Promoting Physical Activity Using Technology

There is no question that technology has changed our lives. Many of these changes, from a physical activity (PA) and public health point of view, are negative: we drive to work or shop, we watch TV or sit in front of computers for many hours, we “Google,” we chat online, we communicate through “texting,” we make friends through “Facebook.” As a result of all these changes, we have lost many low-to-moderate intensity activities from our daily lives and many of us now live a sedentary lifestyle. Well-documented scientific evidence has demonstrated that a sedentary lifestyle is one of the leading causes for most of today’s health problems and chronic diseases, such as obesity, heart disease, cancer, diabetes, etc. One may wonder, since technology is one of the causes of today’s sedentary lifestyle and health problems, how can it help promote PA? As Chinese Tao philosophy says, fortunately, everything has two sides. This is true also for technology. While technology indeed has had many negative impacts on a physically active lifestyle, it has great potential to help promote PA. This article will provide a description on how technology can help promote PA. After providing a brief review on some technologies that have been used in the field of PA promotion for many years, the article will discuss several new and emerging technologies that have great potential to help promote PA on a large scale. Then, persuasive technology, the technology developed and used for attitude and behavior change, will be introduced as a framework for our future technology development and application for PA promotion. Finally, critical practical issues related to technology applications will be briefly examined and addressed.

Note that this article does not plan to include a review of all technologies that have been employed in kinesiology, e.g., computerized training and assessment devices being used in laboratory settings. Rather, the focus will be on the technology that can help promote PA and change exercise behaviors on a large scale in free-living settings. This article will not provide a comprehensive literature review on each technology and related applications, although some key research studies will be cited.

Technology and PA Promotion Applications

Technology is no stranger to PA promotion. In fact, it has been around for a long time. According to technology characteristics, most of these already-used technologies for PA promotion can be classified into three categories: electronic gauges/devices, telephone, and mass media. They are described below, respectively.

Electronic Gauges

Electronic gauges are electronic devices that monitor PA by detecting and processing either mechanical movement of the human body or through bio-electronic signals associated with movement. While most of the electronic gauges are used for measuring PA or its related produced energy expenditure (EE), they could also play an active role by providing feedback to users and motivating them to do more PA. The most popular electronic gauges include pedometers, accelerometers, and heart rate (HR) monitors.

Pedometer: The pedometer, known also as a step counter, is a device which records walking steps taken. The pedometer is the oldest and most popular device for measuring, recording and promoting PA (Bassett & Strath, 2002). It was believed that the first non-electronic pedometer was conceived by Leonardo da Vinci in the 15th century for military applications (Montoye et al., 1996). The real development and usage of pedometers to measure and promote PA started in Japan in the 1960s. In 1965, the Japan Walking Association invented the “10,000 steps/day” slogan and Yamasa, a Japanese company, produced a non-electronic pedometer called “Manpo-meter,” where “Manpo” means “10,000 steps” in Japanese (Hatano, 1993). Eventually, the device was electrified and computerized. The relationship between steps and EE was soon established and integrated into pedometers. Yamasa developed and released the first calorie-meter type of pedometer in the 1980s. Pedometers were picked up by the U.S. researchers in the late 1980s and started to become popular in PA promotion in the 1990s. Today, millions of pedometers have been sold in the U.S. alone and are used in various PA settings.

Pedometers are used mainly for measuring and monitoring steps in PA promotion. In addition, pedometers can be a motivation tool. Because walking is the most popular PA mode, walking, along with pedometers, has become one of the most popular means of PA promotion (Williams et al., 2008). According to two recent reviews, pedometer-based walking has been demonstrated to be associated with significant increases in PA and decreases in body mass index (BMI) and blood pressure (Bravata et al., 2008), and has resulted in a modest amount of weight loss (Richardson et al., 2008). Two key research
questions related to walking and PA promotion have been: (a) how many days are needed to detect a person’s usual walking behavior and (b) how many steps are needed either to maintain or improve one’s health or weight management? The questions were addressed in the recent “Walking for Health” supplement of *Medicine & Science in Sports & Exercise*. A reliable estimate of a person’s walking behavior can be completed in as little as three days although Sunday is well-known for having low step counts (Baranowski, Masse, Ragan, & Welk, 2008). For adults, <5,000 steps per day is considered “Sedentary,” 5,000-7,499 “Low active,” 7,500-9,999 “Somewhat active,” ≥10,000-12,499 “Active,” and ≥12,500 “Highly active;” and children and youths’ standards are emerging and more steps at each activity level are expected (Tudor-Locke et al., 2008). More detailed information on pedometers can be found in an excellent review by Tudor-Locke in the June 2002 issue of *Research Digest* and other PA measurement texts (LaMonte et al., 2006; Montoye et al., 1996; Welk, 2002a).

**Accelerometers.** Similar to pedometers, accelerometers are small portable electronic devices that can measure PA by recording minute-by-minute data of body acceleration and report the data as activity counts per minute. Activity counts can then be used to estimate energy expenditure (Welk, 2002b). Accelerometers are usually worn on the waist and can store data for long periods with flexible recording intervals. Differing from the pedometer, which can only measure steps taken, accelerometers can sense and record movement during a variety of activities and can provide detailed information on frequency, duration, and intensity, and patterns of these activities engaged in by a person. However, accelerometers cannot measure certain activities, such as movement involving only the upper body or water-related activities (Welk, 2002b). Accelerometers have shown acceptable validity and good reliability (Plasqui & Westerterp, 2007) and have been accepted as an accurate objective field measure for PA (Freedson & Miller, 2000). Very recently, a major effort has been made to include an accelerometer in the national surveillance system that monitors secular trends in behavioral and biological health indicators within the U.S. population. Specifically, between 2003 and 2006, the ActiGraph (ActiGraph, Fort Walton Beach, FL) accelerometer was included in the National Health and Nutrition Examination Survey (NHANES) to objectively measure and monitor PA among the U.S. population. As a result of this effort, several research reports (e.g., Matthews et al., 2008; Troiano et al., 2008) have been generated, which, for the first time, provide an estimation of physical activity participation in the U.S. based on an objective measure. Accelerometers have been reported being used in many research studies to assess various types, intensity and duration of PA. The high cost of accelerometers (about $300 per unit) is another limitation. Because of this limitation, accelerometers have been used mainly in research studies, rather than in large scale PA promotion settings.

**Heart rate monitor.** Heart rate (HR) is a physiological variable that is closely related with PA intensity. HR is the earliest field measure of PA and has been widely used to estimate EE since 1907 (Montoye et al., 1996). HR has been used to estimate EE based on the assumption of a linear relationship between HR and oxygen uptake (VO₂) (Wilmore & Haskell, 1971). HR is, however, sensitive to age, gender, temperature, humidity, fatigue, hydration, training status, and emotional stress and EE estimated by HR can be biased by these factors (Rennie et al., 2000). In addition, the HR monitor itself sometimes can be interrupted or delayed in catching each heart beat (Montoye et al., 1996). While a combination of HR and motion monitoring may overcome some of the limitations above, the need to develop individual HR-VO₂ calibration curves and instrumentation costs (about $500 per set) make this method less suitable for PA assessment in free-living settings (LaMonte et al., 2006). Nevertheless, the HR monitor has often been used in PA promotion, mainly for monitoring exercise intensities for highly active individuals (e.g., runners; Torok et al., 1995) and monitoring patients in their rehabilitation process (Adams et al., 2008). In addition, HR programs targeting school children have been created and implemented in many U.S. schools (Kirkpatrick & Birnbaum, 1997).

**Telephone**
The telephone has been used mainly for surveying PA participation of the population and for PA interventions. With a few exceptions (e.g., using ActiGraph for a subsample in the NHANES), all major national surveillance systems (e.g., Behavioral Risk Factor Surveillance System [BRFSS]) use the telephone to survey the U.S. population concerning their PA participation. The telephone thus plays a critical role in monitoring the level of the population’s PA participation. For PA interventions, the telephone played mainly a delivery role. According to a recent review (Eakin, 2007), in which 26 phone-based studies (sixteen on PA, six on dietary behavior, and four on both) were identified and reviewed; the telephone was shown as an effective way to deliver a PA and dietary intervention and led to significant behavior changes. The authors have suggested translating the telephone-based interventions to the population level. However, based on a review of literature, others (Marcus et al., 1998) noticed that the effectiveness of telephone-based interventions is only short-term. More long-term studies on telephone-based PA promotion are needed. Additional information on the mobile phone and its applications and potential are described in a later section, “New and Emerging Technology and Applications.”

**Mass Media**
Mass media refers to the communication methods that can reach large groups of people quickly and effectively. Although there are many types of mass media, the most popular, traditional media types are radio, television and print media (e.g., newspapers and magazines). The Internet and Web are rapidly eclipsing traditional mass media. Mass media that has been employed for PA promotion is usually based on a behavioral change theory (e.g., social marketing or social cognitive). According to a comprehensive review (28 studies were identified after screening more than 200 studies), Marcus et al. (1998) concluded that, although recall of mass-media messages generally was high, mass-media campaigns have very little impact on PA behavior change. There is a need for more research on how to improve media-based PA interventions, especially for socially disadvantaged groups (e.g., low income and the elderly).

**New and Emerging Technology and Applications**
The 20th century was one of the most exciting centuries for technology inventions. Among them, the birth of the computer and the Internet were the most significant developments. These technologies, along with a number of other emerging technologies (e.g., interactive technology, mobile phone/wireless technology, GPS/GIS, voice recognition, etc.), are being quickly utilized as modes for PA promotion. These technologies and related applications are described below.

**Information Technology**
Information technology (IT) refers to the study, design, development, implementation, support or management of computer-based information systems, particularly software applications and computer hardware. Among countless IT inventions and applications that have significantly changed our
persuasive technology, which will be introduced later, quickly
launched in 2004 by Mark Zuckerberg while a student at
lives in the information age, the Internet and World Wide Web are
among the most significant ones. Two major applications of the
Internet for PA promotion are information dissemination and
intervention delivery. Hundreds of thousands of websites have
been developed to provide the public PA-related information.
According to some statistics a few years ago, more than 70,000
health-related websites are available on the Internet (Pagliari &
Gregor, 2004) and more than 68 million people have been
influenced by the information. A quick Google search using
“Physical Activity,” brought up a total of 24,900,000 hits in 0.23
seconds! While the quality of some of the information provided
may be questionable, it is very easy for a user to find needed
information and make a judgment and selection accordingly. In
addition, many government agencies (e.g., Centers for Disease
Control and Prevention [CDC] and National Institutes of Health
[NIH]) have developed websites to disseminate free PA
information to the public. Two good examples of credible free
places to gain access to physical activity information are PubMed
(http://www.ncbi.nlm.nih.gov/pubmed), a health and medical
literature database, and the CDC’s PA website
(http://www.cdc.gov/nccdphp/dnpa/physical/index.htm). In fact,
CDC’s website on the “U.S. Obesity Trends”
(http://www.cdc.gov/nccdphp/dnpa/obesity/trend/maps/) was so
well-designed and informative (e.g., BMI obesity maps) that it is
often cited and presented in many PA promotions.

The development of Internet-based interventions has been
relatively slow. According to a literature review by Berg et al.
(2007), only 10 Internet-based PA intervention studies were
identified that met their inclusion criteria for study quality. The
majority of reviewed studies was tailored to the specific
characteristics of the participants and used interactive self-
monitoring and feedback tools. Although the interventions seem
more effective than a waiting list strategy, the authors called for
more research on the added value of the Internet-based
intervention, namely increased supervisor contact, tailored
information, or theoretical fidelity. Berg and others’ conclusions
were supported by two other review studies of web-based PA
studies by Vandelanotte et al. (2007) and Kroez et al. (2006),
respectively. Of the 15 web-delivered PA intervention studies
reviewed by Vandelanotte et al. (2007), eight studies reported
improvement in PA and the more contacts during the intervention,
the better the intervention outcome. However, intervention
effectiveness was short-lived and there was limited evidence of
maintenance of PA changes. Of the 10 studies (four with PA only
and six with PA and dietary behaviors) reviewed by Kroez et al.
(2006), only one was found having significant effects and one
having “mixed effects” (i.e., within one study both significant and
nonsignificant results were found for either different subgroups or
different outcome measures). More studies are needed before
introducing Internet PA intervention as a large-scale application.

Two new extended Internet functions, i.e., social networking and
self-video publishing, may give Internet-based PA promotion a
new dimension to explore. Two good examples of these functions
are Facebook (http://www.facebook.com/) and YouTube
(http://www.youtube.com/). Facebook is a social networking
website launched in 2004 by Mark Zuckerberg while a student at
Harvard University. Within a few years, the website had more
than 90 million active users around the world. Researchers in
persuasive technology, which will be introduced later, quickly
realized the potential to use this new vehicle for mass behavior
interventions. Dr. B.J. Fogg at Stanford University taught a class
recently which had students create Facebook applications. Within
10 weeks, some of those applications reached 10 million
Facebook users (Fogg, 2008). YouTube is a video-sharing website
where users can upload, view and share video clips. It was created
in 2005 by three former PayPal employees. Like Facebook,
YouTube has reached a large group of active users worldwide
within a few years. In January 2008 alone, nearly 79 million users
had made over 3 billion video views posted to YouTube (Yen,
2008). There is a vital need to figure out how to take advantage of
these new Internet opportunities to promote PA.

Interactive Technology
Interactive technology can be simply defined as any technology
with interactivity, which in fact has been a characteristic of
technology since its infancy (e.g., interactivity of the telegraph or
later the telephone). The fast growth of interactive technology has
led to the development of new interactive communication
strategies, which have a great implication for population-based PA
promotion (Marcus et al., 2000). The simplest example of
interactive technology is Dance Dance Revolution (DDR;
Lanningham-Foster et al., 2006). DDR is a video game that is
played with a floor pad as the controller (also known as the dance
platform) with multiple arrow panels in a grid formation. Playing
DDR has been proven to be good aerobic exercise. Some regular
players have reported weight loss of 10-50 pounds and one player
reported that including DDR in her day-to-day life resulted in a
loss of 90 pounds (American Diabetes Association, 2004). In
many weight loss cases, individuals became motivated to take
additional actions to lose weight, including incorporating
nutritionally sound eating habits and seeking out additional
recreational activities. School physical educators also quickly
realized that DDR can be a wonderful vehicle to promote physical
activity among the U.S. children whose obesity problem already
has become an epidemic. Efforts, in fact, had been done to
evaluate the benefits of DDR as a means for PA intervention.
Studies (e.g., Epstein et al., 2007; Lanningham-Foster et al., 2006)
showed that DDR has been effective in increasing children and
youths’ PA levels. Partnering with the West Virginia Public
Employees Insurance Agency, researchers at West Virginia
University recently developed a large-scale DDR intervention
project called “West Virginia Games for Health,” in which
children play DDR five days a week for at least 30 minutes per
day for 24 weeks. According to a recent press release by the
research team, playing DDR improved the health, attitudes and
behaviors of participating children (WVU Today, 2007).
Similarly, many schools now incorporate DDR as a part of their
physical education curriculums. Incorporating DDR into gym
classes is part of a general shift in physical education, with school
districts de-emphasizing traditional sports in favor of less
competitive activities. Based on the current trend, it is expected
more than 1,500 schools are likely to be using the game by the
end of the decade. In Norway, DDR has even been registered as
an official sport called “Machine Dance.”

The Wii (pronounced as “we”) is another good example of
interactive technology application. The Wii is a home video game
console by Nintendo (Kyoto, Japan). The name “Wii” was
selected for marketing because it can easily be remembered by
people around the world, no matter what language they speak. A
distinguishing feature of the console is its wireless controller, the
Wii Remote, which can be used as a handheld pointing device and
detect movement in three dimensions. Based on these features, a
number of games, e.g., bowling, boxing and tennis, were created.
The interactive features generated attention and interest of
millions of traditional game players and the public. It was
launched in the U.S. November 19, 2006 and 10.61 million were
sold by the end of that month (“Wii,” 2008). Earlier this year,
2008, Nintendo launched Wii Fit, an exercise game consisting of
activities using the Wii balance board peripheral. The game
includes about 40 activities including yoga, strength training,
aerobics, balance, etc. Wii Fit sold over a quarter of a million
copies in the first week of its launch. Exercise and physical
therapy communities picked up the Wii and Wii Fit right away

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and some hospitals already use them in their rehab programs; the responses to their use have been very positive (“Wii,” 2008). As expected, the true energy expenditure by doing video exercises was much lower than playing the real one (for example, Wii tennis versus really playing a match). According to Graves et al. (2007), playing Wii exercise games only increased EE about 2% when compared with playing normal “sedentary” games. Nevertheless, the authors agreed that playing exercise games will at least encourage positive behavior, especially in sedentary children. After reviewing 27 studies of 25 video games, Baranowski, Buday, Thompson, and Baranowski (2008) recently concluded that positive health-related changes can be made by playing these specifically designed video games. They called for more research on the optimal use of game-based stories, fantasy, interactivity, and behavior change technology for promoting health-related behavior changes.

Mobile/Cell Phone and Wireless Technology
Like the computer and Internet, the mobile phone is a great invention of the information age. Technically, a mobile phone functions like an extremely sophisticated radio. It is basically a wireless communication, which can trace its roots to the invention of the radio by Nikolai Tesla in the 1880s (formally presented in 1894 by a young Italian named Guglielmo Marconi). The concept of using hexagonal cells for mobile phone base stations was invented in 1947 by Bell Labs engineers at AT&T and further developed by Bell Labs (Murray Hill, New Jersey) during the 1960s. In 1970, Amos Joel of Bell Labs invented “call handoff” that allowed a mobile phone user to travel through several colloquy cells during the same conversation. Martin Cooper of Motorola (Schaumburg, Illinois) is widely considered to be the inventor of the first practical handheld mobile phone to use in a non-vehicle setting. Using a modern and somewhat heavy portable handset, Cooper made the first call on a handheld mobile phone in 1973 (for more historical aspects of the mobile phone, see: http://en.wikipedia.org/wiki/Cell_phone). Just a few years ago, the average mobile phone user was most likely to be wealthy. These days, according to the Cellular Telecommunications & Internet Association (CTIA, 2008), mobile phone users encompass all ages, races, and economic classes.

PA promotion application. Development of the mobile phone has provided researchers with a convenient method for remote collection of a variety of data. For example, subjects in the past have had to come to a research laboratory to complete training and to provide or download their data. With mobile phones, these tasks can all be done at a distance. Subject burden is greatly reduced, thus making it possible to collect large amounts of data in population-based studies. Furthermore, the reminding system developed in the calling function should greatly improve the quality of the data collected. The mobile phone is already being used in PA research for tracking/monitoring (Arsand et al., 2008) and PA intervention delivery (Hurling et al., 2007). Anderson et al. (2007) reported an effort to estimate and track daily PA by analyzing Global System for Mobile (GSM) cell signal strength and visibility of mobile phones. Some commercial mobile phones have also included pedometer chips and some other advanced features for PA tracking (e.g., for more accurate measures they allow for the calibration step count and step distance, and can save the data for up to two weeks).

Texting: Another big possibility. Another application of mobile phones is text messaging, or simply texting. Texting is the common term for the sending of “short” (160 characters or fewer) text messages from mobile phones using the Short Message Service (SMS). It is available on most mobile phones and some personal digital assistants (PDA) with on-board wireless telecommunications. Short message services are developing very rapidly throughout the world. In 2000, just 17 billion SMS messages were sent; in 2001, the number was up to 250 billion, and in 2004 there were 500 billion SMS messages sent. At an average cost of $0.10 per message, this generates revenues in excess of $50 billion for mobile phone service providers and represents close to 100 text messages for every person in the world. Compared with other countries, the appeal of SMS was more limited in the U.S. for a number of years. However, the addition of Circuit powers SMS voting on the television program “American Idol” introduced many Americans to SMS in 2002, and its usage quickly started rising. In the third quarter of 2006, for example, more than 10 billion text messages crossed Circuit’s network, up almost 15 percent from the preceding quarter. In the U.S., while texting is widely popular among 10-25 year olds, it is becoming increasingly popular among adults and businesses as well. According to both the Mobile Marketing Association and Pew Internet & American Life Project Surveys, 40% of the U.S. mobile phone users use text messaging to communicate with other people (“Text messaging,” 2008).

The potential of the mobile phone power was promptly recognized by health care professionals. According to a recent review (Adler, 2007), among the latest wireless technologies, texting will be the most convenient method in providing patient communication and support. A few texting applications in health care have also been reported, e.g., using text messaging to improve clinical and health promotion attendances (Battistotti et al., 2006) and to telemonitor mobility trends of elderly people (Scanaill et al., 2006). Although no specific PA application using texting has been reported, its potential should prove to be tremendous.

GPS and GIS
Widely available GPS and GIS technology also provides a new tool for PA promotion. GPS refers to Global Positioning System, which is a worldwide radio-navigation system formed from a constellation of 24 satellites and their ground stations. GPS uses these “man-made stars” as reference points to calculate geographic positions accurately within a few meters. With advanced forms of GPS, one can make measurements with accuracy to within a centimeter! GPS receivers have been miniaturized to contain just a few integrated circuits, making them very economical, and making the technology accessible to virtually everyone. GPS, at present, is finding its way into cars, boats, airplanes, construction equipment, movie-making gear, farm machinery, and even laptop computers. GPS will soon become almost as basic as the telephone and may become a universal utility. GIS (Geographic Information Systems) originally referred to a computerized system for asking questions of maps showing current and potential land use in Canada (Longley, Goodchild, Maguire, & Rhind, 1999). With the improvement of computing power, GIS has been applied to almost every field of study. It is now broadly defined as “a computer system for the input, storage, maintenance, management, retrieval, analysis, synthesis, and output of geographic or location-based information” (Longley et al., 1999). GIS has been widely used in public health research and information management (Cromley & McLaflerty, 2002).

The major benefit of GPS/GIS is that it can accurately track where a specific activity happened, which in turn will help provide a better understanding of the interaction between people’s PA and the surrounding environment. Using walking as an example: the pedometer, the most popular tool to track walking, can only tell us how many steps a person has taken, but it does not provide information on where, when and how the walk was completed. Neither is there other critical information on walking (e.g., which activities are combined within one chain of walking? How much do neighborhood environmental characteristics...
contribute to a person’s walking pattern? etc.). With a combination of GPS and a PA measure, the limitation of traditional direct PA measures can be eliminated. Some initial attempts (e.g., Rodriguez et al., 2005; Schutz & Herren, 2000; Terrier et al., 2000) have been reported in the application of GPS with PA measurements. Zhu (2003) further proposed a concept of physical activity space, which describes “the area or space where an individual spends time and engages in physical activity” and is measured using GPS. By integrating the information measured by GPS with GIS, the impact of environment on PA can be examined in detail. The studies based on the SMARTRAQ project (Frank et al., 2005), in which the impact of urban form and community design on PA was examined, are some good examples of GIS applications. More information on GIS and PA promotion can be found in Porter et al. (2004).

**Speech Recognition and Text Classification**

Two other technologies, namely speech recognition and text classification, have also a great potential for PA promotion. Speech recognition is the process of automatically extracting and determining linguistic information conveyed by a sound wave using computers or electronic circuits. Text classification, also known as text categorization, is used to classify pieces of text to predetermined categories based on content. Types of text could include documents, paragraphs, sentences or websites and types of categories could be determined by topic, function, author, style, etc. Using both technologies, an e-diary application was developed (Zhu et al., 2006). In the past, collecting and analyzing diary data had a high subject burden and was expensive. Yet the diary method is the only method that can provide PA participation pattern information and has been considered one of the criteria measures in PA research. The e-diary is able to collect data using a recorder, translate the recorded voice into text, and classify an activity into right categories (e.g., “I walked with a friend for 10 minutes”; “I walked the dog for 20 minutes in the park”; “I walked in the mall for 15 minutes” were some activities listed in the “walking” category) with about 87% accuracy. Many similar applications for the e-diary are expected in the coming years.

There are many other technologies that have been either applied to PA promotion (e.g., robot) or have a great potential for future PA promotion (e.g., radiofrequency identification [RFID] and nanotechnology) but it is impossible to cover all of them. Interested readers should refer to Freedson et al. (2008) and Nigg (2003) for more information.

**Persuasive Technology/Captology: A Useful Framework**

As illustrated above, PA promotion has made the effort to take advantage of technology when available. Most applications, however, have been focused on measuring and tracking PA habits whereas few were designed to hit the heart of PA promotion: change people’s PA behaviors. Fortunately, the concept of persuasive technology and Captology, which are described below, will be helpful for future technology development and application in PA promotion. Persuasion is one of the most effective tools to help change others’ attitudes or behaviors (Dillard & Pfau, 2002). Intentionality is the key for a true persuasion and not all behavior or attitude change is the result of persuasion. For example, the current sky-rocketing high price of gas has made many people give up or significantly decrease their driving, thus potentially increasing their physical activity. Gas price in this case, however, is not a persuasive event since people will likely change back to driving as soon as the price goes down. On the other hand, if the gas price or associated tax is purposely set very high by the government to encourage walking and bicycling as the major transportation mode, the high price would qualify as a persuasion event. In public health, this method (e.g., setting a high cigarette tax to discourage smoking behavior) has been employed and demonstrated effectively (U.S. Department of Health and Human Services, 2000).

Using available present-day technology to assist persuasion is almost as effective as persuasion itself (Fogg, 2003). The first major breakthrough in this relationship was the technology that allowed easier production and distribution of books, flyers, pamphlets, billboards and other forms of written and visual communication. With the introduction and advances of computers and other new technologies, persuasion based in technology is getting smarter. As a result, technology-centered persuasion is rapidly developing. Dr. B.J. Fogg (2003) of Stanford University introduced the term “persuasive technology,” which he defined as “a computing system, device, or application intentionally designed to change a person’s attitude or behavior in a predetermined way.” He further coined the term “Captology,” which he derived as a partial acronym for Computers As Persuasive Technologies (CAPT-ology), for this area of study.

Persuasive technology plays three roles in persuasion: tool (e.g., record steps in a convenient way using a pedometer), media (e.g., powerful images of obesity and diabetes trends by state and by year in the slide presentations created by CDC) and social factor (e.g., Wii boxing with another person). The applications of persuasive technology can also be easily seen in our daily life. While driving, we get instant feedback of our driving speeds from the Speed Monitoring Awareness and Radar Trailer (SMART) and reduce our speed if it is higher than the posted speed limit. A successful application of persuasive technology in health education is the Baby Think It Over Infant Simulator, which is a high-tech doll. Rather than lecturing teenagers on teenage pregnancy, teens are given the Baby Think It Over to take care of as if it was a real baby. After several days of being a “mom” or “dad” by taking care of the “baby,” the teenagers learned the challenges of being a teen parent and they are eager to return the “baby” and resume their normal lives (Out & Lafreniere, 2001). The Nike+iPod shoe is also a good example of persuasive technology related to PA promotion, as it gives instant feedback from a running performance, which is encouraged by music. With only one or two exceptions, most technology applications in PA promotion were not designed under the persuasive technology framework and their roles in changing people’s behavior are limited only to that of a “tool” (Zhu, 2007). Some very successful applications, such as DDR, were not initially designed for PA promotion. Yet, as the tool’s interactive feature caught children and youths’ interests right away, they play the game without knowing they are voluntarily doing something (e.g., exercise) that they have often refused to do. Understanding the unique persuasive features and power that the technology can bring to PA promotion is urgently needed.

While it is a very new field, persuasive technology and its related applications are growing rapidly. Three international conferences on persuasive technology have been conducted since 2006 and the interest has been extended to mobile phone- (Fogg & Eckles, 2007), texting-, and Facebook-based persuasions. The progress in these areas should bring additional application possibilities for PA promotion. Researchers in PA promotion should actively take advantage of new developments in this area and become involved in new technology and application development under the framework of persuasive technology.

**Practical Issues Related to Technology Application in PA Promotion**

Technology has great potential to help with PA promotion. Yet changing behavior, as we learned from many other means and
efforts, will never be an easy task. In addition, few studies have been conducted to examine the barriers and challenges in using technology for PA promotion. Summarized below are key factors in designing or implementing a technology-based PA intervention or promotion.

**Designing and Selecting a Technology Application**

While there are many factors one should consider when designing and selecting a technology application, the classic “KISS (Keep It Simple and Straightforward)” principle is perhaps the most important one. Basically, it states that one should keep a design simple and avoid unnecessary complexity. This is very true for technology applications. A good example in PA promotion is the pedometer. It became the most popular device in PA promotion mainly because it is simple to use. Other design factors to be considered include: (a) give users credit or reward for participation, (b) provide awareness of activity level, (c) provide social support, and (d) consider practical constraints of users’ lifestyles (Consolvo et al., 2006).

**Cost-Effectiveness**

The cost-effectiveness of PA interventions was not studied until recently (see Munro et al., 2004; Sevick et al., 2007). According to a comprehensive, systematic review (Kahn et al., 2002), two informational interventions (“point-of-decision prompts” and “community-wide campaigns”) and three behavioral and social interventions (school-based physical education, social support, and individual-adapted health behavior change) were effective. Evidence, however, is insufficient to determine the cost-effectiveness of a number of other interventions (e.g., health education). More studies are clearly needed.

**Special Populations**

Because applying technology is often associated with technical complexity and cost, which may result in additional barriers to use in disadvantaged population subgroups (e.g., lower income families, older adults, and persons with disabilities; Hagberg & Lindholm, 2005). Thus, there is often a concern when promoting PA using technology among these subgroups, i.e., the technology itself may not be designed for the groups that need it the most. While every effort should be made to address this concern, the widespread integration and usage of high-tech devices in today’s society makes the barriers relatively easy to eliminate. For persons with disabilities, technology may help circumvent traditional barriers. For example, transportation to a central location for an exercise intervention has long been perceived as a key barrier for people with disabilities. With the Internet, a personal trainer can be brought into one’s home to provide individualized, adapted training. As an example, based on the AIMFREE instrument they developed, Rimmer et al. (2004) have developed and implemented a remote Internet-based rating system to examine and evaluate an exercise facility’s disability accessibility.

**Integration**

One of the trends in today’s technology application in PA promotion is integration, which includes integration between technology and behavioral theories, and among technologies. Since technology so far only acts as a “tool,” the use of technology alone may not bring the needed intervention or promotion effect. Therefore, an existing behavior change or social marketing theory should be integrated with the technology application. Many reported applications (see King et al., 2008), in fact, have already done so. Meanwhile, one should not limit new technologies to these existing theories, rather one should be encouraged to explore other roles that technology can play (e.g., media and social actor, Fogg, 2003) and the new technology-centered theories (e.g., Captology). The second integration is to integrate multiple technologies into an application. By taking advantage of the strengths of each technology, an integrated application should be much more convenient and powerful. In fact, many attempts have been made to combine PA measurement and intervention delivery into a single application.

**Interdisciplinary Team**

Technology is so sophisticated today, experts in multiple technological domains are needed to create and develop, and implement an application into free-living population settings. On one hand, many neat applications are designed by technology specialists without taking into careful consideration the needs of the application side. As a result, these applications will likely lead to little or no impact. Thus, to be able to design and implement a useful technology application for PA promotion, an interdisciplinary team, consisting of PA researchers, technology experts, practitioners and users, is needed. How to create such a team and be able to work in a collaborative manner with such a team needs to be a part of the training of future PA researchers and community facilitators.

**Conclusion**

Technology has already changed our lives and we have used it for PA promotion for a long time. Newly developed technology and new ways of thinking concerning how to change people’s attitudes and behaviors using technology have provided us with a new and exciting opportunity to promote PA on a much larger scale. To effectively design and implement a technology-based PA promotion/intervention, factors, such as design, cost, consideration of special populations, integration of technology with behavior change theories, and working with an interdisciplinary team, should be pursued.

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