

SALVE REGINA UNIVERSITY

COMPUTER-BASED INTERVENTIONS, HEALTH BEHAVIOR CHANGE,
AND ETHICS

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DOCTOR OF PHILOSOPHY

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ABSTRACT

The relationship among technology, behavior change, and ethics is examined. The technology concerned is computer-related systems to promote and improve health behavior, in particular, computer-generated feedback reports from an expert system. Although smoking cessation, physical activity, and weight reduction are examined, the primary focus is on maintaining regular physical activity.

A review of the literature demonstrates that computer-generated interventions can be applied to health needs and have many advantages over traditional alternatives. This review also showed that many ethical dilemmas are related to computer-based interventions. At issue is whether the ethical problems of using a computer-based treatment are worth the risk, especially when alternative traditional therapies are available.

Participants' preference for computer-generated feedback delivered through the mail versus feedback via telephone from a human therapist was compared. This study examined whether this preference would affect behavior change success rates and addressed various ethical dilemmas. Subjects were asked about their compliance with the study if they did not receive the mode of intervention they preferred. The data on 263 participants showed that significantly more males than females preferred the computer-generated, personalized reports from an expert system via print. Regardless of preference, 88% of the sample felt they would remain an active participant in the study even if they received information in a manner they did not prefer. By the six-month follow-up the group receiving computer-generated reports through the mail was exercising 120.3 minutes per week versus 101.3 minutes for the telephone participants.

Although there was no statistical difference between these two groups, the results were significantly better ($p < .001$) than the control group ($n = 87$), which averaged only 46.4 minutes of exercise per week.

This dissertation has shown that computer-based interventions can be an effective, preferred, and cost-effective means of spreading healthcare information. The results of this study show that individualized feedback from an expert system, regardless of the means of delivery and participant preferences, produced significant increases in physical activity when compared to a control group. Ethical dilemmas pale in comparison to the benefits of computer-based interventions on behavior change. When compared to more traditional therapies, computer-based treatments hold much promise.

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CHAPTER 1

INTRODUCTION

The goal of the Salve Regina University Ph.D. program is to examine what it means to be human in an age of advanced technology. Consequently, this dissertation investigates the relationship among technology, behavior change, and ethics. As this dissertation demonstrates, an unintended consequence of other technology -- from cars, cell phones, television, the Internet, and numerous labor-saving devices -- is lack of physical exercise with a propensity for such diseases as obesity, heart problems, and diabetes. Many Americans are too sedentary, and it is hardly an exaggeration to say that this nation faces a health crisis. As a result, health interventions delivered in the one-on-one traditional mode are insufficient. They need to be supplemented, ironically, by advanced technology: in this case by computer-assisted health interventions that reach many people quickly and effectively. How this goal should be achieved is the subject of this dissertation. The researchable question is "What is the effect of using technology (as distinct from personal contact) on the adoption of health behaviors by members of the general public?" A related question from the realm of the humanities is "What are the ethical ramifications of this usage?" Thus, this dissertation focuses on technological health intervention and its ethical ramifications.

Throughout this dissertation the technology concerned is computer-related systems to promote and improve health behavior. Although three forms of better health care are examined -- smoking cessation, physical activity, and weight reduction -- the primary focus is on maintaining regular physical activity for better health. For comparison's sake, however, an investigation into computer-related interventions in these

areas is provided since smoking, inactivity, and excessive weight are all responsible for many thousands of preventable deaths yearly. Because new solutions are being sought for better health, computer-based interventions are increasingly focusing on these three areas. Additionally, some areas may not be as developed as others. Therefore, a study of only one of these fields alone may not garner enough information to reflect adequately the scope and type of technology that is being used. Following its general investigation of computer-assisted health measures, this dissertation focuses on technology in the form of computer-generated personalized feedback reports from an expert system. The meaning, design, and creation of an expert system and its benefits are discussed later in this chapter.

After a discussion of the personal, financial, and societal problems caused by smoking, sedentary behavior, and obesity, a review of the literature demonstrates the interesting and exciting work that has been done using computer-based technology. With the growing use of the personal computer and access to the Internet, a new area of intervention is quickly developing. In fact, the Internet, personalized computer feedback, and individually-tailored reports generated by a computer expert system are being utilized in the fields of health promotion, mental health, and rehabilitation.

In other words, research has shown that technological computer-generated and supported interventions can be applied to a variety of health needs. Interestingly, the computer-generated feedback report, which was a central focus of the research on physical activity that was completed for this dissertation, was originally developed for use by those attempting to quit smoking. Thus, success in one area of behavior change therapy such as smoking cessation may eventually mean success for those becoming

more physically active or trying to lose weight and vice versa. Just as people often try to change more than one behavior at a time, the interventions for these problems do not develop in isolation and often lend themselves to multiple applications. This relation is further discussed in Chapter Two.

The Humanities, Particularly Ethics

Certain moral considerations must be made when individuals or groups begin to depend on any technology, such as computers, to conduct therapy and deliver interventions. Thus, the humanities in general and ethics in particular are most helpful when evaluating the use and consequences of computer-based interventions. According to the 1965 National Foundation on the Arts and the Humanities Act, the humanities include but are not limited to languages, linguistics, literature, history, jurisprudence, philosophy, ethics, comparative religion, archaeology, and the arts. They also include those aspects of the social sciences that have humanistic content and employ humanistic methods. Finally, they involve “the study and application of the humanities to the human environment with particular attention to reflecting our diverse heritage, traditions, and history and to the relevance of the humanities to the current conditions of national life” (www.neh.fed.us/whoweare/overview.html).

The U.S. Commission on the Humanities, composed of the presidents of Brown, Yale, Notre Dame, the University of California, the IBM and Atomic Energy Commission chairmen, plus other reputed scholars, have written: “The natural sciences, the social sciences, and the humanities are by nature allies. ...If the interdependence of science and the humanities were more generally understood, (we) would be more likely to become masters of (our) technology and not its unthinkable servants” (1964, 2-3 cited

in Lappin and O'Connor 1998, 78). Additionally, the humanities influence the national ethic and morality, the use of our environment, and material accomplishments. In *Experiences*, Arnold Toynbee asks: "Are not the humanities, in this new guise [of sociology, anthropology, economics, and, above all, psychology], at least as stimulating a field for action as science and technology are. . .to save (man) from himself? (1963, 320-321)." Of the six humanities that are the focus of the Salve Regina University Ph.D. program ethics is clearly the one which is most relevant to this study. Therefore, Chapter Four is entirely devoted to this issue.

For the purposes of this dissertation computer-based treatments for smoking cessation, obesity reduction, and physical activity enhancement are investigated in the literature review in Chapter Two. In addition, the ethical ramifications of such computer-based interventions are discussed at the end of this chapter and at length in Chapter Four. A review of the literature revealed that, besides being cost-effective, computer-based interventions have many advantages over the traditional alternatives, such as visits to a family physician. However, this review also showed that many ethical dilemmas are related to computer-based interventions. For example, some clients feel isolated in "cyberspace" while others experience breaches of confidentiality and/or stalking. Few clinicians are prepared for these problems and other computer-based issues. As a result, additional ethical codes and standards are in the process of development. At issue is whether the ethical problems of using a computer-based treatment are worth the risk, especially when alternative traditional therapies are available.

To answer these questions one must understand the risks, benefits, and effectiveness of these traditional approaches. Thus, they are examined at length in

Chapter Three. As for computer-based interventions, even if they are found to be effective, low-cost, and convenient, do the ethical concerns outweigh their benefits? Finally, it has yet to be studied whether people actually prefer to receive interventions from a computer-generated system or from a human. Does gender or age affect preference? Would people cooperate? What would happen if they received behavior change treatment in a manner they did not prefer? Would they persevere in their treatment, or would they stop trying? Would the various treatment groups demonstrate behavior change when compared to the health/wellness control group?

It is hypothesized here that (1) more people in general would prefer human contact over computer-generated reports, (2) more women than men would prefer human contact to computer-generated reports, (3) those over age 50 would prefer to receive treatment from a human rather than from computer-generated technology, (4) computer-based interventions would produce significant behavior change even for those who do not prefer them; (5) computer-based interventions will demonstrate statistically significant behavior change when compared to the control group, and (6) computer-based interventions will elicit a variety of ethical concerns.

This dissertation seeks to address such related issues by (1) establishing the importance of helping people quit smoking, begin exercising, and lose weight; (2) reviewing the literature in order to present a comprehensive view of the computer-based and computer-generated interventions that are being used to help people change the behaviors listed above, (3) examining both alternative and traditional treatments for fostering behavior change, (4) discussing the meaning of ethics, particularly its

relationship to computer-generated therapy; and (5) presenting the results of original research on physical activity.

This study compared participants' preference for computer-generated feedback delivered through the mail versus "live" feedback via telephone from a human therapist. In fact, this study examined whether this preference would affect behavior change success rates and helped answer some of the ethical dilemmas described above. In sum, is computer-generated intervention ethical and does it work better than traditional forms of intervention, such as a doctor's advice? These results will then be incorporated into a discussion of ethics and the ethical ramifications of computer-generated contacts. Of the six humanities that are the focus of the Salve Regina University Ph.D. Program ethics is clearly the one which is most relevant to this study. Therefore, Chapter Four is entirely devoted to this issue.

To ensure that ethical standards of research were used, this study was reviewed separately by the Investigational Review Boards (IRBs) of both Salve Regina University and The Miriam Hospital. The letters of approval can be found in Appendix A. The data used in this dissertation were gathered as part of a larger study being conducted by Bess H. Marcus, Ph.D., at the Miriam Hospital's Center for Behavioral and Preventive Medicine in Providence, Rhode Island. A letter of permission from Dr. Marcus for the use of this information is found in Appendix B. The participants were aware that although the data they provided would be used for a variety of research purposes, at no time would they be identified by name. A detailed methodology is available in Chapter Five.

Smoking Cessation

Because of the reasons cited earlier, several common health problems can be treated by costly traditional means, such as a doctor's care, or by innovative, less expensive means, such as computer-generated interventions. It is important to show, however, that these health problems, if left untreated, are a major threat to the well-being of the nation. Therefore, the following sections deal briefly and separately with the issues of smoking, exercise, and obesity.

According to the Centers for Disease Control and Prevention (USDHHS 1999, 17), the rate of smoking in the general U.S. population is about 23%. Smoking prevalence is highest among people aged 18-24 (26.7%) and lowest among those aged over 65 years (10%). Currently, smoking rates are 24.9% among males and 20.6% among females. By race and ethnicity the percentages are as follow: 31.5% of American Indians/Alaskan Natives, 24% of whites, 22% of blacks, 16.5% of Hispanics, and 12.5 of Asian/Pacific Islanders are smokers (www.lungusa.org/data/smoke/SMK1.pdf). About 1.2 billion people smoke worldwide. Half will eventually die from smoking-related diseases. More than three million people will die from smoking this year. By 2020, ten million more will die (UC Berkeley Wellness Letter 2002, 8).

Tobacco use has been cited as the main avoidable cause of illness and death in our country. It is responsible for more than 400,000 deaths per year in the United States and approximately \$157 billion in annual health-related economic losses. The economic costs of smoking totaled \$3,391 per smoker each year. The negative effects of smoking were estimated using the Adult and Maternal and Child Health Smoking-Attributable

Mortality, Morbidity, and Economic Costs (SAMMEC) software, which will be discussed in Chapter Two (CDC 2002, 300).

Smoking is a known cause of cancer, heart disease, stroke, and chronic obstructive pulmonary disease (Marcus, Albrecht, King, Parisi, Pinto, Roberts, Niaura, and Abrams 1999, 1229). It has been linked to cancers of the stomach, liver, cervix, uterus, and kidney, as well as one kind of leukemia (UC Berkeley Wellness Letter 2002, 8). Cigarette smoking is also a major preventable risk factor for gum disease. A Centers for Disease Control and Prevention study found that smokers are four times more likely than nonsmokers to develop periodontitis (CDC 2001, 39).

Smoking also puts people at risk for bone density problems, facial wrinkles, and peptic ulcers. Women smokers face increased health risks related to pregnancy, birth, oral contraceptive use, and menstrual function. Lung cancer has become the leading cause of death from cancer among women – surpassing breast cancer (Hebert 2002, 21). An estimated 8.2 million people have a health problem attributable to their current or former tobacco use. The most common conditions were chronic bronchitis, emphysema, and heart attack (Hyland, Vena, Bauer, Li, Giovino, Cummings, and Mowery 2002, 379). Overall, smoking has had adverse effects on society through human loss of life and productivity as well as from the financial burden placed on the health care systems, employers, and smokers' families (Max 2001, 322).

Another Major Health Risk: Excessive Weight

To improve people's health, especially in affluent nations, the development of effective and accessible weight loss programs is important. Weight gain results when energy intake or caloric intake is greater than energy expenditure. This excess energy is

stored in the form of fat, which leads to weight gain. Obesity has reached epidemic proportions in the U.S. More than 97 million adults and 66% of the general population of Americans can be classified as overweight or obese (www.speedyrx.com/weightloss.php; Manson and Bassuk 2003, 229). Data from the Third National Health and Nutrition Survey show that the prevalence of obesity had increased by approximately eight percent from 1980 to 1994. Data from 1999 to 2000 show further increases for both men and women in all age groups. As Americans become more sedentary, it is expected that these trends will continue throughout the 21st century (Flegal, Carroll, Ogden, and Johnson 2002, 1723).

Four leading causes of death are directly related to obesity. They are cardiovascular disease, cancer, respiratory disease, and diabetes mellitus. Other health risks associated with obesity include increased risk of stroke, hypertension, arthritis, gall bladder disease, osteoporosis, osteoarthritis, gout, and reproductive disorders (www.speedyrx.com/weightloss.php). Of these conditions, diabetes is the most closely linked to obesity. Its prevalence appears to have increased as the prevalence of obesity increased (Ibid.). Obesity, which accounts for more than 280,000 deaths each year in the United States, will soon overtake smoking as the leading preventable cause of death (Manson and Bassuk 2003, 229). In 2000, the economic cost of obesity in the United States was more than \$115 billion (www.apha.org/NPHW/facts/overweight.htm).

Obesity is a health problem that appears to lessen life expectancy by as much as 13 years for overweight white males and eight years for overweight white females. Black males may lose as many as 20 years from their lives, while black females can expect to lose five years (Fontaine, Redden, Wang, Westfall, and Allison 2003, 193). Sixty-nine

percent of black women are considered obese compared to 47 percent of white women. Sixty-two percent of black men are considered obese compared to 58 percent of white men (www.apha.org/NPHW/facts/overweight.htm). Additionally, the types and amounts of foods consumed by adults can affect risk for a number of chronic diseases, including osteoporosis, colorectal cancer, and coronary heart disease.

Only 23% of Americans eat a healthy diet (Delichatsios, Friedman, Glanz, Tennstedt, Smigelski, Pinto, Kelley, and Gillman 2001, 215). The problem has been blamed on a “toxic food environment” (Murray 2001, 33). Certain “toxic signs” in our environment include the availability of inexpensive, high-fat, high-sugar foods, the attractive packaging, the clever advertising of prepackaged and fast foods, the expanding serving size seen in super-sized portions, and the decline of physical activity. Particularly vulnerable to these toxins are children (Ibid.). The prevalence of obesity among children in the United States has increased dramatically over the past 30 years. The rates for six- through eleven-year-olds increased from 4% to 11%. During this same period, the prevalence for 12- through 19-year-olds increased from 5% to 11% (Ogden, Flegal, Carroll, and Johnson 2002, 1728). Since overweight children often become overweight adults, this trend is particularly disturbing. Poor eating habits are often established during childhood. In 2001, almost 80% of school children did not consume the recommended five or more servings of fruit and vegetables per day (Ibid.).

The Importance of Physical Activity in a Technological Society

From a physical perspective, humans are healthiest when they remain active. Early humans struggled to obtain food and shelter. Later they exercised through work, transportation, and domestic activities. In the 21st century Americans have become

victims of technological success (Buchner and Miles 2002, 3). Physical activity has been systematically engineered out of our lives through advances in automobiles, entertainment, and labor saving devices. Most people no longer walk to work or even to the bus stop. Humans no longer have to walk across the room to change the television station, to deliver messages, or to answer the phone. Remote controls, e-mail, and cordless phones are technological advances that allow us to make as few movements as possible (King 2001, 207).

According to the Surgeon General, people of all ages can benefit from regular physical activity (www.fitness.gov/execsum.htm). Regular physical activity is defined as moderately intense exercise performed at least five times per week for a minimum of 30 minutes each day or vigorous physical activity at least three times a week for a minimum of 20 minutes day (The Nation's Health 2002, 29). Moderate intensity exercise can be as simple as a brisk walk (a mile in 15 to 20 minutes) done as if a person is late for an important appointment, at a rate at which you can feel your heart rate increase. According to the 2000-2001 Behavioral Risk Factor Surveillance System, 54.6% of Americans aged 18 and older were not doing enough activity to meet the recommendation for moderate physical activity at least 30 minutes per day five days per week (CDC 2003, 764). Currently, fewer than 33 percent of Americans engage in the newly recommended 60 minutes of physical activity for adults and children every day of the week (www.apha.org/NPHW/facts/overweight.htm).

Approximately 25 percent of U.S. adults do not engage in any physical activity and only about 25 percent meet the minimum recommendation. Older adults, less educated people, obese individuals, and ethnic and racial minorities tend to be the least

active (www.fitness.gov/adults.htm). Those below the poverty line, widowed adults, and Southerners were also among the least likely to be active (The Nation's Health 2002, 29). Additionally, almost half of 12- to 21-year olds do not participate in regular vigorous activity. Enrollment in physical education classes has declined among high school students from 42 percent in 1991 to 25 percent in 1995 (www.fitness.gov/execsum.htm).

This trend is particularly troubling when taking into consideration that sedentary behavior is associated with an increased risk of heart disease, high blood pressure, cancer, stroke, diabetes, and obesity. Physical inactivity is responsible for more than 300,000 deaths per year in the United States (The Nation's Health 2002, 29). Additionally, regular physical activity of at least a moderate intensity done on most days of the week lowers the risk of developing non-insulin dependent diabetes (Type II), cardiovascular disease, and some forms of cancer while reducing feelings of anxiety and depression (USDHHS 1999, 11; McGinnis 1992, S197). Moderately intense activity is also important for the prevention of hip fractures/osteoporosis, stroke, and gallstones (Feskanich, Willett, Colditz 2002, 2300). Additionally, exercise appears to offer protection against weight gain because of its effects on fat metabolism (Votruba, Atkinson, Hirvonen, and Schoeller 2002, 1757). Women who walk briskly for 30 minutes a day reduce their risk of heart disease by 35%. Men decrease their risk by 18% (*USA Today*, 13 November 2002).

Although some Americans do participate in regular physical activity, it is clear that most are not active enough. While ecological factors like extremes in temperature and rainfall make physical activity a challenge, a sedentary lifestyle is generally to blame, especially the number of hours spent watching television or using the Internet (Owen,

Leslie, Salmon, and Fotheringham 2000, 157). Computer use is another increasingly common behavior that has the potential to displace physical activity. Fotheringham, Wonnacott, and Owen found that computer use was associated with the increased likelihood of physical inactivity (2000, 273). As noted above, the result of all this inactivity is seen in the growing prevalence of obesity, chronic diseases, and conditions directly related to lack of exercise. In light of pervasive inactivity among the American population, it has become increasingly clear that interventions aimed at small groups of people delivered in face-to-face modalities must be augmented by successful interventions that reach large numbers of people. However, the promise of such programs remains to be fully realized (King 2001, 227). This dissertation attempts to address that concern. Given the association between computer use and physical inactivity, computer-mediated interventions may play a key role in disseminating exercise information, reaching those people most in need of an exercise regimen.

Technology: What, Why, How?

If society is to turn to computer-based interventions as the answer to the epidemic of disease caused by smoking, obesity, and inactivity, then it is essential to have an understanding of technology. However, it will quickly become apparent that technology has as many meanings as it does manifestations. Depending on its application to people, five types of technology have been identified (Callahan 1973, 55ff). This classification emphasizes the potential effect that various types of technology have on human life. These types are preservation, improvement, implementation, destructive, and compensatory technologies. Preservation technologies help humans to adapt to nature, survive various environments, and investigate surroundings. Furnaces and eyeglasses are

two examples. Improvement technologies enhance physical appearance or help embellish the body. Examples of these are genetic engineering, prosthetics, and cosmetic surgery.

Implementation technologies are designed to assist other technologies. These are facilitators or enhancers. For example, the computer allows us to access other information technologies such as the Web. Destructive technologies are designed to cause the obliteration of life and property. Weaponry is a prime example. Compensatory technologies have been developed to help society deal with the effects of other forms of technology. For instance, many labor-saving devices have eliminated the need for humans to physically exert themselves. As a result, exercise machines were invented to enable the body to get the physical activity that is necessary for good health (Callahan 1973, 55ff). Therefore, this dissertation examines the effects of computer feedback as an innovative form of compensatory technology.

Some theorists focus on individual or group motivation as a key factor behind technological innovation. In most cases some human need or desire, whether actual or potential, must be satisfied through the development, transformation, or fabrication of a device or a system to meet this need, a process that is called technology (McGinn Hickman 1990, 19). In this sense, technology can be defined as “the use of systematic procedures to produce intended effects” (Kipnis 1991, 62). Technology is a form of human activity that creates a tangible outcome, has a purpose, and originates in human creativity. It is resource-based, resource-expending, and part of society (McGinn Hickman 1990, 15). The goal of technology is to produce outcomes that require less work and are reliable and predictable (Schumacher 1989, 157).

Each advance in technology reduces to some extent the need for human input. New inventions make obsolete some combination of individual skills, talents, or efforts. Since human error is reduced, greater efficiency is achieved. However, this efficiency, which reduces the need for people to do things together or even be together, may contribute to feelings of isolation. Thus, technology increasingly affects how people interact, influence each other, and feel about themselves (Kipnis 1991, 69).

Additionally, technology can be viewed as a liberator, a threat, or an instrument of power, three interpretations explored by the physicist/ethicist Ian Barbour. Viewed as a liberator, technology has the potential to free humans from hunger, disease, and poverty by providing higher standards of living, more opportunities for choice, and improved communication (Barbour 1993, 4). On the other hand, seen as a threat, “technology is an autonomous and uncontrollable force that dehumanizes all that it touches” (Ibid., 12). In this sense, technology is an all-encompassing system that “imposes its pattern on every aspect of life and thought” (Ibid.). Finally, technology can be viewed simply as an instrument of power. In this sense, technologies are social constructions that are built for particular purposes and thus can never be neutral (Ibid.).

Accordingly, technology elicits various responses from humans. Technophilia is a love of technology that leads to the pursuit and application of technology to all aspects of life. Conversely, technophobia, which is the fear of technology, demands human control over it. By distrusting all large-scale technologies, technophobia strives to limit or curtail human dependence on them (McGinn 1978, 30). Each of these views about technology is heavily laden in moral and ethical considerations. Even if, as in Barbour’s analysis, technology is viewed primarily as an instrument of power, its evaluation

depends on its social consequences, whether good or bad. In this sense, technologies should be designed to provide a wide range of options to the consumer, promote interactions between humans, protect the environment, be cost-effective, and promote human development (Ibid., 32).

Fritjof Capra reminds us, however, that technology should not determine the nature of our value systems and social relations. Rather, the values of our society ought to determine the nature of technology (Capra 1982, 219). Since technology brings with it obvious risks and benefits, it can be used to decrease the negative consequences of living in a technological society and to increase the potential it holds to aid humankind. In this study, the primary goal is to see whether, how best, and to what degree technology can help achieve effective health promotion.

The Role of Technology in Health Promotion

For several reasons, including effectiveness, technology is an ideal medium for disseminating health behavior change information. The success of any population-based intervention depends on the ability to communicate to large numbers of people in a successful and cost-effective manner. Recent advances in information technologies have significantly infiltrated and partly altered society. By 1997, the information technology industry had become the largest industry in the United States in terms of sales. The percentage of U.S. households with personal computers increased from 8% in 1984 to 51% in 2000 (www.census.gov/population/pop-profile/2000/chap10). Forty-nine percent of the population uses e-mail each day (Napolitano and Marcus 2001, 125).

As for access, by 2002, more than 109 million American adults were actively using the Internet (Nielsen Media Research 2002, [www](http://www.nielsen.com)). Of 60,000 U.S. households