistency by saying "from when they first hooked it up, it kept doing the same thing all day and so I felt like it was working."

Feedback from the technology was defined as obtaining any feedback from the technology as a factor of making the patient trust it. Specifically, it was defined as trusting the technology because the user can hear, see, or feel it doing something. Rachel described feedback from the technology by saying, "well with the monitors I saw the times when I was having a contraction I saw that they were actually printing them up so that in itself made me know okay it is doing its job by monitoring and they know and with the heartbeat of course I heard my son's heart beat so I knew it was working then." Specifically, hearing the baby's heartbeat was a dominant theme in describing trust originating from feedback from the technology.

Trust in how providers use technology. The intersection between trusting providers and trusting the technology is how the providers use the technology.

This theme was developed from the categories a) realizing the providers were not using the technology correctly and b) not trusting how the technology is used. Jennifer described her experience with observing how providers used the technology by saying,

> I felt like it wasn't necessarily the fetal monitors that were the problem but it was the staff's use of the fetal monitors or mishandling of or not knowing the best ways to, to uh get the machine to work, to give them the data that they needed. It was hit or miss whether it was monitoring correctly, like at first it seemed like okay is the machine working okay but then you know with all it's alarms going off but then you, more and more realize that it wasn't necessarily the machine but the fact that it wasn't, you know, it wasn't you know using to it's best ability.

In Jennifer's experience the providers mishandling of the technology gave her a low trust in the technology and the providers. Heather said, "I guess when it comes down to it, I trust the technology but I don't necessarily trust how it's used. So if I trusted that it was being used for my best interest, then I would be more okay with it being used." Lindsay similarly expressed a feeling that the technology was being used inappropriately when she said "I just think that our culture hasn't done a good job of saying that the technology is there if you need it, rather than the technology is there, let's use it."

<u>Providers Trust in Technology</u>

In the providers' trust in technology model trust is made of the trustworthiness of the system and the providers' trust in their own abilities to use the technology. This trust level is then dynamically mediated by the presence of critical incidents or outcomes. The result of this process is the formation of strategies that determine how much power the technology will have in the care providing process. The themes that make up this model are described below.

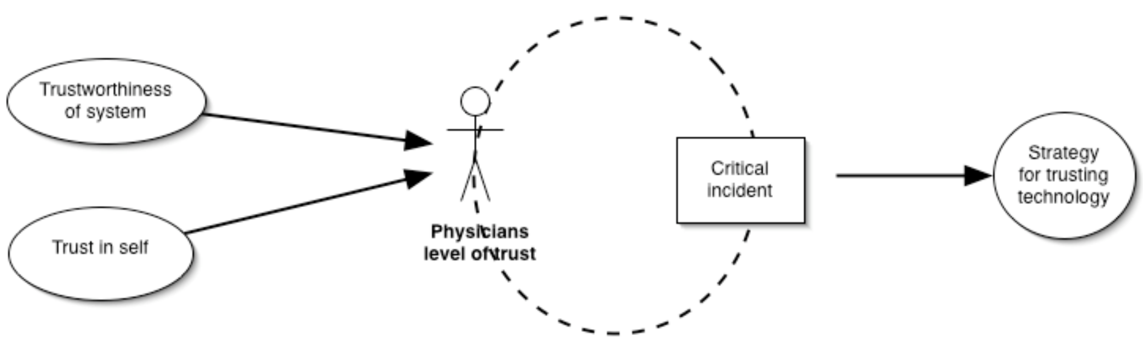


Figure 4.5 Physician's Trust in Medical Technology

Trustworthiness of the system. The trustworthiness of the system is made of the themes a) generally not questioning trustworthiness or blind trust, b) assuming other members of the system have evaluated technology's trustworthiness, and c) time = trust. Blind trust is experiencing trust in the technology as a part of the system and not questioning its trustworthiness. This was expressed by statements such as “as a whole I trust it” (participant 1206), “I go on the trusting side” (participant 1204) and “I don’t doubt it’s functioning” (participant 1203). Assuming that other members of the system evaluated the technology for trustworthiness was the notion that there are checks and balances in the system to determine when technologies should be used and when they aren’t. This includes beliefs that technicians and other entities regularly check the system to make sure it is working and it is the provider’s role to trust that those entities are doing their jobs. This theme was expressed with statements such as “most medical technology is based on research” (participant 1205). Another physician stated that they trusted the technology because “I imagine the equipment is calibrated and tested” (1204). Another physician stated that the hospital had “policies in place for checking equipment,” (1209). Times equals trust is the notion that the trust in the technology is based on the fact that the system has used the technology for a long time. This theme calls for trust in the status quo, by saying that this is the technology the medical world, this hospital, or the doctor has always used and therefore who is the individual to question it’s trustworthiness.

Trust in Self. Trust is self is the notion that a provider must trust their own ability to use the technology. This theme is made of two categories a) having proper training with the technology and b) having previous experience with the technology. Having proper training with the technology was expressed as a factor in the trustworthiness of the technology through participant 1202’s statement:

> I think its has to do with if you are comfortable working in an environment where you have worked with the equipment in the past, and if not, then you have the proper orientation to using the equipment and the different buttons on it, the different alarms. And just kind of, I feel it essential being comfortable using the technology before D-day where we use it in the room and with the patient.

Critical incident. A critical incident is an event that has a significant effect, either positive or negative, on task performance or user {Flanagan}. Critical incidents were described as mediating moments when the technologies failed to produce the expected results. These moments were limited to moments when the user realized the technology was not being accurate or seeing that the technology’s predictions did not match the outcomes. These critical incidents could possibly be expanded to include moments where technology breaks or causes harm as well. The critical incidents were factors that adjusted the providers’ trust levels and caused them to create strategies to allow the technology less power in decision-making.

Strategy for decision-making. Providers discussed two decision-making strategies they used to accommodate their level of trust in the technology; a) allowing the technology limited power and b) performing reliability checks. These strategies together represented the most grounded theme (highest number of codes), in provider’s discussions of their trust in the technology. Limiting the power of the technology is a strategy that prevents full reliance on the technology for decision-making. This strategy included viewing the technology as "only part of the picture, not the "end all" (1206). Participant 1211 discussed this strategy by saying, "You have to look at the whole clinical picture and there are so many variables that play into it and the technology is a good part of that but I wouldn't make a decision based only on the technology." Reliability checks involved looking at the technology's output in context and checking those findings against other factors the provider could observe. Participant 1208 described this by saying,

> We have to be in the room to be able to tell what is going on, um, sometimes it looks like the baby's heart rate is dropping but what actually is happening is the baby moved and now you are picking up the mom's heartbeat, so you have to be in the room in order to tell what is going on.

Discussion

What the findings from this research allude to is the notion that patients trust what they perceive to be well functioning systems (see Figure 4.6). This means that the trustworthiness of the technology can not be separated from the system in which it works. Well functioning systems are those in which users and technology work together confidently and efficiently. Therefore, technologies must be well-designed and usable, but other factors are important for trust to occur.

1) Care providers must be well trained in how to use the technology. They must trust they are prepared to work with the technology in the system. This includes making sure physicians capabilities and limitations are well considered in system design.
2) Systems must be designed to accommodate the technology.
3) Patients must have indication that the system is functioning well. This can include the absence of moments that can create uncertainty, such as false alarms or providers displaying usability issues with the technology.
4) Technologies must be designed for the factors of trustworthiness such as accuracy, reliability/ consistency, modern-ness, and cleanliness. What is useable for providers may also be useable for patients.
5) Patients will benefit from education and information about the technology and its use. When asked about education and the technology most patients said that they were given little or no information about how the technology worked or would be used on them. Hospital tours show them what technologies might be used, but this information is often brief and not necessarily useful.

In the obstetric work system patients see themselves as the products of those systems and perhaps outside stakeholders, rather than members of the system. This representation contrasts with how a patient might see themselves as a key stakeholder and collaborator in a midwifery work system. It can be argued that obstetric system designs this level of patient complacency and compliance through interactions that occur in prenatal health care experiences with ultrasounds and genetic testing.

While patients have relationships with both providers and the technologies, it is how these entities work together that influences trust in the technology. For providers, trust in the technology is essentially rooted in their trust in the system, which includes themselves.

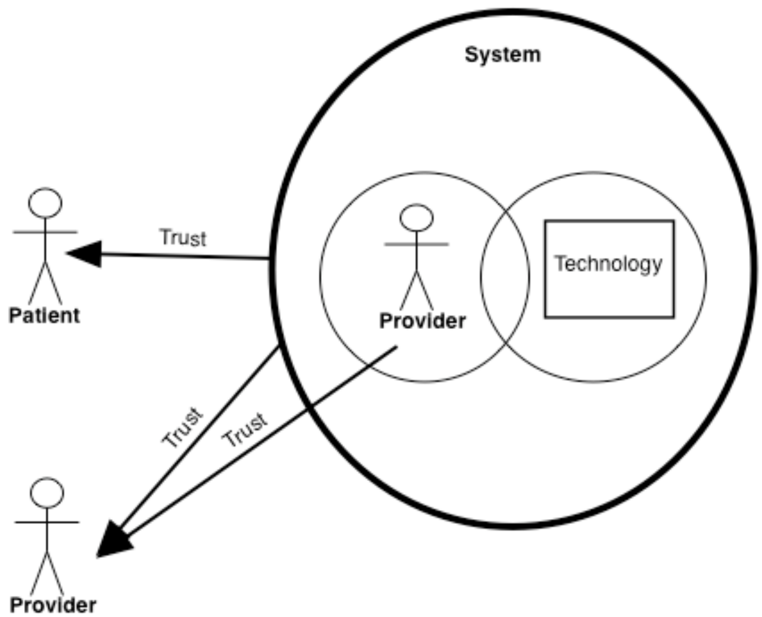


Figure 4.6 Patient and Physician Trust in Medical Technology

A key characteristic of this model is the use of dynamic mental models to form judgments about trustworthiness. For both patients and physicians, trust is determined dynamically, comparing the system's functioning to match a mental of how that system should function. For patients this model may be loosely defined as the absence of any signs of dysfunction. Participants described this as the absence of "uh-oh moments." This can also be combined with beliefs about how the technology should be used, such as believing that a person does not need to use certain technologies unless there is a clinical reason for its necessity. For physicians, this model changes in relation to outcomes and having the technology's feedback match their clinical assessment of what is happening with the patient.

These findings make more sense when thought of in terms of another system with active and passive users, such as commercial aviation. When a person decides to take an airplane for travel, their trust in the airplane is a function of the system as a whole and how the users in that system interact with the technology. A pilot that comments on the intercom system that they do not understand what the red blinking light on the dashboard means, will instill distrust in the passenger. Likewise, a flight attendant that is confident in demonstrating how to use the airplane's devices in emergency situations will instill trust in the system. Additionally, factors such as the plane looking clean and well maintained instill trust; while a plane that looks old, rusty and dirty will make the passenger question its trustworthiness.

Similarly, the pilot must trust that the entire system, in which they are a part of, is well functioning. They must trust that the manufacturers of the plane and its parts have checked the plane's design for quality. They must also trust that the co-pilot, maintenance personnel, air traffic controllers are all appropriately trained and have done their jobs effectively. They also have to have a level of trust in themselves, have they flown this type of plane before, are they alert enough to make the flight, do they feel confident in their abilities to interact with this technology to produce safe and efficient outcomes? The difference between these two systems is that the aviation industry has years of research and intervention in optimizing human-technology interaction and integration.

In the aviation industry there are checklists performed multiple times by multiple system stakeholders to ensure that the system in behaving in a trustworthy manner. Pilots are routinely tested and evaluated to make sure they are capable of operating the technology effectively. In healthcare, not limited to obstetrics, there is a significant amount of resistance to the use of checklists. Many of the system efficiency checks are conducted ad-hoc or are limited to personal perception. Trust in technology is a factor that must considered to address system weaknesses such as patient safety and human error.

Conclusion

Recent healthcare literature has explored the role of patient's trust in physicians in patient behaviors such as adhering to medical advice, malpractice litigation and seeking healthcare services. Pearson hypothesized that changes in the healthcare industry organization and practices are undermining the trust relationship between patients and physicians (Pearson & Raeke, 2000). Some researchers believe that technology replaces human elements in medical practice, therefore reducing patient's trust in physicians (Boehm, 2003). However, the findings of this research show that technology may redefine the trust relationship between patients and providers and associated expectations from each group.

Patient trust is a complicated construct that has different definitions between and within disciplines. Some researchers define trust as a set of beliefs or expectations that a care provider will perform in a certain way. Boehm (2003) argued that increasing interpersonal trust between patients and physicians is a solution to growing malpractice claims. Boehm (2003) defined trust gaining behaviors for physician as communication, revealing emotions, building relationships over time, self-disclosure. The results of this research show that patient trust in physician can also be defined behaviorally, for example perceptions of a physician's behavior with the system in which they are part of.

Other researchers define trust as a more emotional characteristic, where patients have a comforting feeling of faith or dependence in a care providers intentions (Pearson & Raeke, 2000). Pearson and Raeke (2000) believed that trust is a defining feature of a patient physician relationship. Pearson and Raeke's analysis of articles about patient physician trust found that the most common dimension of trust are competence, compassion, privacy and confidentiality, reliability and dependability and communication (Pearson & Raeke, 2000). These features were also accommodated in the model developed here for patient trust in medical technology. Factors such as competence, compassion, privacy and confidentiality, reliability and dependability and communication can be accomplished or ignored through a provider's use of the technology. Providers can express competence, by being able to use technology appropriately. They can express compassion by responding to technology that makes the patient experience uncomfortable, such as the fetal monitor belt or blood pressure cuff being too tight during contractions. Providers can also express respect for privacy and confidentiality by assuring their patients that their records and other information are being kept private. They can express reliability and dependability, in the way they respond to the technology. For example, providers can respond to alarms every time they go off, or they can decide to only respond sometimes. Communication can affect trust, thorough providers' explanation of what the technology is doing and how they are using the feedback from the technology to make decisions.

Pearson et. al. (2000) found a distinction in the literature between social trust and interpersonal trust. Interpersonal trust is defined as trust developed over periods of interaction in which a persons "trustworthy" behavior can be assessed over time. Patient's trust in physician has been linked to increases in several behavioral outcomes such as adhering to medical advice and treatment, patient satisfaction, health status (Pearson & Raeke, 2000). Patient's trust has also been linked to important organizational and economic factors such as decreases in the possibility of a patient leaving a care providers practice and withdrawing from health plan (Pearson & Raeke, 2000). Despite theoretical assumptions, only one study has actually examined the relationship of patient trust to these outcomes and they were not able to form a causal relationship (Safran, Kosinski, & Tarlov, 1998). The findings of this research hypothesize that the design of the technology and the integration of the technology within well functioning systems may produce actual outcomes in terms of patient satisfaction, lower errors, and patient adherement to medical advice and treatment. Designing technologies and systems that allow for appropriate integration of humans and technologies has produced positive system outcomes in many systems (Hendrick & Kleiner, 2001).

Fung et. al. (2005) found that patients prefer physicians with technical qualities as opposed to interpersonal qualities, which is part of an array of research on the trust relationship between physician and patient (Pearson & Raeke, 2000; Tarn *et al.*, 2005). The current study shows that providers' use and competency with technology is a factor in patients' trust in physician. It also shows that the characteristics of the technology are only part of the equation for a patients trust in technology. Future research is needed to quantify the effects of patients distrust in technology. Anecdotally, the findings of this research show that patient distrust leads to more time spent negotiating use of technology between patients and providers and more interruptions in system process.. Interruptions in care have been found to be a source of human and system inefficiency and errors.

Several scales have been developed to measure patients' trust in their care- provider. The *Trust in Physician Scale* was validated by Thom et. al (1999). The researchers administered the scale to 414 patients, through statistical analysis they found high internal consistency, and test-re-test reliability (Thom, Ribisl, Stewart, & Luke, 1999). They concluded that the *Trust in Physician Scale* is an attractive psychometric instrument because it displays construct and predictive validity. They also conclude that the instrument is distinct from patient satisfaction (Thom et al., 1999). The results of this study provide further validation for distinguishing patient satisfaction from trust. In the examination of patients' experience with the technology, patients reported several points of dissatisfaction or negative feelings regarding the technologies used. These descriptions included terms such as dislike, distracting, unnecessary, frustrating and hate, which are all terms related to dissatisfaction. However, in descriptions of the technology's trustworthiness, these factors were as relevant.

Researchers have examined the relationship between physician styles and patient outcomes, and patient personality traits and outcomes. An observational study examined patients' perceptions of their physician's interpersonal manner through ratings, such as, satisfaction, trust, and knowledge of patient and autonomy support. (Franks et al., 2005). The researchers found a relationship between patient's perceptions of their physician and health status decline. Through multilevel analyses, the researchers believe that this relationship is not a physician effect, but may be the result of another confounding variable (Franks et al., 2005). Other studies have looked at patient's assessments of their care provider and linked these ratings with "health status change, adherence, and satisfaction," (p. 229) (Franks et al., 2005). Franks argues that patients are likely to report being more satisfied with their care provider if they have better health status. Franks et. al (2005) argues that although research has concluded that provider traits are related to patient health status, these results may not be related to care provider traits. This indicates a need for more dynamic measures of physician traits. While Franks et. al. (2005), recommended assessment of psychological and personality traits, attitudes towards technology would also be an insightful addition. Additionally, because the findings of this study allude to dynamic mental model processing, performance measures of physician's actions with the technology may also provide insight into the relationship between patients and providers.

Pearson's review paper sought to find the points of trust relationships in healthcare that are strong and to find the "emerging points of weakness that threaten health outcomes," (p. 509) (Pearson & Raeke, 2000). The results of this study show that the interaction between providers and technology is a point that influences trust in technology and is essentially a point that can threaten health outcomes. Moments where providers are unable to use technology appropriately make patient vulnerable to errors and un-necessary interventions.

CHAPTER 5. PHASE III THE DEVELOPMENT OF A TRUST IN MEDICAL TECHNOLOGY INSTRUMENT

Overview

The following study describes the development and validation of an attitudinal instrument to evaluate a user's trust in medical technology. The measurement process involved the invention of variables, modeling of observations, and the evaluation of measures. Inventing variables involved defining constructs within a theoretical framework, identifying indicators of the construct, and mapping those indicators onto the theoretical framework (Wolfe, 2006a). Modeling the observations involved specifying rules for converting observations into numbers, creating a mathematical model of how those numbers could be combined to create measures, and specifying a frame of reference for interpreting measures (Wolfe, 2006a). The evaluation of measures was completed by reliability and validity analyses that ensured measures were stable across multiple contexts and consistent with the framework within which they were created (Wolfe, 2006a).

Introduction

Medical technology has been defined similarly, across groups such as designers, educators, researchers, practitioners and government health and human service organizations, as tools used on the body for health purposes.

- Medical technology is "designed to improve the detection, diagnosis, treatment, and monitoring of disease and illness" (p. 17) (DeMiranda, Doggett, & Evans, 2005).
- Medical technology uses apply to "mechanical, chemical, mathematical, and computerized knowledge systems" (p. 30) (American Association for the Advancement of Science, 1990).
- Medical technology is characterized by "energy forms (mechanical, optical, electrical, acoustical, etc.)" applied to the body for purpose of diagnosing or providing therapy to ailment (p. 1) (Evans, 2003).
- The office of technology assessment (OTA) (1982) defined medical technologies as "drugs, devices and medical and surgical procedures and organizational and support systems within which medical care is delivered."
- Medical technology is the "application of devices, procedures, and knowledge for diagnosing and treating disease for the purpose of maintaining, promoting, and restoring wellness while improving quality of life" (p. 17) (DeMiranda et al., 2005).

Therefore, the difference between technology and medical technology are that medical technologies are used in a health care context, in relation to the body, and are associated with expansive external environmental systems that include basic science, engineering, providers of the technology, users of the technology and receivers of the technological intervention. The goal of this study was to explore trusting attitudes about medical technology.

Trust measurement requires tools that can be used in real-time, and therefore they must be not be invasive or difficult to apply (Human Resources Team, 2003). Rating scales to measure trust between humans and technologies have been developed and used in a variety of research contexts (Bisantz & Seong, 2001; Jian et al., 2000; Lee & Moray, 1992; Madsen & Gregor, 2000; Muir & Moray, 1996a; Taylor et al., 1995; Uggirala et al., 2004).

Lee et al. (1992) conducted an experiment with sixteen undergraduate students to describe the changes in operators' trust during an automation simulation. At the end of each trial, participants received feedback on the performance of the automation and were instructed to complete a set of ten questions that measured the operator’s trust in the automation. They used a regression model to identify the causes of variations in trust. Their results showed that the factors, predictability, dependability, performance, and trust changed after a failure.

In a similar study, Taylor et al. (1995) used simulated aircraft tasks to study the effects of changes in automation adaptation on operator performance and attitudes that might affect automation use. As part of their research, they developed measures of performance and subjective assessment of the operators’ assessment of the timeliness and appropriateness of the computer aid system. They believed that these assessments would provide insight into the operators trust in the automation.

Muir et al. (1996) conducted two experiments with a plant simulation to explore operators' use and trust in automation. After each session operators completed a set of subjective rating scale. Definitions of the factors accompanied the items. Factors included in the instrument were; competence, predictability, dependability, responsibility, reliability over time, faith, trust in the system to be accurate, trust in systems display and overall trust in system. Their results showed that any sign of ineffectiveness reduced ratings of trust because operators rated the trustworthiness of the automation based on their perception of the automation’s competence. They also found that experience did not change ratings of trust

Madsen et al. (2000) developed a psychometric instrument to measure trust between people and computers using cognitive and affective components. The instrument had five sub-scales 1) perceived reliability, 2) perceived technical competence, 3) perceived understandability, 4) faith, and 5) personal attachment. The researchers defined trust, in terms of confidence, as “the extent to which a user is confident in, and willing to act on the basis of, the recommendations, actions, and decisions of an artificially intelligent decision aid,” (p. 1) (Madsen & Gregor, 2000). Trust in medical technology for patients may be very different, because confidence, which is a belief that something will succeed is often based on little knowledge or evidence about the technology or medical situation. Patients also often do not have the autonomy to act on the outputs of the medical technology. Jian et al. (2000) developed the foundations for deriving an empirical scale for trust in automated systems. They found that people perceive trust between humans similarly as trust in machines and perceive trust and distrust as theoretical opposites, unlike concepts such as comfort and discomfort (Zhang, 1996). These findings allows for a one-dimensional understanding of trust in technology.

Bisantz et al. (2001) developed a framework to describe how operators operate and trust systems. Their experiment used an anti-air warfare simulation task to investigate the role of malfunction origin on trust and system use. After each session participants were given a 12 item questionnaire to measure trust in the system. Results provided support for the factors in the framework and use of the empirically developed scale. In their analysis of questionnaire data they also examined positively and negatively worded questions and found that responses were significantly lower for positively framed questions than negatively framed questions.

Trust measurement in health care work systems has focused on interpersonal trust between patients and physician (Franks et al., 2005; Hall et al., 2002; Pearson & Raeke, 2000; Tarn et al., 2005; Thom et al., 1999) and system trust (Balkrishnan et al., 2004; Zheng et al., 2002). Patient's trust has been linked to important organizational and economic factors such as decreases in the possibility of a patient leaving a care providers practice and withdrawing from health plan (Pearson & Raeke, 2000). Interpersonal trust researchers believe that technology replaces human elements in medical practice and may reduce patient's trust in physicians (Boehm, 2003). Understanding trust in medical technology in relation to other aspects of the health care systems is important for the assessment and design of systems and can only be examined with an effective measurement tool.

The purpose of this research was to develop an instrument to measure a person's trust in medical technology and to provide a framework for trust measures involving patients in health care work systems.

Instrument development

The instrument development stage describes the procedures and guidelines through which the instrument was developed. Efforts to establish content, substantive, and structural validity are summarized as part of the instrument development process.

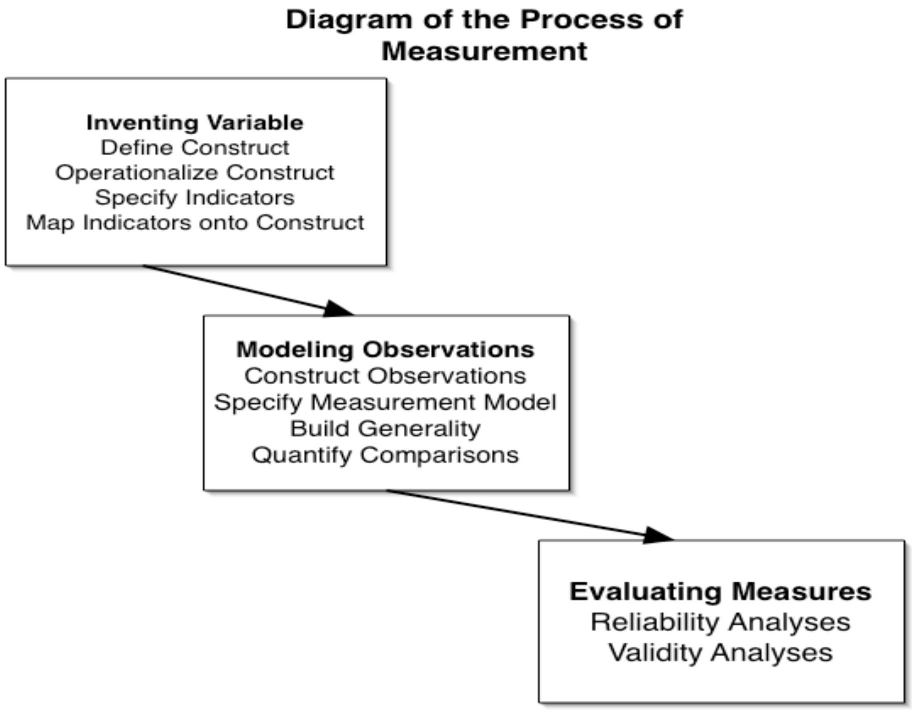


Figure 5.1 Diagram of the process of measurement from Wolfe, E. (2006). Construct specification: Presented at an EDRE 6794 lecture at Virginia Polytechnic Institute and State University

The Crocker & Algina (1986) method was used in the instrument development process as described in (Wolfe & Smith, 2007b). The steps were as follows:

1. Identified the primary purposes for which the test scores would be used.
2. Identified behaviors that represented the construct or defined the domain.
3. Organized a set of test specifications.
4. Assembled an initial pool of items.
5. Pilot testing. Had items reviewed (and revise as necessary).
6. Field testing. Held preliminary item tryouts (and revise as necessary).
7. Determined statistical properties of item scores and, when appropriate, eliminated items that did not meet pre-established criteria.
8. Designed and conducted reliability and validity studies for the final form of the test.
9. Developed guidelines for administration, scoring, and interpretation of the test scores.

Instrument development involved two administrations of the instrument. The administration phases were called pilot testing, and validation.

1. During the pilot testing phase, the quality of individual items was evaluated. Items that exhibited poor performance were revised or omitted from the item pool. Feedback was obtained from experts about the instrument items.

   Items were evaluated on accuracy, communicability, item suitability, difficulty, importance and bias (Wolfe, 2006b).
   - **Accuracy**: Items were evaluated on their ability to answer the question, "does the content make sense from a theoretical perspective?"
   - **Communicability**: Items were evaluated for readability, correctness and clarity of expression, and consistency of style.
   - **Item Suitability**: Items were judged for the suitability of their difficulty, importance, and bias.
   - **Difficulty:** Experts who had an understanding of the educational characteristics of the population (e.g., patients and physicians) assessed item difficulty.
   - **Importance:** Subject matter experts familiar with the characteristics of the examinee population judged items based on the items' importance within the content domain.
   - **Bias** was judged by asking members of subgroups and experts in socio-cultural issues (i.e. English as a second language) to identify items that were potentially offensive, relied on specialized or privileged knowledge, addressed sensitive issues or topics, or were particularly difficult for some subgroups of examinees.

2. During the validation phase preliminary versions of the instrument were administered to 100 participants who had similar characteristics to the population for whom the final test is intended. Based on the results of the validation phase, minor item revisions took place.

Development phase

Development took place in three phases; 1) context/ purposes/ decisions, 2) development of a theoretical framework, and 3) instrumentation.

I. *Context/purpose/decisions.* This stage described the real-world context within which the instrument would be used, the population for which the measures would be made, the purpose for obtaining the measures, the intended uses or interpretations of the measures, and a specific decision that would be made based upon the measures.

This instrument will be used to assess health care system users' trust in medical technology. This instrument measures how a technology can be deemed trustworthy or not, not a person's inclination to be trusting. The Trust in Medical Technology Instrument is intended to be robust, therefore it is able to be used with different user populations.

- Healthcare workers (nurses, physicians, technicians, etc.)
- Patients (of a variety of medical contexts)

- Medical decision makers (patient advocates, counselors)

This instrument is intended to be used to measure the extent patients and healthcare workers feel trust towards a specific medical technology. Under Millman and Greene's framework, the instruments purpose is considered research, combining cognitive and groups (Linn & Education, 1988).

This instrument was developed to provide insight into the relationship between technology characteristics, work processes, training and feelings of trust towards medical technology. Eventually this instrument will be used to assess workers feelings of trust to provide feedback for training and design to create appropriate trust levels for workers. Having too much trust or too little trust in healthcare technology can lead to suboptimal work systems.

II. *Theoretical framework for the instrument.* The theoretical framework includes a formal definition of the construct, a model of the components that make up the construct (*internal model*) and a hierarchical organization for the construct (*process model*).

Internal model. Using trust in technology literature (Bisantz & Seong, 2001; Jian et al., 2000; Lee & Moray, 1992; Madsen & Gregor, 2000; Muir & Moray, 1996a; Taylor et al., 1995; Uggirala et al., 2004), it was inferred that the trust in technology construct was a combination of three major factors, understanding, competence of the tool and self-confidence.

The results from studies one- three indicate that the factors safe, reliability, reliable, trustworthy, and accurate are those factors most related to trust in medical technology, while the factors deceit, produced bad results, not always reliable, untrustworthy, and mistrust are most related to distrust in medical technology (see Figure 5.3).

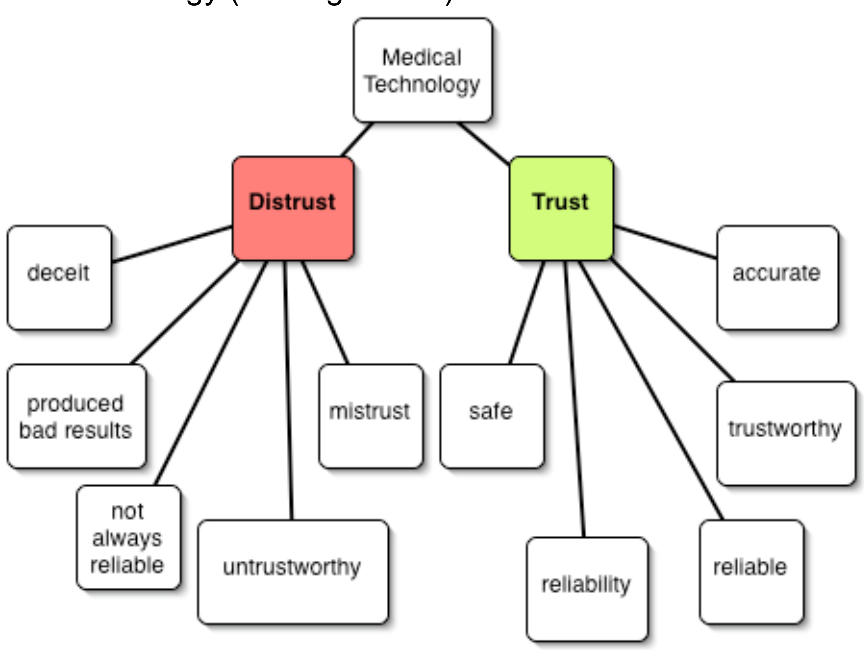


Figure 5.2 Model of trust and distrust in medical technology

In the field study of trust in medical technology in obstetrics trust was found to be related to factors outside of the technology's own appearance and functioning, such as personal beliefs, previous experience, and trust in care providers. This provides evidence for a socio technical definition of trust (see Figure 5.3).

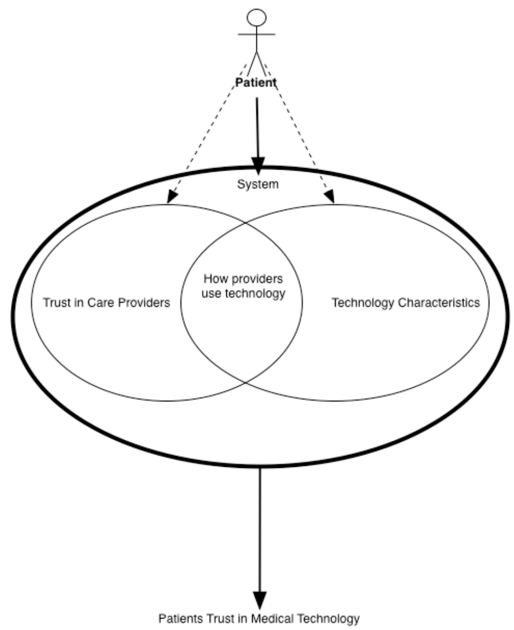


Figure 5.3 Model of patient's construction of trust in medical technology

The internal model was developed based on the 30 factors most related to trust in medical technology in study three (see Table 5.1). Factors of distrust were not used, because study two found trust and distrust in medical technology to be theoretical opposites. Using the understandings from the field study about trust in medical technology, the model also accounts for the three systematic areas for trust formation 1. The technology, 2. The user, and 3. How the user uses the technology.

Table 5.1

Three systematic areas for trust formation; the technology, the user, and how the user uses the technology and the associated factors

Factors in the technology	Factors in the active user	Factors in the how the user uses the technology
Accurate	Accurate	Accurate
Accurately	Accurately	Accurately
Gives real results	Gives real results	Gives real results
Trustworthy	Trustworthy	Trustworthy
Reliable	Reliable	Reliable
Reliability	Reliability	Reliability
Gives correct results	Gives correct results	Gives correct results
Precise	Precise	Precise
Well informed	Well informed	Well informed
Safe	Safe	Safe
Reliance	Reliance	Reliance
Security in caring	Security in caring	Security in caring
Security	Security	Security
Knowledge	Knowledge	Knowledge
Healthy	Healthy	Healthy
Successful	Successful	Successful
Researched	Researched	Researched
Trusting	Trusting	Trusting
Responsible	Responsible	Responsible
Affect lives	Affect lives	Affect lives
Honest	Honest	Honest
Integrity	Integrity	Integrity
Responsibly	Responsibly	Responsibly
Effective	Effective	Effective
Helpful	Helpful	Helpful
Secure	Secure	Secure
Honesty	Honesty	Honesty
Positive	Positive	Positive
Confident	Confident	Confident
Confidence	Confidence	Confidence

Process model. The cognitive structure of trust is made of features from humans primary domain of trust which is trust between people. These features are then translated and used when determining the trustworthiness of technologies in various domains. The basic components for this process reside in the long term memory (Wade & Tavris, 2002).

Long term memory theories hypothesize about the organization of its components. There are generally thought to be four major components (Rosh, 1973).

1. Procedural memories: memories of knowing how to do things such as tying shoes and riding bikes.
2. Declarative memories: knowing things, such as facts, conventions, and concepts. Declarative memory makes up semantic and episodic memory.
3. Episodic memory: internal presentations of personally experienced events.
4. Semantic memory: The memory of general knowledge, including “facts, rules, concepts and propositions.” Semantic memories are “internal representations of the world, independent of any particular context,” (p. 240) (Rosh, 1973).

Semantic memory is where concepts such as trust would be located (Rosh, 1973). Based on the findings in phase I, a prototype model of trust described how trust is processed cognitively. Humans base the trustworthiness of a particular technology within a particular system, based on how they might judge the trustworthiness of another person. The findings in phase II show that this process is conducted globally as well, comparing the technology within the system it works. For example, a person might decide whether or not to trust a doctor based on the same factors they used to determine trustworthiness of another person. Is this person honest, reliable, and confident about their abilities? When assessing the trustworthiness of the technology in the system, humans do not ignore the context in which the technology works. They evaluate the entire system based on the same factors that they developed to determine the trustworthiness of a person. Is the person using the technology trustworthy? Is the technology behaving in a trustworthy manner? Is the person using the technology in a trustworthy manner? Is this a trustworthy system? The answers to those questions together form a person’s trust in the technology.

III. *Instrumentation.* In the instrumentation stage the construct was operationalized by outling the *universe of potential indicators* of the construct and by providing a rationale for the sample of topics chosen (*content sampling*), types of indicators or processes employed (*substantive sampling*), test blueprint, example items, *frame of reference* established for interpreting measures, and measurement model employed (*structural*).

The sample of factors chosen were based on phase I studies 1-3, which provided factors of trust in medical technology. Thirty factors rated most related to trust in medical technology in phase I were chosen to represent topics in the instrument. The three dimensions of the instrument, technology, physician and physicians use of technology were chosen based on the model developed in phase II. The model indicated that patients determine trust in medical technology by evaluating the entire system; the technology, the provider, and how the provider uses the technology.

The processes that were represented in the items were those of 1) behaviors or actions, 2) perceptions, and 3) beliefs. These processes were congruent with the way participants responded to how they defined trust in medical technology in open–ended responses in phase one study one. Behaviors/ actions were things the respondent did to indicate their trust in the subject of the item. An example of a behavior or action would be “I use the technology often,” a person would not use something often if it were deemed untrustworthy. Perceptions were things that the subject of the item did to evoke trustworthiness, such being accurate and reliable. Beliefs were beliefs about subject that indicate trustworthiness, such as “I trust the technology.”

The test blueprint began with a list of the subject and the factors of interest for the 30 most factors related to trust and distrust in medical technology. The test blueprint underwent six iterations. The final instrument can be found in Appendix C. In stage two, the items were combined with the three subjects of interest, the technology, the user, and how the user uses the technology. Every factor was placed with every subject to produce items. Factor subject combinations that were nonsensical were highlighted and evaluated later. Items that could be written in multiple ways were replicated in various formations. Next, different scales were developed and assessed for their relevance to the construct being measured. Next, nonsensical items that could not be re-worded were removed from the subscales.

Table 5.2

Test blue print for factors of trust

Factors of Trust in Medical Technology	Item
Accurate	The technology is accurate.
Trustworthy	The technology is trustworthy.
Reliable	The technology is reliable.
Safe	The technology is safe/
Reliability	The technology has high reliability.
Precise	The technology is precise.
Knowledge	I have knowledge about the technology.
Honest	The technology is honest.
Trusting	I trust the technology.
Positive	I have positive feeling about the technology.
Honesty	The technology is honest.
Responsible	The technology is responsible.
Responsibly	The technology behaves responsibly.
Successful	The technology is successful.
Accurately	The technology performs accurately.
Secure	The technology is secure.
Well_informed	The technology is well informed.
Gives_real_results	The technology gives real results.
Confident	I am confident that the technology works.
Give_correct_results	The technology gives correct results.
Researched	The technology is well researched.
Confidence	I have confidence in the technology
Helpful	The technology is helpful.
Integrity	The technology has integrity.
Security_in_caring	The technology cares.
Affect_lives	The technology affects lives.
Security	The technology has security.
Effective	The technology is effective.
Healthy	The technology will make/ keep me healthy.
Reliance	I have high reliance on the technology.

Table 5.3

Test blueprint for factors of distrust

Factors of Distrust in medical technology.	Distrust Items
Deceit	The technology is deceitful.
Produced_bad_results	The technology produced bad results.
Untrustworthy	The technology is untrustworthy.
Mistrust	I mistrust the technology.
Not_always_reliable	The technology is not always reliable.
Mistakes	The technology makes mistakes.
Misleading	The technology is misleading.
Lost_information	The technology lost my information.
Misfunction	The technology malfunctions.
Dont_work_as_they_shou ld	The technology doesn't work as it should.
Lying	The technology is lying.
Trickery	The technology is tricking me.
Distrust	I distrust the technology.
Failure	The technology fails.
Failures	The technology produces failures.
Not_a_lot_of_information	The technology does not give a lot of information.
Dangerous_situation	The technology is dangerous.
Doubtful	The technology produces doubt.
Errors	The technology makes errors.
Mistake	The technology makes mistakes.
Doubt	The I doubt the technology.
Uncaring	The technology is uncaring.
Doesnt_work	The technology doesn't work.
Harmful	The technology is harmful.
Misadvising	The technology misadvises.
No_confidence	I have no confidence in the technology.
Doesnt_function_properly	The technology doesn't function properly.
No_faith	I have no faith in the technology.
Not_disclosing_risks	The technology does not disclose risks.
Harm	The technology is harmful.

Validation phase

The analyses that provide evidence to assess an instrument's psychometric qualities provide evidence for reliability and validity (Kline, 2005). An instrument is not valid in itself, but it's ability to predict a person's level of a construct is what is considered valid. The Messick (1995) framework for validity assessment, which included test and data evidence for validity assessment, was used to evaluate the trust in medical technology instrument. Messick's (1995) framework evaluates the instrument on content, substantive, structural, generalizability, external and consequential aspects of validity. This section outlines the analysis used to assess the psychometric qualities of the instrument, the results and the aspects of Mesick's framework that were met are discussed.

Sample. The instrument was designed in a checklist format, which necessitated the responder to have had a specific experience with a medical technology to complete. Therefore, to remain consistent with the medical domain represented in phase II, participants were all women who had given birth and used the electronic fetal monitor in some context. Twenty mothers from each age group of 18-35 were invited to complete the instrument through email to total 320 invited participants. Additionally, an advertisement was placed in an online community for new mothers. One hundred and one participants completed the instrument and some provided additional qualitative responses for each item. The average number of children participants had was 1.78. Eighty-four women reported having insurance, 16 women did not have health insurance, and 1 declined to respond to the question. The average age of the participants was 25.28, and the average years of education was 14.53. 82 participants identified as white or Caucasian, 8 identified as African, black, African American or Caribbean, 3 identified as Asian, and 1 as Hispanic. Other participants self-identified as British, Canadian, European, Jamaican, Spanish and Australian. In order to have a range of childbirth experiences represented and levels of trust with technology, participants were recruited who used the electronic fetal monitors in a variety of contexts including home births, in hospitals, intermittently, and continuously. Participants also used a variety of primary care providers for their births including physicians, registered nurses, nurse midwives, doulas, and rotating physicians. These decisions were made to ensure generalizability of the instrument to a wide range of birth models.

Measurement model. Item Response Theory (IRT), also known as latent trait theory, is a measurement model that is an alternative to true score test theory. IRT assumes there is a link between a participant's response on a test item and the construct being measured (trust in medical technology). IRT makes stronger assumptions than classical test theory and in many cases provides correspondingly stronger findings (Kline, 2005). IRT provides several improvements in scaling items and people (Hambleton, Swaminathan, & Rogers, 1991). IRT models are also better at predicting item bias amongst different groups, such as gender and ethnicity (Hogan, 2003). One set back of using this method is that IRT requires complicated estimations when not using the basic Rasch model (Hambleton et al., 1991).

George Rasch and Alan Birnbaum generated the mathematical theory upon which IRT is based. Rasch approached the problem from a substantive perspective, specifying that measurement models must have specific properties in order to be useful. Birnbaum approached the problem from a mathematical modeling perspective, generating models that explain observed data without placing restrictions on the parameters contained in those models. Rasch models tend to be simpler, and easier to estimate models. Birnbaum models, typically referred to as IRT models, tend to be more complex and require large sample sizes (but impose fewer restrictions on the data).

The Rasch Rating Scale model will be used in this study, because the TMT collects Liktert-type responses and the models requires smaller sample sizes for validation (Wolfe & Smith, 2007a). As illustrated in the below equation, the model

$$\pi_{nix} = \frac{\exp \sum_{j=0}^{x} D\left(\theta_n - \delta_i - \tau_k\right)}{\sum_{k=0}^{m} \exp \sum_{j=0}^{k} D\left(\theta_n - \delta_i - \tau_j\right)}$$

describes the probability (πnix) that a specific respondent n will rate on a particular item i with a specific rating scale category x. In the model, £cn represents person n's trust level, £_i represents item i's endorsability, and £nj represents the rating category threshold between category x and category x+1. These models include a threshold difficulty parameter (t_k) that depicts the difficulty of moving from one scoring category to another on a polytomous (likert-type or multiple response option) item. It is assumed that the distance between each category threshold is constant across items within the same rating scale. The *WINSTEPS* (Linacre, 2002) software package will be used to estimate the parameters in the model. Parameter estimates are reported on a single linear continuum in logistic odds ratio units (logits) (Smith, 2000).

Dimensionality. A principal component analysis will be performed to evaluate the dimensionality of the instrument. The Rasch dimension's and residual components' eigenvalues and the percentage variance accounted for by each component will be calculated. Kaiser's Criterion suggests that only components with an eigenvalue greater than 1.00 should be retained (Kline, 2005). Kaiser's rule will be applied and a scree plot of the eigenvalues will be created and examined to determine the number of components to be retained. Kaiser's rule suggests that no component should be retained unless it accounts for at least as much variance as one of the raw variables (Wolfe, 2006a). The Scree Method plots eigenvalues on the Y axis and component numbers on the X axis (Kline, 2005).

Components with four or more loadings with absolute values greater than .60 will be selected as reliable components for interpretation (Kline, 2005). Items with absolute value loadings greater than .30 will be considered part of the construct. Each dimension will then be interpreted based on apparent similarities in the content of items that load on that dimension. Principal components analysis and scree will be performed to make sure the models assumption of unidimensional latent trait are not violated. In order to maintain the assumption of unidimensionality, items will be grouped into subscales.

Reliability. Reliability is the degree that scores are free of measurement errors for a particular group. In instrument development reliability is the degree that responses are constant over multiple submissions of a measure. Reliability is calculated in a different way in true score test theory than in latent trait theory. In latent trait theory the item response is the unit of analysis instead of the total score. In latent trait theory, a standard error is created for each parameter estimated, which avoids the required assumption of homogeneity of variance for true score test theory standard error of measurement (Wolfe, 2006a).

Traditional test reliability, popularized by “Charles Spearman in 1904, is the true person variance / observed person variance for this sample on these test items” (p. 580) (Linacre, 1997). So it is really a "person sample reliability" rather than a "test reliability", where reliability = reproducibility of person ordering (Linacre, 1997). The "true person variance" is not calculated or identified, but can be estimated. KR-20 (cronbach’s alpha) estimates the true person variance by summing up item point-biserials and predicts it with an analysis of variance. WINSTEPS approximates the true person variance with the measure standard errors. KR-20 (Cronbach Alpha) always exceeds the maximum reliability feasible for the measures which deceives the assessor into believing an instrument has better measurement characteristics than it actually has (Linacre, 1997). KR-20 reports the reliability of “raw scores accurately, but these are local, test-dependent rankings and it overstates the reliability of the test-independent, generalizable measures the test is intended to imply” (Linacre, 1997). Rasch reliability will be reported, which is more conservative and less misleading for making inferences outside of a test (Linacre, 1997).

Person and Item reliability will be conducted in WINSTEPS. In WINSTEPS person reliability is the same as test reliability. Low values in person reliability indicate a tight range of person measures, or an undersized number of items (Linacre, 2002). Low item reliability scores indicate a narrow range of item measures, or a small sample size (Linacre, 2002). High reliability (of persons or items) means that there is a high probability that persons (or items) estimated with high measures actually do have higher measures than persons (or items) estimated with low measures (Linacre, 2002). High reliability requires a wide sample and/or low measurement error (Linacre, 1997). High person (test) reliability requires a person sample with a large amount of the construct range and/or an instrument with many items (or long rating scales) (Linacre, 1997). High item reliability requires an instrument with a large item difficulty range and/or a large sample of persons (Linacre, 1997).

Fit. Item and person fit indices will be calculated using WINSTEPS computer software (Linacre, 2002). Item fit indices help confirm whether the items identify the variable intended to measure. Person fit indices help verify whether participants respond to the items in the way they are supposed to as depicted by the model.

First point-measure correlation (PTMEA CORR.), $r_{pm \text{ or } RPM}$, will be examined between the observations on an item and the persons estimated ability *(Linacre, 2002).* Point-measure correlations over .5 are considered good, while .3 or .4 require scrutiny of the item. In the weighted (INFIT) MNSQ column we will look for values less than two, but close to one. Items above 1.5 are considered too high. Unweighted (OUTFIT) ZSTD is considered standard, if the absolute value is greater than two the item should be flagged (Smith, 2000). However, the ZSTD is very sensitive. Unweighted MNSQ items under one indicate overfit, which means the model is doing a better job at predicting than it ought to, will be ignored.

Values around 1.4 will be used, while values greater than 1.4 were scrutinized. When items are scrutinized, I will look for anything such as the wording, format, or item position that may cause the item to function in a way that is different from the other items.

Distracter/rating scale analysis. A rating scale analysis will be conducted to examine the use of the rating scale categories for polytomous items. The analysis will provide additional information about whether or not the structure the TMT required respondents to utilize when providing responses was employed in the manner in which it was intended (Wolfe, 2006b). Generalized p-values will indicate the degree to which the answers for the item are difficult, relative to the total available points. Point-polyserial, polyserial, and point-measure correlations indicate the degree to which the item scores are consistent with the total test scores. Fit indices indicate the degree to which the scored responses of individual respondents are consistent with the expectations of the Rasch model. For methodical purposes the goal is to verify that the rating scale observation conform closely to a specified model (Linacre, 2002).

Results

Dimensionality. The principal components analysis provided evidence for multidimensionality, which lead to the creation of three subscales. Kaiser's rule indicated 13 possible subscales, but only three possessed enough items and logic to be included. Eigenvalues were calculated, variance was accounted, and Kaiser's criterion was used to determine the numbers of components retained in the instrument (see Table 5.4). The instrument includes items related to trust in technology, trust in physician and trust in the healthcare system. The Rasch factor's eigenvalue is 48.1 and accounts for 29% of the variance (see Appendix C.9 for complete values). These results suggest the existence of multidimensionality within the full scale. The eigenvalues of two or more components are well above Kaiser's criterion, suggesting retention of three or more components and thus multidimensionality. The three largest components represent the three domain areas represented in the instrument, technology, provider and how the provider uses the technology.

Table 5.4

Eigenvalues of all Components and the Kaiser's

Factor	Eigenvalue	Percent	Cum Percent
1	31.1732	38.967	38.967
2	12.2743	15.343	54.309
3	5.5092	6.886	61.196
4	2.6888	3.361	64.557
5	2.4134	3.017	67.574
6	2.1051	2.631	70.205
7	1.8676	2.334	72.539
8	1.6205	2.026	74.565
9	1.4563	1.82	76.385
10	1.3461	1.683	78.068
11	1.1506	1.438	79.506
12	1.0942	1.368	80.874
13	1.0269	1.284	82.158
14	0.9483	1.185	83.343
15	0.8488	1.061	84.404

To ensure satisfaction of the unidimensional assumption of the Rasch rating scale model, item analyses were performed on subscales separately. An investigation of the item loadings of the first residual show that all of the items on the factor are positively related to trust in technology (see Table 5.5).

Table 5.5

Factor One Eigenvalues, Item Number and Text

Loading	Item #	Item text
0.812036	Q1	The technology was accurate.
0.883677	Q2	The technology was trustworthy.
0.876487	Q3	The technology was reliable.
0.669783	Q4	The technology was safe.
0.785337	Q5	The technology had reliability.
0.828666	Q6	The technology was precise.
0.790656	Q8	The technology was honest.
0.820144	Q9	I trust the technology.
0.867855	Q10	I had positive feeling about the technology.
0.819439	Q11	The technology was responsible.
0.647163	Q12	The technology behaved responsibly.
0.86061	Q13	The technology was successful.
0.82544	Q14	The technology performed accurately.
0.834301	Q15	I felt secure because of the technology.
0.792787	Q16	The technology was secure.
0.418035	Q17	I was well informed about the technology.
0.74693	Q18	The technology was well informed.
0.821281	Q19	The technology gave real results.
0.849689	Q20	I felt confident that the technology was working.
0.809519	Q21	The technology gave correct results.
0.504104	Q23	I believe the technology was well researched.
0.487355	Q24	The technology was well researched.
0.836129	Q25	I had confidence in the technology
0.809389	Q26	The technology was helpful.
0.80656	Q28	Using the technology gave me security.
0.850788	Q29	The technology was effective.
0.638151	Q30	The technology made/ kept me healthy.
0.580229	Q31	I relied on the technology.

Factor two has positive loadings on items related to the health care provider (see Table 5.6).

Table 5.6

Factor Two Eigenvalues, Item Number and Text

Loading	Item #	Item text
0.640448	Q32	My health care provider was accurate.
0.785753	Q33	My health care provider was trustworthy.
0.862042	Q34	My health care provider was reliable.
0.632924	Q35	My health care provider behaved in a safe manner.
0.626033	Q36	My health care provider was precise.
0.37382	Q37	I knew a lot about my health care provider.
0.820321	Q38	My health care provider was honest.
0.817634	Q39	I trust my health care provider.
0.874118	Q40	I feel good about the health care provider I had.
0.837499	Q41	I have positive feelings about my health care provider.
0.824046	Q42	My health care provider was honest.
0.807036	Q43	My health care provider was responsible.
0.801116	Q44	My health care provider behaved responsibly.
0.359269	Q45	My health care provider was successful with regards to my treatment.
0.728892	Q46	My health care provider was well informed.
0.574001	Q47	My health care provider gave real results.
0.841816	Q48	I had confidence in my health care provider.
0.618576	Q49	My health care provider gave me the correct information about my health situation.
0.258403	Q50	I researched my health care provider.
0.74181	Q51	I had confidence in my health care provider.
0.750931	Q52	My health care provider was helpful.
0.777136	Q53	My health care provider had integrity.
0.570084	Q54	My health care provider cared about me.
0.124698	Q55	My health care provider affected my life.
0.694556	Q56	My health care provider was effective.
0.324146	Q57	My health care provider made or kept me healthy.

Factor three positively loading items are related to how the provider uses the technology (see Table 5.7).

Table 5.7

Factor Three Eigenvalues, Item Number and Text

Loading	Item #	Item text
0.770999	Q58	My health care provider used the medical technology accurately.
0.763641	Q59	My health care provider used the technology in a trustworthy manner.
0.608639	Q60	My health care provider made sure the technology was reliable.
0.835192	Q61	My health care provider used the technology in a safe way.
0.806665	Q62	My health care provider was knowledgeable about the technology.
0.78116	Q63	I trust how my health care provider used the technology.
0.74261	Q64	I feel good about the way my health care provider used the technology.
0.664132	Q65	I have positive feelings about how my health care provider used the technology.
0.89806	Q66	My health care provider used the technology in a responsible manner.
0.853382	Q67	My health care provider used the technology responsibly.
0.767558	Q68	My health care provider was successful in their use of the technology.
0.859124	Q69	My health care provider used the technology accurately.
0.770122	Q70	My health care provider was well informed about the medical technology.
0.539829	Q71	My health care provider used the technology to give real results.
0.880509	Q72	My health care provider was confident using the medical technology.
0.526948	Q73	The results my health care provider obtained from the technology were correct results.
0.425647	Q74	My health care provider used the medical technology to give correct results.
0.817842	Q75	My health care provider used the technology with confidence.
0.173468	Q76	My health care provider believed the technology was helpful.
0.784565	Q77	My health care provider used the technology in a caring manner.
0.670522	Q78	My health care provider used the technology effectively.
0.236036	Q79	My health care provider used the technology to make me or keep me healthy.
-0.077502	Q80	My health care provider had high reliance on the medical technology.

Fit. Point measure correlations were reported, due the infeasibility of using point bi-serial measures, which lose meaning in the presence of missing data. Point measure correlations generally remained in the expected range. 39 items were flagged for further evaluation because of MSw, Zw, Msu, or Zu scores that were above two (see Table 5.8). Criteria for evaluation were :

- Point-measure correlations over .5 are considered good, while .3 or .4 require scrutiny of the item (Wolfe & Smith, 2007a).
- Mean-square weighted and unweighted statistic (MSw and MSu) outside of the 0.5 - 1.5 range of productive of measurement (Linacre, 2004).
- Weighted and unweighted mean-square fit statistic between -2 and 2 (Smith, 2000).

Table 5.8

Items Flagged for Further Evaluation

#	Target	Item	rpm	MSw	Zw	Msu	Zu
1	Tech	The technology was accurate.	0.05	2.82	5.3	5.57	7.6
3	Tech	The technology was reliable.	0.8	0.5	-3.3	0.37	-2.6
8	Tech	The technology was honest.	0.29	2.1	4	2.94	2.9
11	Tech	The technology was responsible.	0.8	0.66	-2.2	0.48	-2.3
12	Tech	The technology behaved responsibly.	0.8	0.59	-2.8	0.53	-2.1
14	Tech	The technology performed accurately.	0.8	0.46	-3.5	0.34	-2.5
18	Tech	The technology was well informed.	0.45	1.78	3.3	1.99	2.2
21	Tech	The technology gave correct results.	0.81	0.53	-3.1	0.38	-2.6
23	Tech	I believe the technology was well researched.	0.15	3.62	9.9	4.31	9.4
26	Tech	The technology was helpful.	0.79	0.59	-2.6	0.45	-2.1
28	Tech	Using the technology gave me security.	0.42	2.09	5.4	3.05	6.8
30	Tech	The technology made/ kept me healthy.	0.82	0.42	-3.9	0.32	-2.7
32	Prov	My health care provider was accurate.	0.54	1.81	4.3	3.52	6.7
34	Prov	My health care provider was reliable.	0.58	0.56	-1.4	0.25	-1.1
35	Prov	My health care provider behaved in a safe manner.	0.63	0.66	-1.1	0.19	-1.7
36	Prov	My health care provider was precise.	0.57	0.77	-0.6	0.23	-1.1
38	Prov	My health care provider was honest.	0.51	1.85	3.3	1.89	2.5
39	Prov	I trust my health care provider.	0.58	0.46	-1.7	0.11	-1.4
40	Prov	I feel good about the health care provider I had.	0.69	0.46	-2.2	0.18	-2.1
41	Prov	I have positive feelings about my health care provider.	0.67	0.47	-2.1	0.18	-1.9
42	Prov	My health care provider was honest.	0.66	0.62	-1.4	0.23	-1.8
45	Prov	My health care provider was successful with regards to my treatment.	0.56	0.51	-1.4	0.21	-0.9
49	Prov	My health care provider gave	0.67	0.44	-2.2	0.14	-1.9

		me the correct information about my health situation.					
51	Prov	I had confidence in my health care provider.	0.59	1.73	3.6	2.08	4
52	Prov	My health care provider was helpful.	0.66	0.6	-1.4	0.23	-1.7
53	Prov	My health care provider had integrity.	0.64	0.69	-1	0.26	-1.5
54	Prov	My health care provider cared about me.	0.65	0.33	-2.4	0.15	-1.3
56	Prov	My health care provider was effective.	0.4	2.2	3.6	1.87	1.8
57	Prov	My health care provider made or kept me healthy.	0.65	0.71	-1	0.38	-1.2
58	P & T	My health care provider used the medical technology accurately.	0.63	1.8	3.5	1.62	2.3
60	P & T	My health care provider made sure the technology was reliable.	0.75	0.41	-2.3	0.33	-1.2
62	P & T	My health care provider was knowledgeable about the technology.	0.75	0.41	-2.3	0.19	-1.7
63	P & T	I trust how my health care provider used the technology.	0.74	0.33	-2.6	0.14	-1.6
64	P & T	I feel good about the way my health care provider used the technology	0.77	0.57	-1.7	0.37	-1.5
65	P & T	I have positive feelings about how my health care provider used the technology.	0.77	0.58	-1.8	0.33	-1.8
68	P & T	My health care provider was successful in their use of the technology.	0.79	0.43	-2.4	0.26	-1.8
73	P & T	The results my health care provider obtained from the technology were correct results.	0.7	0.89	-0.3	0.42	-0.9
77	P & T	My health care provider used the technology in a caring manner.	0.38	2.78	4.9	3.37	3.8
80	P & T	My health care provider had high reliance on the medical technology.	0.6	2.08	4.6	1.99	3.5

*Bold indicates fit statistic that inspired further investigation.

Rating scale analysis. Items in all four analyses, the total instrument, scale 1, scale 2, and scale 3, appear the be functioning well for the three scale points agree, neutral and disagree based on plots of category probabilities (see Appendix C.6 – C.8) and Linacre's rating scale guidelines (see Table 5.9).

Table 5.9

Linacre's Rating Scale Guidelines

Guideline	Decision
At least 10 observations of each category	Yes
Regular observation distribution	Yes
Average measures advance monotonically with category	Yes
OUTFIT mean-squares less than 2.0	Yes
Step calibrations advance	Yes
Ratings imply measures and measure imply ratings	Yes
Step difficulties advance by at least 1.4 logits	Yes
Step difficulties advance by les than 5.0 logits	Yes

Source: Linacre, J. M. (2004). Optimizing rating scale category effectiveness. In *Introduction to Rasch Measurement*. Maple Grove, Minnesota.

Preliminary guideline: All items orientated with latent variable

- All items employed the same rating scale and therefore cooperated to a shared latent variable. Rating scale categories for negatively-oriented items often function differently in rating scale categories (Yamaguchi, 1997). Because study two showed that trust and distrust are theoretical opposites negative items were not used, which provides more evidence that all items are orientated with the latent variable.

Guideline #1: At least 10 observations of each category

- The lowest number of observations for the total instrument and separate sub scales is 55, which is well above the 10 observation guideline (see Tables 5.10- 5.13).

Guideline #2: Regular observation distribution

- Based on the results from the qualitative study, it was expected that the population would be mostly trusting. Therefore the distribution count should have higher number of counts for 3=agree, which indicated higher trust and descend to category 1=disagree. This distribution pattern is consistent across the total instrument and all three subscales (see Tables 5.10- 5.13).

Guideline #3: Average measures advance monotonically with category

- Smith (2000) says that "observations in higher categories must be produced by higher measures (or else we don't know what a "higher" measure implies). This means that the average measures by category, for each empirical set observations, must advance monotonically up the rating scale," (p.22). This guideline was met by measure averages across the four analyses (see Tables 5.10- 5.13). This means that empirically Category 3 represents a higher level of the construct trust than categories two and three.

Guideline #4: OUTFIT mean-squares less than 2.0

- All unweighted mean-squares are less than 2.0.

Guideline #5: Step calibrations advance

- The "scale structure measures", also called "step calibrations", progress in all occurrences.

Guideline #6: Ratings imply measures and measure imply ratings

- This guideline says that the rating should imply the measure and vice versa, this is determined with the coherence statistic (see Tables 5.10- 5.13). The computation coherence is outlined in Tables 5.10- 5.13. as (X) M->C (Measure implies Category %) which indicates the percentage of the rating that is expected to be observed in a category and are actually observed in the category (Linacre, 2004). This guideline met, because of moderate coherence statistics.

Guideline #7: Step difficulties advance by at least 1.4 logits.

- Scale structure measures advance a distance of 1.7 logits for all occurrences.

Guideline #8: Step difficulties advance by les than 5.0 logits

- Scale structure measures advance a distance of 1.7 logits for all occurrences.

Table 5.10

Rating scale total instrument 1= disagree, 2= Neutral, 3= Agree

Total

Category	Count	Count%	Measure average	Outfit Unweighted MNSQ	Structure measure (t)	Coherence M->C[a]	Coherence C-> M[b]
1	441	6	-2.25	1.35	none	64%	24%
2	1165	15	11.16	0.71	-5.59	45%	44%
3	5574	71	30.63	1.32	5.59	88%	93%

Table 5.11

Rating scale for scale 1 Technology 1= disagree, 2= Neutral, 3= Agree

Scale 1

Category	Count	Count%	Measure average	Outfit Unweighted MNSQ	Structure measure (t)	Coherence M->C[a]	Coherence C-> M[b]
1	289	10	-8.65	1.15	none	69%	39%
2	653	24	7.48	0.8	-8.81	53%	60%
3	1546	56	26.34	1.46	8.81	84%	86%

Table 5.12

Rating scale for scale 2 Technology 1= Disagree, 2= Neutral, 3= Agree

Scale 2

Category	Count	Count%	Measure average	Outfit Unweighted MNSQ	Structure measure (t)	Coherence M->C[a]	Coherence C-> M[b]
1	96	5	-6.6	1.15	NONE	51%	19%
2	235	13	12.94	0.56	-6.22	48%	51%
3	1514	81	35.26	1.83	6.22	92%	95%

Table 5.13

Rating scale for scale 3 Technology 1= Disagree, 2= Neutral, 3= Agree

Scale 3

Category	Count	Count%	Measure average	Outfit Unweighted MNSQ	Structure measure (t)	Coherence M->C[a]	Coherence C-> M[b]
1	55	5	-12.8	1.5	NONE	75%	43%
2	277	23	13.2	0.69	-16.66	66%	55%
3	826	69	38.66	1.15	16.66	86%	93%

Reliability. The TMT produced high reliability across the various subscale for person (test) and item reliability ranging from .71 to .92 (see Table 5.14).

Table 5.14

KR-20, Real and Modeled Person Reliability, and Real and Modeled Item Reliability for Scales 1-3 and Total Instrument

Scale	Items	winsteps (KR-20)	Person RELIABILITY (real)	Person RELIABILITY (modeled)	item reliability (real)	item reliability (modeled)
total	80	1*	0.86	0.87	0.92	0.92
1	31	1*	0.81	0.84	0.82	0.86
2	26	.96*	0.53	0.56	0.86	0.87
3	23	1	0.58	0.58	0.71	0.75

Discussion

The trust in medical technology instrument will require revisions before it considered a high quality instrument, however it is ready for use. Future studies will involve validation in a variety of medical domains including consumer health products. The validation studies found that trust in technology is in fact a multidimensional construct involving subscale of technology characteristics, provider characteristics and characteristics of the how the provider uses the technology.

The purpose of the fit indices was to flag potentially problematic response patterns. Once a flag has been raised, it is the responsibility of the data analyst or instrument developer to seek plausible explanations for the flag. It is unwise to simply delete an item from an instrument based on a fit flag alone. These indices provide relative measures and are subject to Type I statistical errors. By scrutinizing the misfitting items or persons or the patterns of responses associated with them, valuable knowledge may be gained. There are many reasons why misfit might occur:

For persons:

- Lucky guesses
- Test security breeches
- Carelessness
- Specialized knowledge or deficiencies

For items:

- Multidimensionality
- Poor item quality
- Cueing of correct answer
- Miskeying

Therefore, items flagged as misfitting should be evaluated and redesigned for future validation studies.

All of Linacre's (2002) guidelines were met, regardless of their level of importance, which provided evidence of measure stability, measure accuracy (fit), description of the sample, and inference for the next sample (see Table

5.15). Additionally, the instrument produced high reliability across the various subscale for person (test) and item reliability.

Table 5.15

Summary of Guideline Pertinence

Guideline	Measure Stability	Measure accuracy	Description of sample	Inference for next sample
Pre. Scale oriented with latent variable	*Essential*	*Essential*	*Essential*	*Essential*
At least 10 observations of each category	*Essential*	*Helpful*		*Helpful*
Regular observation distribution	*Helpful*			*Helpful*
Average measures advance monotonically with category	*Helpful*	*Essential*	*Essential*	*Essential*
OUTFIT mean-squares less than 2.0	*Helpful*	*Essential*	*Helpful*	*Helpful*
Step calibrations advance			*Helpful*	
Ratings imply measures and measure imply ratings				*Helpful*
Step difficulties advance by at least 1.4 logits		*Helpful*		*Helpful*
Step difficulties advance by les than 5.0 logits	*Helpful*			

Source: Linacre, J. M. (2004). Optimizing rating scale category effectiveness. In *Introduction to Rasch Measurement*. Maple Grove, Minnesota.

<u>Validity evidence.</u>

Messick proposed a six-component framework for validity assessment involving content, substantive structural, generalizability, external and consequential aspects of validity (Messick, 1995). Validity evidence was provided through test and data based evidence.

- The **content** aspect refers to evidence of content relevance, representativeness, and technical quality of the instrument.
- The **substantive** aspect refers to the theoretical rationale for observed consistencies in responses, including process models of task performance and empirical evidence that the theoretical processes are actually engaged by respondents in the assessment tasks.
- **Structural** aspect refers to the fidelity of the scoring structure to the structure of the construct domain.
- **Generalizability** aspect refers to the degree to which test score properties and interpretations generalize to and across population groups, settings, and tasks including validity generalization of test criterion relationships.

- **External** aspect includes convergent and discriminate evidence from multitrait-multimethod comparisons as well as evidence of criterion relevance and applied utility.
- **Consequential** aspect refers to the value implications of score interpretation as a basis for action as well as the actual and potential consequences of test use, especially regarding bias, fairness, and distributive justice.

The table below illustrates efforts that were made to contribute to the various aspects of validity with test based and data based evidence (Wolfe & Everett V. Smith).

Table 5.16

Test Based Validity Evidence

Type of Evidence	Aspect of Validity	Validity Evidence
Test based evidence	Content	✓ Documentation of purpose & uses of the instrument ✓ Documentation of use of domain analysis ✓ Development of test blueprint & item templates ✓ Documentation of test development process ✓ Expert Review (Readability, Clarity, Clarity of instructions, Fairness, Sensitivity)
	Substantive	✓ Development of operationalized definition & theoretical framework of the construct (including internal, external, & processing models) ✓ Documentation of use of expertise ✕ Verifying of use of the proposed processes by respondents (think aloud)
	Structural	✓ Development of internal model ✓ Rationale for adoption of reference framework (criterion versus normative) ✓ Rationale for developing response format (rating scale and/or distracters) ✓ Rationale for adoption of measurement model
	Generalizability	✓ Specification of target population ✓ Selection of norming population
	External	✓ Demonstrating that the construct theory is sufficiently developed to support investigations of external aspect evidence
	Consequential	✕ Detecting positive or negative impact on systems (systemic validity)

Table 5.17

Data Based Validity Evidence

Type of Evidence	Aspect of Validity	Validity Evidence
Data based evidence	Structural	✓ Demonstrating internal relationships among items (structural fidelity) or subsets of items consistent with the underlying theory (factor analysis, item difficulty hierarchies that are consistent with the construct map) ✓ Demonstrating that conditional difficulties of items are equal or consistent with known influences on test performance (differential item functioning analysis) ✓ Utilizing a measurement model that combines (weights) information across observations (scales) and takes into account (controls for) undesirable influences on the scores in a manner that is consistent with intended score interpretation (e.g., criterion-referenced versus norm-referenced).
	Generalizability	✓ Demonstrating reliability of measures from the instrument across a variety of contexts ✓ Internal consistency ✕ Test-retest ✕ Interrater ✕ Alternate form ✕ Application of meta-analytic procedures to validity coefficients across a variety of measurement contexts and samples (validity generalization)
	External	✕ Demonstrating that predicted group differences are realized empirically. ✕ Experimentation: Any theory-based comparison that yields outcomes consistent with theory. ✕ Comparison of Groups: Differences between groups that theory predicts will be different on the underlying construct. ✕ Changes Over Time: Individuals are typically expected to change over time as a result of maturation. Observed differences such as these can also be used as evidence for construct validity.
	Consequential	✓ Detecting positive or negative impact on individuals (bias) (e.g., identifying substantively explainable DIF versus sources of item or test bias, determining whether the labels generated in test use result in stigmatization of some groups, expert judgment about the suitability of test content for making decisions about individuals and groups)

The final instrument can be found in Appendix C.10, a screen shot of the instrument is provided in figure 5.4.

Experiences with Medical Technology

Please answer the following questions with regards to your most recent childbirth experience.

How many children do you have?

What is the date of your youngest child birth?

Did you have health insurance?
Yes No

What type of insurance did you have?

Please select the events that characterized your birth experience.

Ultrasound	Cecesarean section	Lamaze
Electronic fetal monitor	Amniocentesis	Pain relief (epidural)
	Induction	other:

These questions are about your experiences with the electronic fetal monitor. Please answer them to the best of your ability. There are no right or wrong answers.

The technology was accurate.
agree
neutral
disagree
Please provide details regarding your selection (optional).

The technology was trustworthy.
agree
neutral
disagree
Please provide details regarding your selection (optional).

The technology was reliable.
agree
neutral
disagree
Please provide details regarding your selection (optional).

The technology was safe.
agree
neutral
disagree
Please provide details regarding your selection (optional).

The technology had reliability.
agree
neutral
disagree
Please provide details regarding your selection (optional).

The technology was precise.
agree
neutral
disagree
Please provide details regarding your selection (optional).

Figure 5.4 Final trust in medical technology instrument

CHAPTER 6. CONCLUSION

Dr. Ben Shneiderman, a noted professor, scholar of human computer interaction and author of *Software Psychology: Human Factors in Computer and Information Systems* (1980) stated in the journal *Science* that:

> Science 1.0 heroes such as Galileo, Newton, and Einstein produced key equations that describe the relationships among gravity, electricity, magnetism, and light. By contrast, Science 2.0 leaders are studying trust, empathy, responsibility, and privacy. The great adventure for the next 400 years will be to define, measure, and predict the interaction among these variables so as to accelerate scientific discovery, engineering innovation, ecommerce, and education (Shneiderman, 2008).

In the text *Emerging Needs and Opportunities for Human Factors Research* (1995) Roberta L. Klatzky, professor of human computer interaction at Carnegie Mellon and Dr. M.M. Ayoub, professor of industrial engineering at Texas Tech University stated:

> In considering human factors research needs related to health care, we are particularly concerned with new research topics that are likely to reflect societal and technological developments in the coming decade. We also consider more long-standing problems that previous research has failed to address.

The studies presented in this dissertation addressed the lack of understanding of the construct trust in medical technology for patients and care-providers. Quantitative and qualitative methods were used to define the construct empirically, analyze the construct in practice, and develop a tool to measure the construct. The findings of the research addressed Shneiderman's (2008) goals for Science 2.0 leaders by seeking to "define, measure and predict" (p. 1349) trust in medical technology, given the responsibility and empathy required in a health care context. Additionally, this research addressed the goals for human factors research described in *Emerging Needs and Opportunities for Human Factors Research*, by looking the long-standing issue of trust in technology and accounting for the previously developed models' limitations in the health care domain. The questions proposed by and generated from this research will contribute theoretical and practical knowledge to the societal and technological developments in health care, such as increased automation, adoption and use of technology by providers and home health care users. Understanding trust in medical technology provides a framework for understanding how care can and should be provided in health care using the innovations of today and tomorrow.

In summary, the studies in phase I demonstrated that trust in medical technology and trust in technology are perceived differently by participants and should be addressed as separate constructs. The studies used empirical methods developed by human factors and ergonomics researchers (Jian et al., 1998c; Zhang, 1996) to develop a framework of the factors that make up the construct.

The studies in phase II demonstrated that patients have user experiences with medical technology. The study's methods included participatory ergonomics methods (Brown, 2005; Hendrick & Kleiner, 2001) such as interviews and fieldwork. Analysis and results included a variety of qualitative analytical techniques such as, coding and memo-writing, to produce a grounded theory model of patient's and provider's construction of trust in medical technology. The study demonstrated that patients and providers construct trust in medial technology differently but both within the context of a socio technical system.

Phase III used findings from phase I and phase II to develop a tool to measure trust in medical technology. The validation activities for the tool provided evidence for measuring trust in medical technology with three separate subscales: the technology, the user, and how the user uses the technology. Validation activities also provide evidence for measuring trust dichotomously (yes or no) rather than different levels of trust (strongly trust versus trust).

Recommendations

The recommendations from this research are in the form of design guidelines for trustworthiness based on the factors that make up the construct trust in medical technology, technology design recommendations and system design recommendations.

Design guidelines for trust in medical technology.

Factor	Guideline
Accurate	The technology must be accurate
Accurately	The technology must behave in an accurate manner
Gives real results	The technology must give real results
Trustworthy	The technology must be trustworthy
Reliable	The technology must be reliable
Reliability	The technology must portray reliability
Gives correct results	The technology must give correct results
Precise	The technology must be precise
Well informed	The technology must be well informed
Safe	The technology must be safe
Reliance	The user must be able to rely on the technology
Security in caring	The technology must show that it cares
Security	The technology must be secure
Knowledge	The user must have knowledge about the technology
Healthy	The technology must make the user healthy
Successful	The technology must be successful
Researched	The technology must researched
Trusting	The technology must be trusting
Responsible	The technology must be responsible
Affect lives	The technology must affect the life of the user
Honest	The technology must be honest
Integrity	The technology must have integrity
Responsibly	The technology must behave responsibly
Effective	The technology must be effective
Helpful	The technology must be helpful
Secure	The technology must be secure
Honesty	The technology must portray honesty
Positive	The technology must be positive
Confident	The technology must be confident
Confidence	The technology must portray confidence

Based on the findings from these studies and the literature the following recommendations are made for patient and provider users of medical technology and system design (see Table 6.1 and 6.0.2).

Table 6.1

Recommendations for Technology Design

Problem	Recommendation
Providers need to feel confident in their ability to use the technology to trust it, (Phase II findings), (Madsen & Gregor, 2000; Taylor et al., 1995).	• High fidelity training with technology (Austin, Gregory, & Tabak, 2006; Tan, Ti, Suresh, Ho, & Lee, 2002). • Technology competency assessments (Volkin & Dargan, 2006). • Including usability in the design of technology (Liljegren, 2006).
Providers need to trust the system in order to trust technology (Phase II findings).	• The medical staff must have an effective departmental infrastructure (Veltman, 2007). • The labor and delivery unit should function as a fully staffed unit 24/7 (Veltman, 2007). • Technology should be appropriately integrated in the system (i.e. no unnecessary or un-usable technologies). • Training should be high-fidelity, with the entire team, to address system weaknesses at all levels from communication to infrastructure.
Trust in providers is a prerequisite for trust in technology (Phase II findings).	• Interpersonal trust interventions (Pearson & Raeke, 2000).
Provider's use of technology is a prerequisite for patient trust in technology (Phase II findings).	• Make usability a priority when making purchasing decisions (Liljegren, 2006). • Training and competency for providers.
Technology characteristics are a prerequisite for patient trust in technology (Phase II findings).	• Design consideration of trustworthiness for patient users (Phase I findings).

Table 6.2

Recommendations for System Design

Problem	Recommendation
Special attention is often not given to high-risk births. These cases are often the focus for liability when there is an adverse outcome (Veltman, 2007).	• Incorporation of midwife models frees physicians for high-risk situations (Cragin & Kennedy, 2006; Gould, 2000). • Increase human members of the obstetric team (Veltman, 2007), as opposed to increasing reliance on technology. • The labor and delivery unit should function as a fully staffed unit 24/7 (Veltman, 2007).
Every person on the unit does not have the skills to do their part in responding to uncommon, but critical obstetric emergencies (Veltman, 2007).	• High fidelity simulation training for uncommon procedures, such as forcep deliveries (McLaughlin & Wagner, 2006; Tan et al., 2002).
Obstetricians often need to be in multiple places at a time (Veltman, 2007).	• In-house presence of each member of the team including the obstetrician should be increased (Veltman, 2007). • Incorporation of midwife models frees physicians for high-risk situations (Cragin & Kennedy, 2006; Gould, 2000).
Providers honor patient requests that are fundamentally unsafe (Nerum, Halvorsen, Sorlie, & Oian, 2006; Veltman, 2007; Young, 2006).	• Education for patients about technologies and risk will help them make better-informed decisions (Redman, 1993).
High risk situations are monitored remotely (Veltman, 2007).	• Reduce reliance on monitoring technologies. • Train for appropriate trust in technologies (Phase II findings). • Create a joint-optimized work system (Hendrick & Kleiner, 2001).
The system fails to recognize human cognitive and physical limitations, and the resulting effects on vigilance (Veltman, 2007)	• Consider human limitations and capabilities in technology integration and the propensity to over-rely on technology during fatigue in the design of technology (Harris, Hancock, Arthur, & Caird, 1995).

Theoretical and practical contributions

In addition to contributing to an identified need for applied and theoretical research that examines human capabilities and limitations in the context of health care technologies and systems (Harrison, Koppel, & Bar-Lev, 2007; Silver, Geis, & Bateman, 2004; Veltman, 2007), the studies in this dissertation produced the following theoretical and practical contributions.

Theoretical Contributions

- Defined the construct trust in medical technology.
- Identified the factors that make up the construct trust in medical technology.
- Developed an understanding of the construct within a health care work system.

Practical Contributions

- Developed and validated a tool to measure the construct trust in medical technology.
- Provided recommendations for the design of medical technology and systems.

Future research

The results of this research provide a foundation for more complex research regarding trust and medical technology. The design guidelines from Phase I should be explored more thoroughly and validated. These results can be explored individually in terms of design (i.e. how to design for the perception of accuracy as opposed to designing for actually accuracy) or as a whole through the development of prototypes. The relationship between the identified factors of trust in medical technology should be explored to determine if some factors are more important and/or related to each other. Neurology researchers are finding new ways of measuring trust through functional magnetic resonance imaging (Montague, King-Casas, & Cohen, 2006), which may lead to simpler and more dynamic methods of measuring the construct. Future research should look towards more dynamic methods of measuring trust in technology.

An unexpected finding was patient's high level of trust in the technology, despite their negative user experiences. Preliminary negative case analysis data was collected from women who had homebirths or midwife assisted births and was not included in the data set for phase II. The women who had experiences in the midwife work system had a different knowledge about the technology that was used in their birth and different experiences altogether. These preliminary findings suggest a larger study that compares experiences with technology and childbirth in different environments (home births, birth centers, small hospital, larger hospital). Findings from these studies may explain why cultures that use midwife work systems as a primary model of care providing function with lower mortality and cost of providing care that US systems which are based on he obstetric work system (Cragin, 2006). Future research will be conducted to examine how the lack of patient education about the medical technology functions in obstetric systems and how this influences decision-making.

Future research should also look at how educational materials should be designed for patients. Researchers have explored the use of technology to educate patients, but more research is needed about how to educate patients about technology. High fidelity simulation can be used to explore more thoroughly explore how technology and trust functions in actual practice with teams of providers in obstetric work systems.

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Appendices

Appendix A. Phase I

A.1 IRB Approval Letter

VirginiaTech

Office of Research Compliance
1880 Pratt Drive (0497)
Blacksburg, Virginia 24061
540/231-4358 Fax: 540/231-0959
E-mail: ctgreen@vt.edu
www.irb.vt.edu

FWA00000572(expires 7/20/07)
IRB # is IRB00000667.

DATE: September 8, 2006

MEMORANDUM

TO: Woodrow Winchester
Enid Montague

FROM: Carmen Green

SUBJECT: **IRB Exempt Approval:** "The Development of a Measure of Trust in Medical Technology" , IRB # 06-481

I have reviewed your request to the IRB for exemption for the above referenced project. I concur that the research falls within the exempt status. Approval is granted effective as of September 8, 2006.

As an investigator of human subjects, your responsibilities include the following:

1. Report promptly proposed changes in previously approved human subject research activities to the IRB, including changes to your study forms, procedures and investigators, regardless of how minor. The proposed changes must not be initiated without IRB review and approval, except where necessary to eliminate apparent immediate hazards to the subjects.

2. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

cc: File
Department Reviewer:Thurmon E. Lockhart
T. Coalson 0118

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A.2 Table Initial word set

	Courage	Honesty	Persistence	Wrong
Absolute	Credence	Honor	Persuasion	Yoke
Ambiguity	Credit	Inarguable	Phony	
Anger	Creed	Incontestable	Pledge	
Aplomb	Cruel	Incontrovertible	Positive	
Apprehensive	Custody	Incorporate	Predictability	
Assertion	Deception	Incredulity	Principle	
Assurance	Declaration	Independence	Probable	
Attack	Definite	Indisputable	Promise	
Bashfulness	Denial	Indubitable	Question	
Belief	Denomination	Inducement	Reciprocate_with_fairness	
Believe	Dependence	Inevitable	Regret	
Benevolence	Determination	Infidelity	Reliability	
Betray	Diffidence	Integrate	Reliable	
Beware	Disbelief	Integrity	Reliance	
Biased	Dispute	Intimacy	Rely_on	
Bind	Distance	Irrefutable	Respect	
Can_be_relied_upon	Distrust	Join	Respectful	
Cartel	Doctrine	League	Responsibility	
Casual	Doubt	Lie	Robustness	
Cautious	Doubtless	Love	Scruple	
Caution	Embody	Loss	Secure	
Certain	End	Loyalty	Security	
Certainty	Entrust	Merge	Security_in_caring_response	
Certitude	Error	Mingle	Selfish	
Charge	Faction	Misleading	Shyness	
Cheat	Faith	Mistake	Sincere	
Closeness	Failure	Mistrust	Timid	
Coalition	Familiarity	Mi	Trustworthy	
Commit	Falsity	Modesty	Unbelief	
Competence	Feeling	Moral	Undeniable	
Complacency	Fidelity	Must_have	Understandability	
Confidence	Firm	Motivational_relevance	Unerring	
Confidential	Firmness	Mutuality	Unfailing	
Constancy	Fied	Naive	Unquestionable	
Contingent	Friendship	Nobility	Usefulness	
Conviction	Fund	Obligation	View	
Cooperation	Guardianship	Opinion	Wariness	
Count_on	Harm	Overcharge		
Couple	Heresy	Overtrust		
	Hesitation			

A.3 Words from both TMT and TT that were dropped or added for Study 2.

Table Words from both TMT and TT that were dropped or added for Study 2.

Words	Initial Set	Added Words	Eliminated Words	Study 2 Words
Ability		X		X
Absolute	X			X
Accurate		X		X
Accurately		X		X
Advancements		X		X
Affect lives		X		X
Aid		X		X
Always correct		X		X
Ambiguity	X		X	
Anger	X			X
Aplomb	X		X	
Apprehensive	X		X	
Appropriate		X		X
Assertion	X		X	
Assumption		X		X
Assumptions		X		X
Assurance	X			X
Attack	X			X
Awareness of limits		X		X
Back up		X		X
Based on research findings		X		X
Bashfulness	X		X	
Be there when you need it		X		X
Belief	X	X	X	X
Believe	X	X	X	X
Believing		X		X
Beneficial		X		X
Benevolence	X		X	
Best you could receive		X		X
Betray	X		X	
Beware	X		X	
Biased	X		X	
Bind	X		X	

Can be relied upon	X			X
Cartel	X		X	
Casual	X		X	
Cause problems		X		X
Causes harm		X		X
Caution	X		X	
Cautious	X		X	
Certain	X			X
Certainty	X			X
Certitude	X		X	
Charge	X		X	
Cheap		X		X
Cheat	X		X	
Closeness	X		X	
Coalition	X		X	
Comfortable		X		X
Commit	X		X	
Competence	X			X
Complacency	X		X	
Confidence	X			X
Confident		X		X
Confidential	X		X	
Consent		X		X
Constancy	X			X
Contingent	X		X	
Conviction	X		X	
Cooperation	X			X
Correct		X		X
Correct results		X		X
Could provide gains		X		X
Count on	X			X
Couple	X		X	
Courage	X		X	
Credence	X		X	
Credit	X		X	
Creed	X		X	
Cruel	X			X
Custody	X		X	
Dangerous situation		X		X
Deceit		X		X
Deception	X			X

Declaration	X		X	
Definite	X	X		X
Denial	X		X	
Denomination	X		X	
Dependable		X		X
Dependence	X		X	
Determination	X		X	
Determining fate		X		X
Diffidence	X		X	
Disbelief	X		X	
Disclosure of risks		X		X
Discouraging		X		X
Dispute	X		X	
Distance	X		X	
Distrust	X	X		X
Do not believe		X		X
Doctrine	X		X	
Does not believe		X		X
Does not believe in advancement		X		X
Doesn't function properly		X		X
Doesn't work		X		X
Don't work as they should		X		X
Doubt	X	X		X
Doubtful		X		X
Doubtless	X		X	
Effective		X		X
Efficient		X		X
Embody	X		X	
End	X		X	
Entrust	X			X
Error	X			X
Errors		X		X
Evidence		X		X
Expectation		X		X
Faction	X		X	
Fail you		X		X
Failure	X	X		X
Failures		X		X
Faith	X	X	X	X
False		X		X

Falsity	X			X
Familiarity	X		X	
Faster		X		X
Feel		X		X
Feeling	X		X	
Fidelity	X		X	
Fied	X		X	
Firm	X		X	
Firmness	X		X	
Flakes out		X		X
Flawed		X		X
Friendship	X		X	
Fund	X		X	
Gives correct results		X		X
Gives real results		X		X
Glitches		X		X
Good enough		X		X
Guardianship	X		X	
Hard to use		X		X
Harm	X	X		X
Harmful		X		X
Healthy		X		X
Helpful		X		X
Heresy	X		X	
Hesitation	X			X
Hide		X		X
Honest		X		X
Honesty	X			X
Honor	X		X	
Hurting		X		X
Inarguable	X		X	
Inclined		X		X
Incontestable	X		X	
Incontrovertible	X		X	
Incorporate	X		X	
Incredulity	X		X	
Independence	X		X	
Indisputable	X		X	
Indubitable	X		X	
Inducement	X		X	
Inefficient		X		X

Inevitable	X		X	
Infidelity	X		X	
Information		X		X
Informed		X		X
Integrate	X		X	
Integrity	X			X
Intimacy	X		X	
Irrefutable	X		X	
Join	X		X	
Keeping information		X		X
Knockoff		X		X
Knowing how it works		X		X
Knowledge		X		X
Knowledge of risks		X		X
Lack of confidence		X		X
Lack of proof		X		X
Lack of support		X		X
League	X		X	
Lie	X		X	
Loss	X		X	
Lost information		X		X
Love	X		X	
Loyalty	X		X	
Lying		X		X
Make better		X		X
Makes vulnerable		X		X
Merge	X		X	
Mi	X		X	
Mingle	X		X	
Misadvising		X		X
Misfunction		X		X
Misleading	X	X		X
Mistake	X	X		X
Mistakes		X		X
Mistrust	X			X
Modesty	X		X	
Moral	X		X	
Motivational relevance	X		X	
Must have	X		X	
Mutuality	X		X	
Naive	X		X	

No confidence		X		X
No faith		X		X
No review		X		X
Nobility	X		X	
Not a lot of information		X		X
Not advanced enough		X		X
Not always reliable		X		X
Not disclosing risks		X		X
Not God enough to work		X		X
Not having faith		X		X
Not inclined to use		X		X
Not malfunctioned		X		X
Not willing to use		X		X
Not working properly		X		X
Obligation	X		X	
Of no use		X		X
Opinion	X		X	
Overcharge	X		X	
Overtrust	X	X		X
Perform correctly		X		X
Persistence	X		X	
Persuasion	X		X	
Phony	X		X	
Pledge	X		X	
Positive	X			X
Precise		X		X
Predictability	X		X	
Principal	X		X	
Probable	X		X	
Problems		X		X
Produced bad results		X		X
Promise	X		X	
Proven		X		X
Provide gains in my life		X		X
Question	X		X	
Reciprocate with fairness	X		X	
Regret	X		X	
Reliability	X			X
Reliable	X	X		X
Reliance	X	X	X	X
Relied on		X		X

Rely on	X		X	
Researched		X		X
Resisting change		X		X
Respect	X		X	
Respectful	X		X	
Responsibility	X		X	
Responsible		X		X
Responsibly		X		X
Results that are farfetched		X		X
Robustness	X		X	
Safe		X		X
Scruple	X		X	
Secrecy		X		X
Secure	X			X
Security	X			X
Security in caring response	X			X
Selfish	X		X	
Should not use		X		X
Shyness	X		X	
Sincere	X		X	
Skeptical		X		X
Successful		X		X
System crash		X		X
Tested		X		X
Things go wrong		X		X
Timid	X		X	
Tolerant		X		X
Toxic		X		X
Trickery		X		X
Trusting		X		X
Trustworthy	X	X		X
Unbelief	X		X	
Uncaring		X		X
Uncomfortable		X		X
Undeniable	X		X	
Understandability	X			X
Understanding		X		X
Understanding risks		X		X
Uneasiness		X		X
Unerring	X		X	
Unfailing	X		X	

Unnecessary		X		X
Unquestionable	X		X	
Untrustworthy		X		X
Use		X		X
Use the right technology		X		X
Used		X		X
Used on others		X		X
Useful		X		X
Usefulness	X			X
Using		X		X
View	X		X	
Want to use		X		X
Wariness	X		X	
Wary		X		X
Well informed		X		X
What is right		X		X
Whole-heartedly believe		X		X
Will not cause any harm		X		X
Will not harm		X		X
Willing		X		X
Without consent		X		X
Without Harm		X		X
Wondering		X		X
Work		X		X
Works		X		X
Wrong	X			X
Yoke	X		X	

A.4 Principal Components Analysis Questionnaire Study

Table
Principal Components Analysis Questionnaire Study

Component One		Component Two		Component Three	
TT	TMT	TT	TMT	TT	TMT
Anger_*		Ability			Be_there_when_you_need_it
Attack_*		Absolute			Belief
Cause_harm_*	Cause_harm	Accurate			Believe
Cause_problems_*	Cause_problems	Accurately			Believing
Cruel_*	Cruel	Advancements		Consent	
Dangerous_situation_*	Dangerous_situation	Aid		Cooperation	
Deceit_*	Deceit	Always			Count_on
Deception_*	Deception	Appropriate		Healthy	
Discouraging_*	Discouraging	Be		Honest	
Distrust_*	Distrust	Correct		Honesty	
Do_not_believe_*	Do_not_believe	Could		Integrity	
Does_not_believe_*	Does_not_believe		Gives_real_results	Perform	
Does_not_believe_in_advancement_*	Does_not_believe_in_advancement		Healthy	Responsible	
Doesnt_function_properly_*	Doesnt_function_properly		Information	Responsibly	
Doesnt_work_*	Doesnt_work		Informed	Security	
Dont_work_as_they_should_*	Dont_work_as_they_should		Integrity	Trustworthy	
Doubt_*	Doubt		Knowing_how_it_works		
Doubtful_*	Doubtful		Knowledge		
Error_*	Error		Knowledge_of_risks		
Errors_*	Errors		Positive		

Fail_you_*	Fail_you		Precise		
Failure_*	Failure		Reliability		
Failures_*	Failures		Reliable		
False_*		Relied			
Falsity_*	Falsity		Relied_on		
Flakes_out_*	Flakes_out		Researched		
Flawed_*	Flawed		Responsible		
Glitches_*	Glitches		Responsibly		
	Good_enough		Safe		
Hard_to_use_*	Hard_to_use		Secure		
Harm_*	Harm		Security		
Harmful_*	Harmful		Security_in_caring_response		
Hesitation_*	Hesitation		Successful		
Hide_*			Trusting		
Hurting_*	Hurting		Trustworthy		
Inefficient_*	Inefficient		Understandability		
Knockoff_*	Knockoff		Understanding		
Lack_of_confidence_*	Lack_of_confidence		Understanding_risks		
Lack_of_proof_*	Lack_of_proof		Use_the_right_technology		
Lack_of_support_*	Lack_of_support		Useful		
Lost_information_*	Lost_information		Usefulness		
Lying_*	Lying		Well_informed		
Makes_vulnerable_*	Makes_vulnerable		What_is_right		
Misadvising_*	Misadvising		Will_not_harm		
Misfunction_*	Misfunction		Willing		
Misleading_*	Misleading				
Mistake_*	Mistake				
Mistakes_*	Mistakes				
Mistrust_*	Mistrust				
No_confidence_*	No_confidence				

No_faith_*	No_faith				
No_review_*	No_review				
Not_a_lot_of_information_*	Not_a_lot_of_information				
Not_advanced_enough_*	Not_advanced_enough				
Not_always_reliable_*	Not_always_reliable				
Not_disclosing_risks_*	Not_disclosing_risks				
Not_God_enough_to_work_*	Not_God_enough_to_work				
Not_having_faith_*	Not_having_faith				
Not_inclined_to_use_*	Not_inclined_to_use				
Not_willing_to_use_*	Not_willing_to_use				
Not_working_properly_*	Not_working_properly				
Of_no_use_*	Of_no_use				
Problems_*	Problems				
Produced_bad_results_*	Produced_bad_results				
Results_that_are_farfetched_*	Results_that_are_farfetched				
Should_not_use_*	Should_not_use				
Skeptical_*	Skeptical				
System_crash_*	System_crash				
Things_go_wrong_*	Things_go_wrong				
Toxic_*	Toxic				
Trickery_*	Trickery				
Uncaring_*	Uncaring				
Uncomfortable_*	Uncomfortable				
Uneasiness_*	Uneasiness				
Unnecessary_*	Unnecessary				
Untrustworthy_*	Untrustworthy				

Wary_*	Wary				
Without_consent_*	Without_consent				
Wrong_*	Wrong				
	FALSE				

A.5 Means, Standard Deviations, and Coefficient Alpha Reliability Estimate for the Study's Variables

Table Means, Standard Deviations, and Coefficient Alpha Reliability Estimate for the Study's Variables

Variable	Pairs	Means	SD	Mode	Reliability estimate
1	2 vs 1	4.88	1.17	4	0.99
2	3 vs 1	5.10	1.48	5	0.99
3	4 vs 1	3.90	1.39	5	0.99
4	5 vs 1	4.88	1.36	6	0.99
5	6 vs 1	5.76	1.81	7	0.99
6	7 vs 1	4.39	1.30	5	0.99
7	8 vs 1	4.15	1.37	3	0.99
8	9 vs 1	4.34	1.22	5	0.99
9	10 vs 1	4.05	1.28	3	0.99
10	11 vs 1	4.34	1.33	5	0.99
11	12 vs 1	4.05	1.41	3	0.99
12	13 vs 1	3.76	1.20	4	0.99
13	14 vs 1	4.46	1.50	5	0.99
14	15 vs 1	6.29	1.10	7	0.99
15	16 vs 1	3.88	1.23	3	0.99
16	17 vs 1	4.68	1.40	5	0.99
17	18 vs 1	5.61	1.28	6	0.99
18	19 vs 1	4.39	1.28	5	0.99
19	20 vs 1	6.17	1.14	7	0.99
20	21 vs 1	4.46	1.45	6	0.99
21	22 vs 1	4.22	1.24	4	0.99
22	23 vs 1	4.20	1.19	5	0.99
23	24 vs 1	4.15	1.37	5	0.99
24	25 vs 1	3.54	1.03	3	0.99
25	26 vs 1	4.12	1.44	5	0.99
26	27 vs 1	3.59	1.30	3	0.99
27	28 vs 1	4.51	1.33	5	0.99
28	29 vs 1	3.22	1.15	3	0.99
29	30 vs 1	4.27	1.40	5	0.99
30	3 vs 2	5.54	1.32	7	0.99
31	4 vs 2	4.88	1.29	5	0.99
32	5 vs 2	5.20	1.19	6	0.99
33	6 vs 2	4.41	1.20	5	0.99
34	7 vs 2	3.76	1.46	4	0.99
35	8 vs 2	5.85	1.04	6	0.99
36	9 vs 2	5.44	1.76	7	0.99
37	10 vs 2	3.98	1.41	3	0.99
38	11 vs 2	5.68	1.13	6	0.99

39	12 vs 2	4.95	1.48	6	0.99
40	13 vs 2	4.85	1.49	6	0.99
41	14 vs 2	3.80	1.27	5	0.99
42	15 vs 2	4.10	1.45	5	0.99
43	16 vs 2	5.02	1.33	6	0.99
44	17 vs 2	4.22	1.39	3	0.99
45	18 vs 2	5.37	1.20	6	0.99
46	19 vs 2	4.37	1.46	5	0.99
47	20 vs 2	5.39	1.16	6	0.99
48	21 vs 2	4.24	1.39	6	0.99
49	22 vs 2	4.37	1.43	4	0.99
50	23 vs 2	4.66	1.26	5	0.99
51	24 vs 2	5.41	1.52	7	0.99
52	25 vs 2	3.98	1.23	5	0.99
53	26 vs 2	3.90	1.43	3	0.99
54	27 vs 2	4.56	1.58	4	0.99
55	28 vs 2	3.83	1.39	5	0.99
56	29 vs 2	3.20	1.29	3	0.99
57	30 vs 2	5.22	1.35	5	0.99
58	4 vs 3	4.73	1.38	4	0.99
59	5 vs 3	6.41	0.97	7	0.99
60	6 vs 3	4.83	1.26	5	0.99
61	7 vs 3	4.10	1.46	5	0.99
62	8 vs 3	4.76	1.41	5	0.99
63	9 vs 3	5.07	1.39	5	0.99
64	10 vs 3	4.07	1.27	3	0.99
65	11 vs 3	4.66	1.35	5	0.99
66	12 vs 3	4.78	1.44	5	0.99
67	13 vs 3	4.51	1.27	4	0.99
68	14 vs 3	4.12	1.25	3	0.99
69	15 vs 3	4.76	1.37	5	0.99
70	16 vs 3	4.85	1.44	5	0.99
71	17 vs 3	4.24	1.45	5	0.99
72	18 vs 3	5.27	1.43	6	0.99
73	19 vs 3	4.39	1.30	5	0.99
74	20 vs 3	5.51	1.34	6	0.99
75	21 vs 3	4.61	1.24	5	0.99
76	22 vs 3	4.34	1.24	4	0.99
77	23 vs 3	4.98	1.17	5	0.99
78	24 vs 3	4.73	1.50	6	0.99
79	25 vs 3	4.02	1.21	5	0.99
80	26 vs 3	3.93	1.44	5	0.99
81	27 vs 3	4.29	1.45	5	0.99
82	28 vs 3	4.39	1.24	5	0.99
83	29 vs 3	3.54	1.25	3	0.99
84	30 vs 3	5.66	1.84	7	0.99

85	5 vs 4	4.39	1.36	5	0.99
86	6 vs 4	3.44	1.29	3	0.99
87	7 vs 4	3.44	1.42	3	0.99
88	8 vs 4	3.54	1.29	3	0.99
89	9 vs 4	4.68	1.21	5	0.99
90	10 vs 4	3.93	1.47	4	0.99
91	11 vs 4	3.78	1.42	3	0.99
92	12 vs 4	4.54	1.27	5	0.99
93	13 vs 4	4.49	1.53	6	0.99
94	14 vs 4	3.76	1.28	3	0.99
95	15 vs 4	3.73	1.45	3	0.99
96	16 vs 4	6.07	1.25	7	0.99
97	17 vs 4	3.46	1.16	4	0.99
98	18 vs 4	3.63	1.58	3	0.99
99	19 vs 4	3.93	1.49	3	0.99
100	20 vs 4	3.98	1.44	3	0.99
101	21 vs 4	4.10	1.32	5	0.99
102	22 vs 4	3.93	1.40	3	0.99
103	23 vs 4	3.78	1.41	4	0.99
104	24 vs 4	3.71	1.33	4	0.99
105	25 vs 4	4.54	1.36	5	0.99
106	26 vs 4	3.73	1.41	4	0.99
107	27 vs 4	5.90	1.11	7	0.99
108	28 vs 4	3.93	1.31	4	0.99
109	29 vs 4	4.51	1.47	6	0.99
110	30 vs 4	4.44	1.40	5	0.99
111	6 vs 5	4.88	1.36	4	0.99
112	7 vs 5	4.37	1.37	5	0.99
113	8 vs 5	4.61	1.39	5	0.99
114	9 vs 5	5.05	1.45	6	0.99
115	10 vs 5	4.24	1.39	5	0.99
116	11 vs 5	4.61	1.53	5	0.99
117	12 vs 5	4.98	1.35	5	0.99
118	13 vs 5	4.68	1.62	4	0.99
119	14 vs 5	4.12	1.45	5	0.99
120	15 vs 5	4.88	1.35	6	0.99
121	16 vs 5	4.49	1.34	5	0.99
122	17 vs 5	4.20	1.50	4	0.99
123	18 vs 5	5.10	1.50	5	0.99
124	19 vs 5	4.24	1.32	4	0.99
125	20 vs 5	5.44	1.57	6	0.99
126	21 vs 5	4.51	1.27	5	0.99
127	22 vs 5	4.61	1.22	5	0.99
128	23 vs 5	4.76	1.28	4	0.99
129	24 vs 5	4.68	1.54	6	0.99
130	25 vs 5	4.02	1.27	4	0.99

131	26 vs 5	3.59	1.58	3	0.99
132	27 vs 5	4.56	1.32	5	0.99
133	28 vs 5	4.51	1.27	5	0.99
134	29 vs 5	3.15	1.11	3	0.99
135	30 vs 5	5.59	1.50	7	0.99
136	7 vs 6	4.29	1.29	5	0.99
137	8 vs 6	4.05	1.26	4	0.99
138	9 vs 6	3.90	1.28	5	0.99
139	10 vs 6	3.85	1.46	3	0.99
140	11 vs 6	3.85	1.33	3	0.99
141	12 vs 6	3.66	1.35	3	0.99
142	13 vs 6	3.68	1.37	4	0.99
143	14 vs 6	4.10	1.43	5	0.99
144	15 vs 6	5.41	1.69	7	0.99
145	16 vs 6	3.85	1.26	3	0.99
146	17 vs 6	4.29	1.38	4	0.99
147	18 vs 6	5.49	1.27	6	0.99
148	19 vs 6	4.39	1.38	4	0.99
149	20 vs 6	5.66	1.32	6	0.99
150	21 vs 6	3.90	1.46	5	0.99
151	22 vs 6	4.24	1.26	4	0.99
152	23 vs 6	4.07	1.39	3	0.99
153	24 vs 6	3.46	1.43	3	0.99
154	25 vs 6	3.05	1.24	3	0.99
155	26 vs 6	3.56	1.60	3	0.99
156	27 vs 6	3.88	1.31	3	0.99
157	28 vs 6	4.71	1.35	5	0.99
158	29 vs 6	3.20	1.23	3	0.99
159	30 vs 6	4.34	1.48	3	0.99
160	8 vs 7	3.22	1.47	3	0.99
161	9 vs 7	3.54	1.61	3	0.99
162	10 vs 7	3.63	1.34	3	0.99
163	11 vs 7	3.56	1.23	4	0.99
164	12 vs 7	3.61	1.24	3	0.99
165	13 vs 7	3.98	1.44	3	0.99
166	14 vs 7	4.05	1.45	4	0.99
167	15 vs 7	4.34	1.20	5	0.99
168	16 vs 7	3.56	1.40	3	0.99
169	17 vs 7	5.73	1.18	7	0.99
170	18 vs 7	4.39	1.32	5	0.99
171	19 vs 7	4.22	1.17	4	0.99
172	20 vs 7	4.83	1.39	5	0.99
173	21 vs 7	5.12	1.31	5	0.99
174	22 vs 7	4.27	1.30	4	0.99
175	23 vs 7	4.37	1.18	5	0.99
176	24 vs 7	3.76	1.26	4	0.99

177	25 vs 7	3.15	1.24	3	0.99
178	26 vs 7	3.88	1.47	3	0.99
179	27 vs 7	3.85	1.42	4	0.99
180	28 vs 7	3.93	1.39	5	0.99
181	29 vs 7	3.12	1.25	3	0.99
182	30 vs 7	3.71	1.42	3	0.99
183	9 vs 8	5.27	1.40	6	0.99
184	10 vs 8	3.98	1.35	4	0.99
185	11 vs 8	6.37	1.09	7	0.99
186	12 vs 8	4.44	1.45	5	0.99
187	13 vs 8	4.56	1.52	4	0.99
188	14 vs 8	3.73	1.48	3	0.99
189	15 vs 8	4.12	1.44	5	0.99
190	16 vs 8	3.98	1.39	4	0.99
191	17 vs 8	3.93	1.35	3	0.99
192	18 vs 8	5.05	1.40	5	0.99
193	19 vs 8	3.98	1.49	3	0.99
194	20 vs 8	5.20	1.55	7	0.99
195	21 vs 8	3.29	1.33	3	0.99
196	22 vs 8	3.98	1.44	5	0.99
197	23 vs 8	4.29	1.27	4	0.99
198	24 vs 8	5.66	1.13	6	0.99
199	25 vs 8	3.27	1.07	3	0.99
200	26 vs 8	3.54	1.61	3	0.99
201	27 vs 8	3.78	1.13	4	0.99
202	28 vs 8	3.61	1.32	3	0.99
203	29 vs 8	3.10	1.37	3	0.99
204	30 vs 8	4.29	1.50	5	0.99
205	10 vs 9	4.00	1.32	5	0.99
206	11 vs 9	5.46	1.32	6	0.99
207	12 vs 9	4.29	1.50	5	0.99
208	13 vs 9	4.51	1.34	4	0.99
209	14 vs 9	3.37	1.26	4	0.99
210	15 vs 9	3.76	1.41	4	0.99
211	16 vs 9	4.78	1.13	5	0.99
212	17 vs 9	4.05	1.30	5	0.99
213	18 vs 9	4.78	1.42	5	0.99
214	19 vs 9	4.46	1.31	4	0.99
215	20 vs 9	4.93	1.27	5	0.99
216	21 vs 9	3.68	1.40	5	0.99
217	22 vs 9	4.54	1.40	5	0.99
218	23 vs 9	3.98	1.37	3	0.99
219	24 vs 9	4.78	1.47	6	0.99
220	25 vs 9	4.22	1.04	5	0.99
221	26 vs 9	3.85	1.51	4	0.99
222	27 vs 9	4.54	1.29	4	0.99

223	28 vs 9	3.78	1.21	3	0.99
224	29 vs 9	3.29	1.25	3	0.99
225	30 vs 9	4.80	1.33	5	0.99
226	11 vs 10	3.71	1.38	3	0.99
227	12 vs 10	3.66	1.33	3	0.99
228	13 vs 10	3.59	1.16	3	0.99
229	14 vs 10	4.32	1.29	5	0.99
230	15 vs 10	4.05	1.16	4	0.99
231	16 vs 10	3.73	1.34	4	0.99
232	17 vs 10	3.56	1.27	4	0.99
233	18 vs 10	4.05	1.45	3	0.99
234	19 vs 10	4.59	1.45	4	0.99
235	20 vs 10	4.05	1.34	3	0.99
236	21 vs 10	3.24	1.28	3	0.99
237	22 vs 10	4.27	1.63	3	0.99
238	23 vs 10	4.39	1.26	5	0.99
239	24 vs 10	4.02	1.33	4	0.99
240	25 vs 10	3.46	1.27	3	0.99
241	26 vs 10	3.66	1.35	3	0.99
242	27 vs 10	3.63	1.11	3	0.99
243	28 vs 10	4.32	1.17	4	0.99
244	29 vs 10	4.29	1.42	3	0.99
245	30 vs 10	3.85	1.28	4	0.99
246	12 vs 11	4.22	1.52	5	0.99
247	13 vs 11	4.29	1.52	4	0.99
248	14 vs 11	3.68	1.27	3	0.99
249	15 vs 11	3.90	1.43	5	0.99
250	16 vs 11	3.78	1.27	4	0.99
251	17 vs 11	3.59	1.50	3	0.99
252	18 vs 11	5.20	1.33	6	0.99
253	19 vs 11	3.66	1.28	3	0.99
254	20 vs 11	5.15	1.39	6	0.99
255	21 vs 11	3.07	1.29	3	0.99
256	22 vs 11	4.07	1.56	3	0.99
257	23 vs 11	3.80	1.63	3	0.99
258	24 vs 11	5.78	1.26	7	0.99
259	25 vs 11	3.80	1.36	4	0.99
260	26 vs 11	3.56	1.57	4	0.99
261	27 vs 11	3.56	1.47	3	0.99
262	28 vs 11	3.46	1.38	3	0.99
263	29 vs 11	2.95	1.12	3	0.99
264	30 vs 11	4.49	1.23	5	0.99
265	13 vs 12	6.10	1.20	7	0.99
266	14 vs 12	3.56	1.45	3	0.99
267	15 vs 12	3.71	1.27	3	0.99
268	16 vs 12	4.02	1.29	5	0.99

269	17 vs 12	3.88	1.29	5	0.99
270	18 vs 12	4.34	1.62	6	0.99
271	19 vs 12	3.78	1.35	3	0.99
272	20 vs 12	4.54	1.67	6	0.99
273	21 vs 12	3.78	1.47	5	0.99
274	22 vs 12	3.88	1.42	4	0.99
275	23 vs 12	4.49	1.40	5	0.99
276	24 vs 12	4.78	1.44	5	0.99
277	25 vs 12	3.68	1.33	3	0.99
278	26 vs 12	3.85	1.35	3	0.99
279	27 vs 12	3.93	1.44	5	0.99
280	28 vs 12	4.02	1.35	5	0.99
281	29 vs 12	3.54	1.16	3	0.99
282	30 vs 12	4.51	1.42	5	0.99
283	14 vs 13	3.78	1.41	4	0.99
284	15 vs 13	4.07	1.39	3	0.99
285	16 vs 13	3.90	1.24	4	0.99
286	17 vs 13	3.90	1.30	4	0.99
287	18 vs 13	4.17	1.55	4	0.99
288	19 vs 13	3.68	1.13	3	0.99
289	20 vs 13	4.37	1.41	5	0.99
290	21 vs 13	3.90	1.36	3	0.99
291	22 vs 13	3.93	1.23	5	0.99
292	23 vs 13	4.29	1.40	5	0.99
293	24 vs 13	4.66	1.44	5	0.99
294	25 vs 13	4.00	1.05	4	0.99
295	26 vs 13	4.02	1.52	3	0.99
296	27 vs 13	4.10	1.37	5	0.99
297	28 vs 13	3.83	1.26	5	0.99
298	29 vs 13	3.85	1.37	4	0.99
299	30 vs 13	4.49	1.42	4	0.99
300	15 vs 14	4.17	1.41	5	0.99
301	16 vs 14	3.73	1.23	4	0.99
302	17 vs 14	3.56	1.50	5	0.99
303	18 vs 14	4.56	1.29	5	0.99
304	19 vs 14	4.29	1.27	4	0.99
305	20 vs 14	4.88	1.36	5	0.99
306	21 vs 14	3.73	1.36	5	0.99
307	22 vs 14	4.00	1.40	3	0.99
308	23 vs 14	4.02	1.47	5	0.99
309	24 vs 14	3.59	1.30	4	0.99
310	25 vs 14	3.15	1.22	3	0.99
311	26 vs 14	4.17	1.63	5	0.99
312	27 vs 14	3.39	1.43	3	0.99
313	28 vs 14	5.24	1.41	6	0.99
314	29 vs 14	4.05	1.52	3	0.99

315	30 vs 14	3.90	1.32	5	0.99
316	16 vs 15	3.90	1.30	5	0.99
317	17 vs 15	4.68	1.29	5	0.99
318	18 vs 15	5.66	1.32	6	0.99
319	19 vs 15	4.32	1.25	4	0.99
320	20 vs 15	5.95	1.32	7	0.99
321	21 vs 15	4.37	1.44	5	0.99
322	22 vs 15	4.34	1.28	5	0.99
323	23 vs 15	4.00	1.28	5	0.99
324	24 vs 15	3.88	1.40	3	0.99
325	25 vs 15	3.17	1.16	3	0.99
326	26 vs 15	3.76	1.56	3	0.99
327	27 vs 15	3.88	1.27	4	0.99
328	28 vs 15	4.61	1.45	5	0.99
329	29 vs 15	3.34	1.09	3	0.99
330	30 vs 15	4.44	1.23	5	0.99
331	17 vs 16	3.76	1.34	4	0.99
332	18 vs 16	4.02	1.29	3	0.99
333	19 vs 16	4.66	1.44	5	0.99
334	20 vs 16	3.95	1.55	4	0.99
335	21 vs 16	3.56	1.50	3	0.99
336	22 vs 16	4.54	1.25	4	0.99
337	23 vs 16	3.90	1.32	5	0.99
338	24 vs 16	4.22	1.19	5	0.99
339	25 vs 16	4.90	1.28	5	0.99
340	26 vs 16	3.61	1.36	3	0.99
341	27 vs 16	6.07	1.37	7	0.99
342	28 vs 16	3.76	1.11	4	0.99
343	29 vs 16	3.56	0.98	3	0.99
344	30 vs 16	4.41	1.40	5	0.99
345	18 vs 17	4.56	1.45	5	0.99
346	19 vs 17	4.90	1.20	6	0.99
347	20 vs 17	4.66	1.56	5	0.99
348	21 vs 17	5.66	1.04	6	0.99
349	22 vs 17	4.39	1.34	4	0.99
350	23 vs 17	4.76	1.34	4	0.99
351	24 vs 17	3.49	1.36	3	0.99
352	25 vs 17	3.10	1.07	3	0.99
353	26 vs 17	3.61	1.56	4	0.99
354	27 vs 17	3.88	1.58	3	0.99
355	28 vs 17	4.00	1.34	3	0.99
356	29 vs 17	3.20	1.31	3	0.99
357	30 vs 17	4.39	1.39	5	0.99
358	19 vs 18	4.29	1.47	4	0.99
359	20 vs 18	5.27	1.94	7	0.99
360	21 vs 18	4.37	1.44	5	0.99

361	22 vs 18	4.12	1.54	3	0.99
362	23 vs 18	4.68	1.60	5	0.99
363	24 vs 18	4.61	1.56	5	0.99
364	25 vs 18	3.17	1.30	2	0.99
365	26 vs 18	4.15	1.59	4	0.99
366	27 vs 18	3.93	1.49	3	0.99
367	28 vs 18	4.93	1.52	5	0.99
368	29 vs 18	3.17	1.48	3	0.99
369	30 vs 18	4.66	1.51	5	0.99
370	20 vs 19	4.59	1.18	5	0.99
371	21 vs 19	4.15	1.15	5	0.99
372	22 vs 19	6.24	1.32	7	0.99
373	23 vs 19	3.49	1.29	3	0.99
374	24 vs 19	3.66	1.35	4	0.99
375	25 vs 19	3.32	0.99	3	0.99
376	26 vs 19	3.46	1.31	3	0.99
377	27 vs 19	4.15	1.09	4	0.99
378	28 vs 19	3.90	1.32	3	0.99
379	29 vs 19	3.22	1.35	3	0.99
380	30 vs 19	4.46	1.23	4	0.99
381	21 vs 20	4.51	1.40	5	0.99
382	22 vs 20	4.63	1.36	5	0.99
383	23 vs 20	5.10	1.22	6	0.99
384	24 vs 20	4.88	1.31	6	0.99
385	25 vs 20	3.05	1.22	3	0.99
386	26 vs 20	4.24	1.73	5	0.99
387	27 vs 20	4.05	1.50	5	0.99
388	28 vs 20	4.90	1.09	5	0.99
389	29 vs 20	3.41	1.22	4	0.99
390	30 vs 20	4.95	1.36	5	0.99
391	22 vs 21	4.32	1.42	5	0.99
392	23 vs 21	4.15	1.35	5	0.99
393	24 vs 21	3.56	1.12	3	0.99
394	25 vs 21	3.12	1.33	3	0.99
395	26 vs 21	3.73	1.48	5	0.99
396	27 vs 21	3.61	1.26	4	0.99
397	28 vs 21	4.15	1.35	5	0.99
398	29 vs 21	3.44	1.38	3	0.99
399	30 vs 21	3.93	1.40	3	0.99
400	23 vs 22	3.66	1.06	3	0.99
401	24 vs 22	4.07	1.42	3	0.99
402	25 vs 22	3.59	1.26	3	0.99
403	26 vs 22	3.73	1.40	3	0.99
404	27 vs 22	4.22	1.37	5	0.99
405	28 vs 22	3.63	1.20	4	0.99
406	29 vs 22	3.49	1.33	3	0.99

407	30 vs 22	4.10	1.48	4	0.99
408	24 vs 23	4.12	1.25	5	0.99
409	25 vs 23	3.83	1.32	4	0.99
410	26 vs 23	4.49	1.23	5	0.99
411	27 vs 23	3.56	1.50	3	0.99
412	28 vs 23	4.85	1.39	5	0.99
413	29 vs 23	3.46	1.48	3	0.99
414	30 vs 23	4.34	1.46	5	0.99
415	25 vs 24	3.71	1.15	3	0.99
416	26 vs 24	3.63	1.32	3	0.99
417	27 vs 24	4.02	1.08	4	0.99
418	28 vs 24	3.68	1.37	3	0.99
419	29 vs 24	3.20	1.35	4	0.99
420	30 vs 24	4.29	1.38	4	0.99
421	26 vs 25	3.56	1.16	4	0.99
422	27 vs 25	4.66	1.35	5	0.99
423	28 vs 25	3.51	1.27	3	0.99
424	29 vs 25	3.27	1.12	3	0.99
425	30 vs 25	4.05	1.28	4	0.99
426	27 vs 26	3.41	1.34	3	0.99
427	28 vs 26	4.24	1.45	4	0.99
428	29 vs 26	3.88	1.62	3	0.99
429	30 vs 26	3.73	1.28	4	0.99
430	28 vs 27	3.56	1.03	3	0.99
431	29 vs 27	3.10	1.18	3	0.99
432	30 vs 27	4.37	1.44	4	0.99
433	29 vs 28	4.00	1.16	4	0.99
434	30 vs 28	4.00	1.12	4	0.99
435	30 vs 29	3.24	1.14	3	0.99

Note: N= 64.

Cluster Analysis

Table Cluster Analysis

Number of Clusters	Distance	Leader	Joiner
29	3.674234614	Accurate	Accurately
28	3.674234614	Honesty	Secure
27	3.674234614	Positive	Confident
26	3.674234614	Knowledge	Healthy
25	3.719318934	Accurate	Gives_real_results
24	3.719318934	Positive	Confidence
23	3.741657387	Trustworthy	Reliability
22	3.741657387	Trusting	Responsible
21	3.741657387	Precise	Well_informed
20	3.741657387	Honest	Integrity
19	3.741657387	Helpful	Effective
18	3.741657387	Safe	Reliance
17	3.785938897	Trusting	Affect_lives
16	3.807886553	Reliable	Give_correct_results
15	3.807886553	Successful	Researched
14	3.829708431	Honest	Responsibly
13	3.851406669	Knowledge	Security
12	3.872983346	Trustworthy	Reliable
11	3.872983346	Honesty	Helpful
10	3.872983346	Safe	Security_in_caring
9	3.894440482	Knowledge	Successful
8	3.915780041	Trustworthy	Precise
7	3.952847075	Safe	Knowledge
6	3.961120573	Honest	Honesty
5	4.016537782	Safe	Trusting
4	4.034572812	Accurate	Trustworthy
3	4.063191333	Honest	Positive
2	4.136889268	Safe	Honest
1	4.185386519	Accurate	Safe

Appendix B. Phase II

B.1 Role Analysis Code Summary

Q12. What in your opinion is the care providers role/ job or responsibility with regards to your pregnancy/ child's birth?

102 open codes were created during a line-by-line coding procedure. Codes were created in vivo, meaning participants own words were used to create codes. Codes were then categorized into code families using atlas.ti. Code families grouped codes with similar meanings and definitions. Of the 102 codes, 16 families were created. Families are discussed in order of their groundedness (number of codes in each family)

Keep Baby and Mom Healthy (25)
This family is defined as the patient's perception that the health care providers role is to make sure the mom and baby are safe and healthy
Example codes are: make sure baby gets here safely, keep baby safe, and make sure I'm ok.
Communicate (13)
This family is defined as the patient's perception that the health care providers role is to communicate information to the patient.
Example codes are provide explanation, communicate openly, explain what is happening, give information.
Personal attention (11)
This family is defined as the patient's perception that the health care providers role is provide personal attention to the patient.
Participant expressed this by saying that they felt it was the physicians job to pt them fit, make them feel comfortable, not hurry them through appointments, know their wants on a deeper level, be understanding of their emotional state.
Good Outcomes (10)
This family is defined as the patient's perception that the health care providers role is make sure everything goes calmly, that the baby arrives safely, everything is medically correct, and successful.
Manager (10)
This family is defined as the patient's perception that the health care providers role is as a manager of the pregnancy.
They described physicians role as that of a guardian, controller, or overseer whose job is the take care of them, tell them what to do, and monitor them.
Tell Problems/ Disclosure (8)
This family is defined as the patient's perception that the health care providers role is to keep the patient informed of anything that is wrong.
Patient expressed this by saying they felt it was the physician's job to be honest, upfront about complication, and not hold anything back.
Listen (6)
This family is defined as the patient's perception that the health care providers role is to listen to the patients.

They expressed this by saying that they felt it was a physician's job to not be afraid to listen, and to listen to questions and concerns.

Explain Things (6)

This family is defined as the patient's perception that the health care providers role is to explain what they are dong, why things need be done and in a way that they can understand.

Disclose Risk (5)

This family is defined as the patient's perception that the health care providers role is to give information about risks.

Patients expressed this by say it was the health providers role to talk about risk, give the statistics and disclose the percentage of times things don't work.

Invitation to Participate (4)

This family is defined as the patient's perception that the health care providers role is to invite patients to participate in the process by asking questions and telling how they feel.

Participants expressed this by saying that they felt it was the physicians role to make sure the patient doesn't feel like their questions are a bourdon and to remind patients that they can ask question or talk about their concerns.

Consultant (4)

This family is defined as the patient's perception that the health care providers role is to be like a consultant in the process as opposed to a manager.

They described this by saying they felt like the patient's job is to be a consultant, to assist them in giving birth, and to help them make their own decision.

Provide Best Care (3)

This family is defined as the patient's perception that the health care providers role is give them the best care.

Patients described this by saying they felt the health care providers job is to make sure they receive the best care.

Be Flexible (3)

This family is defined as the patient's perception that the health care providers role is to be flexible.

Participants described his b sang that they felt it was the care providers job to be flexible, to work with their schedules and not to attempt to schedule c-section or induce unnecessarily

Shift Roles (3)

This family is defined as the patient's perception that the health care providers role is to shift roles when necessary.

They expressed this by saying care providers should be a partner until something goes wrong.

Be Open-minded (2)

This family is defined as the patient's perception that the health care providers role is to be open minded.

They expressed this by saying it was the physician's job to be open-minded and to be open-minded to patient opinions.

Patients were asked what they felt their role was with regards to their pregnancy and child's birth.
Q11. What, in your opinion is your role/ job/ duties/ responsibilities as a patient?

92 open codes were created during a line-by-line coding procedure. Codes were created in vivo, meaning participants own words were used to create codes. Codes were then categorized into code families using atlas.ti. Code families grouped codes with similar meanings and definitions. Of the 92 codes, 16 families were created. Families are discussed in order of their groundedness (number of codes in each family)

Do independent research (20)
This family is defined as the patient's perception that it is the patient's role to doing their own research outside of the hospital and physician. Things like getting a second opinion and reading things on your own.
This was expressed with codes such as doing ones own research, learning from different sources and learning as much as possible.
Communicate with doctor (19)
This family is defined as the patient's perception that it is the patient's role to communicate with the doctor.
This was expressed by codes that explicitly stated keep doctors informed, include the doctor, let the doctor know about problems and regret statements such as I wish I had expressed concerns, or told the doctor when I was uncomfortable.
Ask Questions (13)
This family is defined as the patient's perception that it is the patient responsibility to ask questions.
This was expressed by codes such as get advice from the doctor ask questions, just as questions.
Passive/ be taken care of (8)
This family is defined as the patient's perception that it is the patient responsibility to be taken care of.
This was expressed by codes such as it is not every patients job to be informed and allow other people to take care of me.
Be Proactive (6)
This family is defined as not just letting the doctor control everything and being an active participant in the process. It is also about actively resisting the systems inclination to make a patient passive.
This exemplified through codes such as "know what to specify upfront, know what to specify at the hospital, and know what to specify with the doctor," "I couldn't just lean back and let him take care of everything," "not getting pushed though, not getting ignored."
Be Honest (6)
This family is defined as patients believing that it is their role to be honest. Example codes are, be honest and tell provider the truth.
Be proactive (6)

This family is defined as the patient's perception that it is the patient responsibility to be proactive and take an active part in the experience.
Be skeptical/ power (6)
Doctors do job/ don't get in their way (5)
This family is defined as the patient's perception that it is the patient responsibility to let the doctors do their job without hindering their work process. This was expressed by coded such as don't slow things down or complicate things, help doctors as best as I could, just to be healthy for them to make it go easier, make it easy for them to do their job, and make sure I don't do anything that could hinder their reports.
Understand (5)
Be more aware, understand, make sure you understand what's going on, be aware of what they are saying work together.
Don't totally rely on doctor (4)
Expressed but codes such as "don't take everything the doctor says," "making decisions based on info in addition to physicians info," and "making decisions different from doctors recommendations."
Work Together (4)
This family is defined as the patient's perception that it is the patient responsibility to work with the physician in a partnership.
Work together, physician as partner, be willing to work together.
Be Personal Advocate (3)
This family is defined as the patient's perception that it is the patient responsibility to be their own advocate or look out for their best interest.
Express needs
This family is defined as the patient's perception that it is the patient responsibility to express their needs.
Participants expressed this by saying things such as "I feel like I have the responsibility to just press the button and ask" and "the patient should feel comfortable to ask for things."
Manners (3)
This family is defined as the patient's perception that it is the patient responsibility to be mannerly.
Codes (3): [11 be helpful] [11 be kind] [11 Be respectful.]
Make decisions (2)
This family is defined as the patient's perception that it is the patient responsibility to make decisions.
Codes include make an educated decision and make decisions for themselves and their family.

Q 11a What in your opinion is the role, job or responsibilities of your patients?

Care Providers were asked what they saw their role as providers and what they saw their patients roles as.

Code Family: 11a be a partner

Created: 09/24/07 05:05:50 PM (Super)
Codes (3): [11a be a partner with provider] [11a be a partner] [11a I would like to see a partnership]
Quotation(s): 3
Code Family: 11a listen to provider/ accept what they say as authority
Created: 09/24/07 05:06:09 PM (Super)
Codes (4): [11a accept advice] [11a do their best to follow advice] [11a follow advice] [11a listen to advice]
Quotation(s): 3
Code Family: 11a patient determines their role
Created: 09/24/07 05:06:26 PM (Super)
Codes (7): [11a frustrating when patients won't do the things that will help them] [11a its up to them whether they want to listen or comply] [11a patients determine their own role] [11a role is as much as the patient makes it] [11a role is patients choice, can be active or passive] [11a up to the patient to do the things suggested] [11a wishing patient had a certain role, but acknowledging that they dont always]
Quotation(s): 6
Code Family: 11a patients determine their own role
Created: 09/16/07 04:27:20 PM (Super)
Codes (6): [11a its up to them whether they want to listen or comply] [11a patients determine their own role] [11a role is as much as the patient makes it] [11a role is patients choice, can be active or passive] [11a up to the patient to do the things suggested] [11a wishing patient had a certain role, but acknowledging that they don’t always]
Quotation(s): 6
Code Family: 11a tell provider things
Created: 09/24/07 05:06:38 PM (Super)
Codes (6): [11a keep physicians abreast of new developments] [11a telling provider about anxiety] [11a telling provider about concerns] [11a telling provider if they don't feel well] [11a voice concerns] [11a voice preferences]
Quotation(s): 3
Code Family: 11a to learn
Created: 09/24/07 05:06:43 PM (Super)
Codes (7): [11a be knowledgeable about illness and health] [11a read up on anything they have questions on] [11a reading prior to going to the office] [11a reading what provider gives them] [11a reading= knowing what to expect] [11a reading= making the "right" decisions] [11a stay informed]
Quotation(s): 6
Code Family: 11a to make decisions
Created: 09/24/07 05:06:47 PM (Super)
Codes (5): [11a make best informed decisions] [11a make decisions based on materials from provider] [11a the purpose of the doctor patient relationship is for patients to make their own decisions] [11a use the medical opinions given to make decisions] [11a use their views to mae decisions]
Quotation(s): 3

Code Family: 11a to take care of themselves
Created: 09/24/07 05:06:52 PM (Super)
Codes (9): [11a have the responsibility to not do anything to endanger their child or themselves] [11a do their best to take care of pregnancy] [11a isn't the doctors responsibility to make sure the patient is healthy] [11a responsibility is completely up to them] [11a take care of baby] [11a take care of themselves] [11a take responsibility for their health] [11a take responsibility for their own care] [11a they have a large role in their management]
Quotation(s): 8

Q12a What is your actual role/ job/ duties/ responsibilities as a physician with regards to a patients pregnancy and childbirth?

Code Family: 12a be educated
Created: 09/22/07 08:54:07 PM (Super)
Codes (9): [12a be familiar with current research and literature] [12a offer latest information regarding complications] [12a stay up wth latest information regarding complications] [12b be educated] [12b be educated enough to make informed decisions] [12b dont want to think i could have done that different] [12b know anything that is abnormal in pregnancy] [12b know how to treat anything abnormal] [12b really understand what i' doing]
Quotation(s): 6
Code Family: 12a ensure good outcomes
Created: 09/22/07 08:53:55 PM (Super)
Codes (5): [12a have a good baby outcome] [12b make sure she can have a normal labor and delivery] [12b make sure shes in optimal health] [12b provide for succcessful management of child] [12b provide for successful delivery of child]
Quotation(s): 4
Code Family: 12a ensure safety
Created: 09/21/07 11:48:25 AM (Super)
Codes (5): [12a ensure babies safety through labor] [12a ensure moms safety] [12a uncover health risks for baby and mom] [12b dont want to harm people] [12b provde a safe enionrment]
Quotation(s): 3
Code Family: 12a provide emotional support
Created: 09/22/07 08:53:22 PM (Super)
Codes (12): [12a be a friend] [12a have them be happy throughout pregnancy] [12a help them through the process] [12a provide emotional suport] [12a provide reassurance and support] [12a understanding who they are] [12b be compasionate] [12b be compassionate] [12b be empathetic] [12b be understanding that it is a difficult process] [12b provide emotional support] [12b understand what they are going through]
Quotation(s): 8
Code Family: 12a providing physical support
Created: 09/21/07 11:54:04 AM (Super)

Codes (8): [12a be ready with the sucton] [12a blood tests] [12a exams] [12a fundal height measurement] [12a geneic tests] [12a manipulations on patients] [12a ultrasounds] [12b provide physical support]
Quotation(s): 4
Code Family: 12a relationship building
Created: 09/22/07 09:11:53 PM (Super)
Codes (10): [12a establis a nurturing relationship] [12a establis a relationship that they can eel comfortbale discussing fears and excitement and intimate problems] [12a having a real relationship with the patient] [12a its more than a relationship of trust] [12a make sure patient trusts you] [12a make sure the patient would tell about abuse] [12a trying to form relationships with patients] [12b have a relationship with the patient] [12b provide a trustowrthy environment] [12b shouldn't get emotionally involved with patient]
Quotation(s): 6
Code Family: 12a sharing information
Created: 09/22/07 08:53:02 PM (Super)
Codes (14): [12a address quesions about breas feeding] [12a educate about wha is the righ food to eat] [12a giving advice] [12a giving health advice] [12a giving opinion] [12a giving personal opinion] [12a inform patient of heir options] [12a inform patients] [12a inform patients of how I do things] [12a making recommendations] [12a tell patients what to expect] [12a to educate] [12b educate] [12b teaching about the best ime to get pregnant]
Quotation(s): 12

B.2 Participant Profiles

Jennifer (participant 1101) is a 32 year old Caucasian living in Blacksburg, VA. Jennifer and her husband have two children. Jennifer identifies as Christian and works as a human relations specialist. She spends 8+ hours on the computer a day. Jennifer participated in Lamaze before she gave birth to her most recent child on March 10, 2007 at Montgomery Regional Hospital using electronic fetal monitoring. She received reconstructive surgery after the birth of her child.

Jessica (participant 1102) is a 34 year old Caucasian living in Montville, VA. Jessica and her husband have three children. Jessica identifies as Baptist and spends less than an hour on the computer a day. Jessica gave birth to her last child on June 11, 2007 at Roanoke Community Hospital in which she used electronic fetal monitoring and an epidural.

Amanda (participant 1103) is a 35 year old Caucasian living in Blacksburg, VA. Amanda and her husband have three children. She works as a research associate. Amanda uses a computer between three and five hours a day. Amanda's major surgeries have included having her tonsils removed and a miscarriage DNC. During Amanda's last pregnancy she had amniocentesis to make sure her baby's lungs were developed before delivery. Amanda's delivery on January 9, 2007 at Montgomery Regional Hospital was a scheduled a cesarean section due to a condition she had called placenta privia. Pain relief was used.

Melissa (participant 1104) is a 20 year old Hispanic living in Blacksburg, VA. Melissa and her husband gave birth to their first child on January 16, 2005. Melissa identifies as Presbyterian and is currently a student. She uses a computer 8+ hours a day. Melissa's baby was delivered by a midwife at the Winchester Medical Center using electronic fetal monitoring.

Sarah (participant 1105) is a 25 year old Caucasian living in Floyd, VA. Sarah and her husband gave birth to their first child on October 4, 2006. Sarah identifies as Unitarian and works as a preschool teacher. She uses a computer less than one hour a day. Sarah's delivery at Radford Carilion Hospital was a scheduled cesarean section because her baby was breach. Electronic fetal monitoring and pain relief was used.

Nicole (participant 1106) is a 25 year old Caucasian living in Christiansburg, VA. Nicole and her husband had their first child on January 4, 2007. Nicole identifies as Methodist and works as a technical editor. She uses a computer 8+ hours a day. Nicole gave birth at Radford Carilion Hospital where she was induced and used electronic fetal monitoring. Nicole had gall bladder surgery shortly after giving birth.

Heather (participant 1107) is a 28 year old Caucasian living in Blacksburg, VA. Heather and her husband have two children. Heather is a stay at home mom and uses a computer less than an hour a week. Heather gave birth on January 23, 2007 at Montgomery Regional Hospital using electronic fetal monitoring.

Amy (participant 1108) is a 26 year old Caucasian living in Blacksburg, VA. Amy and her husband have two children. Amy identifies as Christian and is currently a graduate student. She uses a computer 8+ hours a day. Amy has auto-immune system disorder and ITP. Amy's delivery on December 14, 2007 at Radford Carilion Hospital was a scheduled cesarean section. Electronic fetal monitoring and pain relief was used.

Michelle (participant 1109) is a 21 year old Caucasian living in Roanoke, VA. Michelle is partnered and had her first child June 13, 2007. Michelle identifies as Christian and had laparoscopic surgery. Michelle gave birth at Roanoke Community Hospital where she was induced and used electronic fetal monitoring and pain relief.

Elizabeth (participant 1110) is a 31 year old living in Christiansburg, VA. Elizabeth and her husband have two children. Elizabeth is a stay at home mom and uses a computer between five and eight hours a day. She has had two major surgeries that include tubes in the ears and her tonsils removed. Elizabeth's delivery on November 13, 2007 at Montgomery Regional Hospital was a cesarean section. Electronic fetal monitoring and pain relief was used.

Rebecca (participant 1111) is a 32 year old living in Christiansburg, VA. Rebecca and her husband have two children. Rebecca identifies Christian and works as a writer. She uses a computer three hours a day. Rebecca has had elbow surgery. Rebecca participated in Lamaze and gave birth on November 1, 2007 at Radford Carilion Hospital using electronic fetal monitoring.

Stephanie (participant 1112) is a 29 year old Caucasian living in Blacksburg, VA. Stephanie and her husband have four children. Stephanie identifies as Mormon. She is a stay at home mom and uses a computer less than an hour a day. She has had her tonsils removed. Stephanie gave birth on October 1, 2007 at Montgomery General Hospital where she was induced and used electronic fetal monitoring and pain relief.

Kimberly (participant 1113) is a 34 year old Asian living in Christiansburg, VA. Kimberly and her husband gave birth to their first child September 7, 2006. Kimberly identifies as Christian and works as a nurse. She uses a computer five to eight hours a day. She has had exploratory surgery. Kimberly participated in Lamaze and gave birth at Montgomery Regional Hospital where she was induced and used electronic fetal monitoring and pain relief.

Maria (participant 1114) is a 27 year old Caucasian student living in Oceana, VA. Maria is partnered and has three children. Maria identifies as Christian and uses a computer three to five hours a day. Maria had major surgery when she broke her neck. Maria gave birth to her most recent child on June 17, 2007 at Roanoke Community Hospital and used electronic fetal monitoring and pain relief.

Angela (participant 1115) is an African American living in Roanoke, VA. Angela is partnered and her first child was born on June 17, 2007. Angela identifies as Christian. She uses a computer less than one hour a day. At ages 7 and 16, Angela had major surgeries to put pins in her arms and legs. Angela gave birth at Roanoke Community Hospital where she was induced and used electronic fetal monitoring and pain relief.

Lisa (participant 1116) is a 32 year old Caucasian homemaker living in Blacksburg, VA. Lisa and her husband have three children. Lisa identifies as Christian. She uses a computer about one hour a day. Lisa used Bradley classes delivered her most recent child on July 20, 2007 at Radford Carilion Hospital using electronic fetal monitoring.

Christina (participant 1117) is a 27 year old Caucasian mom living in Indianapolis, Indiana. Christina and her husband had their first child on December 22, 2006. Christina identifies as Christian. She uses a computer between one and three hours a day. Christina was induced, used electronic fetal monitoring, and had an emergency cesarean section.

Tiffany (participant 1118) is a 29 year old African American living in Roanoke, VA. Tiffany is single and has four children. She works as a nurse. Tiffany uses a computer less than an hour a day. Tiffany participated in Lamaze and gave birth on June 16, 2007 at Roanoke Community Hospital using electronic fetal monitoring and pain relief.

Crystal (participant 1119) is a 29 year old Caucasian and lives in Blacksburg, VA. Crystal and her husband gave birth to their first child on June 22, 2006. Crystal identifies as partially Catholic and works as a Virginia Tech Chef. She uses a computer between one and three hours a day. Crystal’s delivery at Montgomery Regional Hospital was an emergency cesarean section. Electronic fetal monitoring and pain relief was used.

Erin (participant 1120) is a 19 year old Caucasian and lives in Roanoke, VA. Erin is single and gave birth to her birth child on June 19, 2007. Erin identifies as Catholic. Erin has had surgery to have her wisdom teeth removed. She uses a computer less than an hour a day. Erin gave birth at Roanoke Community Hospital and was induced and used electronic fetal monitoring and pain relief.

Kelly (participant 1121) is a 28 year old Caucasian living in Leesburg, VA. Kelly and her husband have two children. Kelly identifies as Presbyterian and is a realtor. Kelly uses a computer between one and three hours a day. Kelly delivered twins on May 1, 2007 at the Reston Hospital Center and used electronic fetal monitoring and pain relief.

Rachel (participant 1122) is a 26 year old African American is from Miami, FL. Rachel and her husband have two children. Rachel uses a computer between one and three hours a day. Rachel participated in Lamaze and had an episiotomy. Rachel delivered in November 2006 at Fort Wainwright, a military base hospital using electronic fetal monitoring.
Jamie (participant 1123) is a 28 year old African American living in Salem, VA. Jamie is single and gave birth to her second child June 20, 2007. Jamie is a stay at home mom and identifies as Baptist. Jamie uses a computer between one and three Jamie had amniocentesis during her pregnancy. Jamie's delivery at Roanoke Community Hospital was a cesarean section where she was induced and had electronic fetal monitoring and pain relief.

Amber (participant 1124) is a 26 year old African American living in Houston, TX. Amber and her husband have two children. Amber works for the Houston City airport security and identifies as Christian. Amber uses a computer between three and five hours a day. Her major surgeries include having her tonsils removed, a breast reduction, and having her tubes tied. During her pregnancy as well as the actual childbirth she had a doula to take care of her emotional needs. Amber gave birth on May 30, 2007 at Memorial Herman Hospital (Texas Medical Center) where she had an episiotomy, electronic fetal monitoring, induction, and pain relief.

Appendix C. Phase III

C.1 Fit Definitions

MNSQ is the mean-square infit statistic with expectation 1. Values substantially less than 1 indicate dependency in your data; values substantially greater than 1 indicate noise. See dichotomous and polytomous fit statistics.

>2.0 Off-variable noise is greater than useful information. Degrades measurement.
>1.5 Noticeable off-variable noise. Neither constructs nor degrades measurement
0.5 - 1.5 Productive of measurement
<0.5 Overly predictable. Misleads us into thinking we are measuring better than we really are.
(Attenuation paradox.)

Misfits <1.0 are only of concern when shortening a test.

ZSTD is the infit mean-square fit statistic t standardized to approximate a theoretical "unit normal", mean 0 and variance 1, distribution. ZSTD (standardized as a z-score) is used of a t-test result when either the t-test value has effectively infinite degrees of freedom (i.e., approximates a unit normal value) or the Student's t-statistic distribution value has been adjusted to a unit normal value. The standardization is shown on RSA, p.100-101.

Ben Wright advises: "ZSTD is only useful to salvage non-significant MNSQ>1.5, when sample size is small or test length is short."

OUTFIT is a t standardized outlier-sensitive mean square fit statistic, more sensitive to unexpected behavior by persons on items far from the person's measure level.

>2.0 Off-variable noise is greater than useful information. Degrades measurement.
>1.5 Noticeable off-variable noise. Neither constructs nor degrades measurement
0.5 - 1.5 Productive of measurement
<0.5 Overly predictable. Misleads us into thinking we are measuring better than we really are.
(Attenuation paradox.)

MNSQ is the mean-square outfit statistic with expectation 1. Values substantially less than 1 indicate dependency in your data; values substantially greater than 1 indicate the presence of unexpected outliers.

ZSTD is the outfit mean-square fit statistic t standardized similarly to the INFIT ZSTD. ZSTD (standardized as a z- score) is used of a t-test result when either the t-test value has effectively infinite degrees of freedom (i.e., approximates a unit normal value) or the Student's t-statistic distribution value has been adjusted to a unit normal value.

PTBSE CORR (reported when PTBIS=Yes) or PTBSA CORR (reported when PTBIS=All) is the point-biserial correlation, rpbis, between the individual item (or person) response "scores" and the total person (or item) test score (less the individual response "scores"). Negative values for items often indicate mis-scoring, or rating (or
partial credit) scale items with reversed direction. Letters indicating the identity of persons or items appearing on the fit plots appear under PTBSE. For adaptive tests, an rpbis near zero is expected. See Correlations.

PTMEA CORR. (reported when PTBISERIAL=N) is the point-measure correlation, rpm or RPM, between the observations on an item (as fractions with the range 0,1) and the corresponding person measures, or *vice versa.* Since the point-biserial loses its meaning in the presence of missing data, specify PTBISERIAL=N when there are missing data or when CUTLO= or CUTHI= are specified. The point-measure correlation has a range of -1 to +1.

C.2 Fit Statistics for total instrument

Fit Statistics for total instrument

		point measure correlation	INFIT MSQ	infit Z	outfit MNSQ	outfit Zstd
Item	**Target**	**rpm**	**MSw**	**Zw**	**Msu**	**Zu**
1	Technology	**0.14**	**1.96**	**3.5**	**4.62**	**6.2**
2	Technology	0.57	0.91	-0.5	1.17	0.7
3	Technology	0.73	0.61	**-2.5**	**0.48**	**-2.1**
4	Technology	0.64	0.91	-0.5	0.81	-0.6
5	Technology	0.57	0.91	-0.4	1.17	0.6
6	Technology	0.6	0.98	0	0.92	-0.2
7	Technology	0.72	0.7	-1.8	0.51	-1.9
8	Technology	**0.21**	**1.85**	**3.2**	**2.65**	**3**
9	Technology	0.72	0.62	**-2.5**	**0.49**	-2
10	Technology	0.71	0.76	-1.5	0.55	-1.9
11	Technology	0.7	0.87	-0.7	0.66	-1.5
12	Technology	0.69	0.76	-1.5	0.72	-1.2
13	Technology	0.63	0.87	-0.8	1.17	0.7
14	Technology	0.74	0.58	**-2.6**	**0.43**	**-2.2**
15	Technology	0.7	0.7	-1.6	**0.49**	-1.7
16	Technology	0.72	0.9	-0.6	0.69	-1.4
17	Technology	0.71	0.66	**-2.2**	0.59	-1.7
18	Technology	**0.36**	**1.57**	**2.6**	**2.06**	**2.6**
19	Technology	0.71	0.64	**-2.4**	0.6	-1.7
20	Technology	0.7	0.75	-1.4	0.53	-1.6
21	Technology	0.73	0.68	-2	0.5	-2
22	Technology	0.68	0.89	-0.5	0.57	-1.4
23	Technology	**0.06**	**3**	**9.1**	**4.5**	**9.9**
24	Technology	**0.45**	1.3	1.7	1.39	1.5
25	Technology	**0.49**	1.03	0.2	1.3	1.3
26	Technology	0.73	0.73	-1.6	0.5	-2
27	Technology	0.65	0.94	-0.3	0.77	-0.7
28	Technology	**0.34**	**1.83**	**4.6**	**2.87**	**6.4**
29	Technology	0.7	0.87	-0.8	0.7	-1.4
30	Technology	0.77	0.55	**-2.9**	**0.39**	**-2.5**
31	Technology	0.61	1.07	0.5	1.06	0.4
32	Physician	0.6	1.28	1.8	1.13	0.7
33	Physician	**0.49**	1	0.1	0.74	-0.4
34	Physician	**0.46**	0.86	-0.3	**0.41**	-0.8

35	Physician	**0.43**	1.32	1.1	0.81	-0.1
36	Physician	0.5	0.8	-0.5	**0.3**	-1.1
37	Physician	**0.49**	0.9	-0.3	0.58	-0.7
38	Physician	**0.25**	**1.91**	**3.8**	**3.01**	**4.1**
39	Physician	**0.49**	0.71	-0.7	**0.28**	-1
40	Physician	0.53	0.86	-0.4	0.5	-0.8
41	Physician	**0.46**	1.15	0.6	0.71	-0.3
42	Physician	0.51	0.99	0.1	0.59	-0.6
43	Physician	**0.44**	0.75	-0.7	1.04	0.3
44	Physician	**0.47**	0.89	-0.2	0.54	-0.5
45	Physician	**0.46**	0.68	-0.7	**0.32**	-0.8
46	Physician	**0.44**	1.19	0.7	0.89	0
47	Physician	**0.45**	1.01	0.1	0.85	0
48	Physician	**0.46**	1.19	0.8	0.88	-0.1
49	Physician	0.52	0.87	-0.3	**0.47**	-0.8
50	Physician	0.53	1.07	0.4	0.98	0.1
51	Physician	**0.32**	**2.1**	**5.5**	**2.34**	**4.5**
52	Physician	0.5	1	0.1	0.78	-0.2
53	Physician	**0.46**	1.21	0.8	0.86	0
54	Physician	**0.49**	0.58	-1.2	0.54	-0.4
55	Physician	**0.37**	1.35	1.4	**1.89**	1.7
56	Physician	**0.21**	**1.71**	**2.6**	**2.69**	**2.8**
57	Physician	0.54	0.83	-0.5	**0.48**	-0.9
58	P & T	0.52	1.14	0.7	0.9	-0.2
59	P & T	0.52	0.94	-0.1	0.69	-0.5
60	P & T	0.51	0.68	-1.1	0.86	0
61	P & T	0.55	0.82	-0.8	0.99	0.1
62	P & T	0.56	0.7	-1	**0.34**	-1.2
63	P & T	0.54	0.64	-1.1	**0.35**	-1
64	P & T	0.58	0.69	-1.1	**0.43**	-1.1
65	P & T	0.62	0.64	-1.4	**0.3**	-1.7
66	P & T	0.6	0.76	-1	0.52	-1.1
67	P & T	0.5	0.74	-0.9	0.86	-0.1
68	P & T	0.54	0.67	-1.2	0.59	-0.6
69	P & T	0.61	0.65	-1.6	0.55	-1
70	P & T	0.52	0.73	-1.1	0.93	0
71	P & T	**0.44**	0.9	-0.2	0.75	-0.2
72	P & T	0.58	0.72	-1.4	0.76	-0.6
73	P & T	0.5	0.9	-0.2	**0.43**	-0.9
74	P & T	0.56	0.86	-0.6	0.78	-0.4
75	P & T	0.55	0.91	-0.4	1.04	0.2
76	P & T	**0.45**	0.86	-0.4	1.05	0.3
77	P & T	**0.3**	**1.64**	**2.2**	1.31	0.7
78	P & T	0.54	0.83	-0.5	0.56	-0.7
79	P & T	0.57	0.67	-1.5	0.82	-0.2

80	P & T	**0.45**	1.25	1.3	1.48	1.4

C.3 Fit Statistics for scale 1

Fit Statistics for scale 1

		point measure correlation	**INFIT MSQ**	**infit Z**	outfit MNSQ	**outfit Zstd**
Item	**Target**	**rpm**	**MSw**	**Zw**	**Msu**	**Zu**
1	Technology	**0.05**	**2.82**	**5.3**	**5.57**	**7.6**
2	Technology	0.69	0.77	-1.4	1.23	0.9
3	Technology	0.8	0.5	**-3.3**	**0.37**	**-2.6**
4	Technology	0.75	0.72	-1.6	0.61	-1.4
5	Technology	0.58	1.05	0.3	1.42	1.1
6	Technology	0.7	0.89	-0.6	0.75	-0.8
7	Technology	0.76	0.68	-1.9	0.52	-1.8
8	Technology	**0.29**	**2.1**	**4**	**2.94**	**2.9**
9	Technology	0.76	0.65	**-2.2**	0.5	-1.8
10	Technology	0.77	0.63	**-2.3**	0.53	-1.8
11	Technology	0.8	0.66	**-2.2**	**0.48**	**-2.3**
12	Technology	0.8	0.59	**-2.8**	0.53	**-2.1**
13	Technology	0.68	0.98	-0.1	1.01	0.1
14	Technology	0.8	**0.46**	**-3.5**	**0.34**	**-2.5**
15	Technology	0.75	0.64	-2	**0.42**	-1.8
16	Technology	0.81	0.71	-1.9	0.54	**-2.2**
17	Technology	0.76	0.66	**-2.1**	0.61	-1.5
18	Technology	**0.45**	**1.78**	**3.3**	**1.99**	**2.2**
19	Technology	0.77	0.63	**-2.4**	0.59	-1.7
20	Technology	0.75	0.64	-2	**0.45**	-1.8
21	Technology	0.81	0.53	**-3.1**	**0.38**	**-2.6**
22	Technology	0.74	0.78	-1.1	**0.48**	-1.7
23	Technology	**0.15**	**3.62**	**9.9**	**4.31**	**9.4**
24	Technology	0.58	1.31	1.7	1.25	1
25	Technology	0.62	1.1	0.7	1.17	0.8
26	Technology	0.79	0.59	**-2.6**	**0.45**	**-2.1**
27	Technology	0.73	0.82	-0.9	0.65	-1.1
28	Technology	**0.42**	**2.09**	**5.4**	**3.05**	**6.8**
29	Technology	0.78	0.72	-1.8	0.65	-1.6
30	Technology	0.82	**0.42**	**-3.9**	**0.32**	**-2.7**
31	Technology	0.69	1.07	0.5	1.04	0.3

C.4 Fit statistics Scale 2

Fit statistics Scale 2

		point measure correlation	**INFIT MSQ**	**infit Z**	outfit MNSQ	**outfit Zstd**
Item	**Target**	**rpm**	**MSw**	**Zw**	**Msu**	**Zu**
32	Physician	0.54	**1.81**	**4.3**	**3.52**	**6.7**
33	Physician	0.64	0.86	-0.4	0.59	-0.8
34	Physician	0.58	0.56	-1.4	**0.25**	-1.1
35	Physician	0.63	0.66	-1.1	**0.19**	-1.7
36	Physician	0.57	0.77	-0.6	**0.23**	-1.1
37	Physician	0.58	0.83	-0.5	1.44	0.9
38	Physician	0.51	**1.85**	**3.3**	**1.89**	**2.5**
39	Physician	0.58	**0.46**	-1.7	**0.11**	-1.4
40	Physician	0.69	**0.46**	**-2.2**	**0.18**	**-2.1**
41	Physician	0.67	**0.47**	**-2.1**	**0.18**	-1.9
42	Physician	0.66	0.62	-1.4	**0.23**	-1.8
43	Physician	0.56	0.54	-1.5	0.88	0.1
44	Physician	0.6	0.64	-1.1	**0.26**	-1.2
45	Physician	0.56	0.51	-1.4	**0.21**	-0.9
46	Physician	**0.47**	**1.6**	1.8	1.1	0.4
47	Physician	0.57	0.82	-0.5	1.31	0.7
48	Physician	0.55	1.26	1	**1.74**	1.6
49	Physician	0.67	**0.44**	**-2.2**	**0.14**	-1.9
50	Physician	0.63	1.03	0.2	0.74	-0.5
51	Physician	0.59	**1.73**	**3.6**	**2.08**	**4**
52	Physician	0.66	0.6	-1.4	**0.23**	-1.7
53	Physician	0.64	0.69	-1	**0.26**	-1.5
54	Physician	0.65	**0.33**	**-2.4**	**0.15**	-1.3
55	Physician	0.62	1.12	0.5	1.06	0.3
56	Physician	**0.4**	**2.2**	**3.6**	**1.87**	1.8
57	Physician	0.65	0.71	-1	**0.38**	-1.2

C.5 Fit statistics for scale 3

Fit statistics for scale 3

		point measure correlation	**INFIT MSQ**	**infit Z**	outfit MNSQ	**outfit Zstd**
Item	**Target**	**rpm**	**MSw**	**Zw**	**Msu**	**Zu**
58	P & T	0.63	**1.8**	**3.5**	**1.62**	**2.3**
59	P & T	0.73	0.82	-0.6	0.66	-0.7
60	P & T	0.75	**0.41**	**-2.3**	**0.33**	-1.2
61	P & T	0.77	0.86	-0.6	0.93	-0.1
62	P & T	0.75	**0.41**	**-2.3**	**0.19**	-1.7
63	P & T	0.74	**0.33**	**-2.6**	**0.14**	-1.6
64	P & T	0.77	0.57	-1.7	**0.37**	-1.5
65	P & T	0.77	0.58	-1.8	**0.33**	-1.8
66	P & T	0.75	0.97	-0.1	0.61	-1.1
67	P & T	0.76	0.53	-1.8	0.65	-0.5
68	P & T	0.79	**0.43**	**-2.4**	**0.26**	-1.8
69	P & T	0.8	0.68	-1.4	0.52	-1.5
70	P & T	0.81	0.55	-1.9	**0.4**	-1.7
71	P & T	0.67	0.92	-0.1	0.77	-0.2
72	P & T	0.74	1.04	0.3	1.12	0.5
73	P & T	0.7	0.89	-0.3	**0.42**	-0.9
74	P & T	0.7	1.35	1.5	1.23	0.8
75	P & T	0.71	1.33	1.6	1.24	1
76	P & T	0.67	0.83	-0.5	0.75	-0.1
77	P & T	**0.38**	**2.78**	**4.9**	**3.37**	**3.8**
78	P & T	0.71	0.83	-0.5	1.18	0.5
79	P & T	0.76	0.77	-0.9	0.64	-0.9
80	P & T	0.6	**2.08**	**4.6**	**1.99**	**3.5**

C.6 Category Probabilities: Modes - Structure Measures At Intersections For Scale 1

```
        CATEGORY PROBABILITIES: MODES - Structure measures at intersections
P      ++---------+---------+---------+---------+---------+---------++
R  1.0 +                                                             +
O      |                                                             |
B      |11                                                         33|
A      |  1111                                                 3333  |
B   .8 +      111                                           333      +
I      |         11                                       33         |
L      |           111                                 333           |
I      |              11                             33              |
T   .6 +                11                         33                +
Y      |                  1       222222222       3                  |
    .5 +                   11  222         222  33                   +
O      |                    2**               **2                    |
F   .4 +                 222   11           33   222                 +
       |               22        11       33        22               |
R      |            222            1     3            222            |
E      |         222                11*33                222         |
S   .2 +      222                   33 11                   222      +
P      |  2222                   333     111                   2222  |
O      |22                   3333           1111                   22|
N      |              3333333                   1111111              |
S   .0 +33333333333333                                 11111111111111+
E      ++---------+---------+---------+---------+---------+---------++
      -30       -20       -10         0        10        20        30
        Person [MINUS] Item MEASURE
```

C.7 Category Probabilities: Modes - Structure Measures At Intersections For Scale 2

CATEGORY PROBABILITIES: MODES - Structure measures at intersection

C.8 Category Probabilities: Modes - Structure Measures At Intersections For Scale 3

```
        CATEGORY PROBABILITIES: MODES - Structure measures at intersecti
P      ++------+------+------+------+------+------+------+------++
R  1.0 +                                                         +
O      |                                                         |
B      |111                                                   333|
A      |   111                                             333   |
B   .8 +      11                                         33      +
I      |        11                  2                  33        |
L      |          11           22222 22222           33          |
I      |            1        22           22        3            |
T   .6 +             11    22               22    33             +
Y      |               1  2                   2  3               |
    .5 +                *2                     2*                +
O      |               2 11                   33 2               |
F   .4 +             22    1                 3    22             +
       |            2       1               3       2            |
R      |          22         11           33         22          |
E      |        22             11       33             22        |
S   .2 +      22                 11   33                 22      +
P      |   222                     1*3                     222   |
O      |222                      333 111                      222|
N      |                   333333       111111                   |
S   .0 +3333333333333333333                   1111111111111111111+
E      ++------+------+------+------+------+------+------+------++
      -40    -30    -20    -10      0     10     20     30     40
        Person [MINUS] Item MEASURE
```

C.9 Rasch residuals reported as eigenvectors

Item	Res1	Res2	Res3	Res4	Res5	Target
Q1	0.14	-0.45	0.22	-0.12	-0.07	Q1 Accurate
Q2	-0.26	-0.18	-0.13	-0.06	-0.19	Q2 Trustworthy
Q3	-0.49	0.21	-0.25	-0.16	-0.12	Q3 Reliable
Q4	-0.46	0.07	-0.26	-0.2	-0.17	Q4 Safe
Q5	-0.4	0.05	-0.11	-0.17	-0.26	Q5 Reliability
Q6	-0.36	-0.05	-0.08	0.02	-0.16	Q6 Precwase
Q7	-0.33	0.21	-0.25	-0.09	0.36	Q7 Knowledge
Q8	0.01	-0.44	0.22	0.31	0.04	Q8 Honest
Q9	-0.51	0.26	-0.33	-0.11	0.06	Q9 Trusting
Q10	-0.6	0.14	-0.19	-0.22	0.26	Q10 Positive
Q11	-0.72	0.09	-0.28	-0.4	-0.01	Q11 Responsible
Q12	-0.5	0	-0.1	0.03	-0.04	Q12 Responsibly
Q13	-0.19	0.03	0	0.15	-0.1	Q13 Successful
Q14	-0.61	0.31	-0.32	-0.2	0.32	Q14 Accurately
Q15	-0.55	0.31	-0.36	-0.08	0.31	Q15 Secure
Q16	-0.63	0.07	-0.14	-0.22	-0.14	Q16 Secure
Q17	-0.28	-0.05	-0.19	-0.04	-0.25	Q17 Well_informed
Q18	-0.07	-0.31	0.1	0.37	0.11	Q18 Well_informed
Q19	-0.37	0.23	-0.04	0.15	-0.35	Q19 Gives_real_results
Q20	-0.52	0.31	-0.35	0.01	0.58	Q20 Confident
Q21	-0.61	-0.09	-0.17	-0.18	0.28	Q21 Give_correct_results
Q22	-0.47	0.24	-0.33	-0.02	0.57	Q22 Researched
Q23	0.1	-0.53	0.27	0.51	0.11	Q23 Researched
Q24	-0.28	-0.45	0.23	0.14	0.04	Q24 Researched
Q25	-0.14	-0.55	0.26	0.27	0.09	Q25 Confidence
Q26	-0.63	0.05	-0.15	-0.31	0.03	Q26 Helpful
Q27	-0.58	0.1	-0.1	-0.17	-0.13	Q27 Affect_lives
Q28	0.03	-0.6	0.24	0.08	0.13	Q28 Security
Q29	-0.68	0.11	-0.14	-0.25	-0.13	Q29 Effective
Q30	-0.65	0.25	-0.25	-0.14	0.19	Q30 Healthy
Q31	-0.39	0.12	0.06	0.11	-0.35	Q31 Reliance
Q32	-0.49	-0.07	0.02	-0.08	-0.3	Q32 Accurate
Q33	0.49	-0.23	-0.27	-0.27	0.07	Q33 Trustworthy
Q34	0.67	-0.07	-0.29	-0.16	0.13	Q34 Reliable
Q35	0.78	-0.12	-0.29	-0.04	0.14	Q35 Safe
Q36	0.26	0.09	0.02	0.12	0.13	Q36 Precise
Q37	0.64	-0.09	-0.25	-0.15	-0.03	Q37 Knowledge
Q38	0.23	-0.36	0.15	0.21	0.27	Q38 Honest
Q39	0.72	0.27	-0.32	-0.02	0.06	Q39 Trusting

Q40	0.61	0.01	-0.3	-0.27	0.08	Q40 Positive
Q41	0.76	-0.14	-0.33	-0.29	0.06	Q41 Positive
Q42	0.64	0.15	-0.33	-0.17	-0.1	Q42 Honesty
Q43	0.72	0.27	-0.32	-0.02	0.06	Q43 Responsible
Q44	0.72	0.08	-0.36	-0.08	0.04	Q44 Responsibly
Q45	0.77	0.11	-0.29	-0.05	0.02	Q45 Successful
Q46	0.14	-0.21	0.01	-0.08	-0.51	Q46 Well_informed
Q47	0.53	-0.03	-0.14	-0.06	-0.02	Q47 Gives_real_results
Q48	0.49	-0.24	-0.28	-0.27	-0.34	Q48 Confident
Q49	0.76	0.02	-0.38	-0.17	0.17	Q49 Give_correct_results
Q50	0.34	0.04	-0.11	-0.12	-0.18	Q50 Researched
Q51	0.26	-0.59	0.23	0.2	0.31	Q51 Confidence
Q52	0.66	0.01	-0.17	-0.03	0.24	Q52 Helpful
Q53	0.58	-0.1	-0.12	-0.04	0.09	Q53 Integrity
Q54	0.56	-0.02	-0.25	-0.19	-0.09	Q54 Security_in_caring
Q55	0.36	-0.15	0.25	-0.24	0.35	Q55 Affect_lives
Q56	0.14	-0.32	0.33	-0.16	0.23	Q56 Effective
Q57	0.37	-0.13	-0.24	-0.4	-0.35	Q57 Healthy
Q58	0.14	-0.07	-0.06	-0.31	-0.54	Q58 Accurate
Q59	0.38	0.36	-0.21	0.12	-0.01	Q59 Trustworthy
Q60	0.28	0.8	0.03	0.39	-0.13	Q60 Reliable
Q61	0	0.16	0.15	-0.13	-0.35	Q61 Safe
Q62	0.19	0.83	-0.01	0.42	-0.11	Q62 Knowledge
Q63	0.28	0.8	0.03	0.39	-0.13	Q63 Trusting
Q64	0.2	0.82	-0.07	0.29	-0.06	Q64 Positive
Q65	0.09	0.64	0.06	0.13	-0.16	Q65 Positive
Q66	0.13	0.5	0.58	-0.36	0.03	Q66 Responsible
Q67	0.18	0.3	0.59	-0.22	0.07	Q67 Responsibly
Q68	0.17	0.42	0.66	-0.41	-0.01	Q68 Successful
Q69	0.05	0.56	0.58	-0.43	0.18	Q69 Accurately
Q70	0.16	0.45	0.66	-0.39	0.23	Q70 Well_informed
Q71	0.43	0.29	0.51	-0.4	0.18	Q71 Gives_real_results
Q72	-0.01	0.15	-0.05	0.03	0.12	Q72 Confident
Q73	0.17	0.59	0.06	0.51	-0.07	Q73 Give_correct_results
Q74	-0.06	0.33	-0.07	0.09	0.3	Q74 Give_correct_results
Q75	0.03	0.03	-0.07	-0.12	0.01	Q75 Confidence
Q76	0.24	0.69	0.08	0.46	-0.16	Q76 Helpful
Q77	-0.02	-0.3	0.01	-0.12	-0.11	Q77 Security_in_caring

Q78	0.07	0.21	0.11	0.24	0.03	Q78 Effective
Q79	0.16	0.43	0.64	-0.5	0.19	Q79 Healthy
Q80	0.06	0.04	0.34	-0.44	-0.4	Q80 Reliance

C.10 Final Instrument

Experiences with Medical Technology

Please answer the following questions with regards to your most recent childbirth experience.

How many children do you have?

What is the date of your youngest child birth?

Did you have health insurance?
Yes No

What type of insurance did you have?

Please select the events that characterized your birth experience.

Ultrasound
Electronic fetal monitor
Cecesarean section
Amniocentesis
Induction
Lamaze
Pain relief (epidural)
other:

These questions are about your experiences with the electronic fetal monitor. Please answer them to the best of your ability. There are no right or wrong answers.