Chapter 27
Emerging Communication Systems to Curb Physical Inactivity

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The reader will gain an overview of how emerging systems can contribute to curbing physical inactivity and how critical psychological processes can shape the design of systems in this domain. By the end of this chapter, the reader should be able to do the following:

- Understand how exposure, attention, and behavior change can be influenced by information systems
- Identify how online information technologies and data transfer systems may be facilitated by the Internet or telecommunications, including Twitter, Facebook, and the use of simpler forms such as text messaging
- Identify key attributes of stand-alone electronic delivery systems (e.g., counseling websites), social networks, monitoring and tracking systems, search engines, recommender systems, and gamification systems
- Understand information processing stages from a psychological perspective
- Understand ways of characterizing information systems that are relevant to influencing physical inactivity

Physical inactivity and sedentary behavior now constitute troubling health care issues of the 21st century, and lack of physical activity has been shown to be among the top 10 leading causes of death and disability in moderate- to high-income countries (Davis et al. 2014; O'Reilly et al. 2011). Physical activity comprises movements resulting in increased energy expenditure and improved physical fitness (Pettee et al. 2012). Its absence, physical inactivity, is a significant public health risk that must be reduced to decrease coronary heart disease, breast and colon cancer, and diabetes, among many other conditions directly or indirectly linked to this risk factor (Lee et al. 2012).

Increasing physical activity can confer important benefits on 39 diseases and health conditions (Hillsdon et al. 2005). A systematic review of 29 randomized controlled trials to promote physical activity or combat inactivity showed that the interventions have a positive moderate effect in increasing physical activity (Hillsdon et al. 2005). These programs entail counseling, activity prescriptions, social support, provision of written information, and self-monitoring—all techniques that continue to be important in the current generation of behavioral interventions using emerging media and electronic systems with the same objectives.

Exposure and attention to the information are prerequisites for the influence of any intervention, including online programs and new electronic systems for curbing sedentary behavior. *Exposure* implies reading, viewing, or listening to the information, whereas *attention* involves focusing on the presented content to ensure understanding and subsequent recall. Both exposure and attention must occur for the information to be received by the audience. Exposure and attention are thus prerequisites of the behavior change sought by researchers and practitioners trying to elicit physical activity. Emerging electronic systems (e.g., websites, search engines, expert recommendation systems) have been designed to ensure that materials reach their relevant audiences, potential viewers can search for the information in a systematic fashion, and materials are presented in an interactive, engaging fashion.

The effects of emerging electronic interventions on increasing activity can be measured in terms of changes in behavioral, clinical, or biological outcomes in direct and indirect recipients of the program. *Behavior change* is the modification of the intensity and duration of a behavior performed at an earlier (arbitrary) time. Biological outcomes of import in this domain include weight loss, blood pressure, and blood glucose measures, as well as the prevention of physical conditions (e.g., cancer, diabetes). Interventions for promoting physical activity are often concerned with increasing the frequency of the behavior and moving people from inactivity to initiation. Interventions for increasing sport performance have the objective of increasing movement duration and precision.

In this chapter, we provide a perspective on emerging communication systems for addressing physical inactivity, which have important potential implications for the sedentary behavior field in terms of how exposure, attention, and behavior change can be influenced by information systems. Online information technologies are characterized by using data transfer systems facilitated by the Internet or telecommunications, including Twitter, Facebook, and the use of simpler forms such as text messaging. These technologies include, but are not limited to, stand-alone electronic delivery systems (e.g., counseling websites), social networks, monitoring and tracking systems, search engines, recommender systems, and gamification systems. We first describe the information processing stages from a psychological perspective and then characterize the information systems that are relevant to influencing physical inactivity. We discuss established contributions and, when available, system efficacy and consider future opportunities for this exciting area.

Determinants of Exposure and Attitude

The classic assumption in attitude research is that people are motivated to defend their attitudes from challenges (e.g., Festinger 1957; Hart et al. 2009; Olson and Stone 2005) and that this defense leads them to seek out and disseminate attitude-consistent information. In attitude theory (e.g., Albarracín et al. 2005; Eagly and Chaiken 1993; Zanna and Rempel 1988), the term *attitude* represents an evaluation of an entity (an issue, person, event, object, or behavior; e.g., jogging, President Obama). Selective exposure and selective dissemination both enable people to defend their attitudes, beliefs, or behaviors by restricting challenging information and ensuring the availability of consistent information. Selectivity of this type results in what is known as a *congeniality bias*, traditionally referring to exposure but here used to encompass information dissemination as well (see Hart et al. 2009).

Festinger was probably the first to formalize the notion of attitudinal selectivity (1957, 1964). His work states that people avoid information inconsistent with their attitudes and decisions to prevent the unpleasant state of arousal known as *cognitive dissonance*. The potential for learning that one is mistaken can cause dissonance and trigger a search for consistent information to reestablish the more pleasant state of cognitive consonance. In this chapter (see also Cappella et al. 2015), we also propose that cognitive dissonance can trigger *dissemination* of consistent information to avoid the presence of dissonant, threatening information in a social network.

The *congeniality principle* has often been examined with a laboratory paradigm in which participants select information from alternatives. Prior to this selection, participants make a decision (e.g., about the guilt of a defendant in a mock trial), form an attitude (e.g., toward works of art), report an existing attitude (e.g., on abortion), or report a prior behavior (e.g., whether they have smoked in the past). Afterwards, participants can select information about the same issue (e.g., abortion, smoking) from a list of options usually presented as titles or abstracts of available articles. Typically, half of these options support the participant's attitude and the other half contradict it. Selection of more articles that agree and fewer that disagree with prior attitudes or behavior indicates a congeniality bias, whereas selection of fewer agreeable articles and more disagreeable ones indicates an *uncongeniality bias*.

In one of the first studies ever investigating selective exposure (Adams 1961), mothers reported their belief that child development was predominantly influenced by genetic or environmental factors. They could choose to hear a speech supporting either point of view. Consistent with the congeniality bias, mothers overwhelmingly chose the speech that favored their view on the issue. Despite periodic challenges to the existence of attitudinal selectivity (e.g., Freedman and Sears 1965), findings from research synthesis indicate a bias favoring congenial information, even though there are important moderators of the phenomenon. Hart and colleagues' (2009) meta-analysis synthesized 67 eligible reports of selective exposure that contained 91 studies incorporating 300 statistically independent groups with around 8,000 participants. The average effect indicating a congeniality bias was

estimated at $d = 0.36$ (95% CI = 0.34, 0.39) according to fixed-effects analysis and $d = 0.38$ (95% CI = 0.32, 0.44) according to the random-effects analysis, both indicating a moderate congeniality bias.

Hart and his colleagues (2009) proposed a model of selective exposure determinants. This model can be expanded to also incorporate attitudinal selectivity in *dissemination* of information (see also Cappella et al. 2015). In this model, information choices are meant to fulfill goals to defend attitudes, beliefs, and behaviors and to accurately appraise and represent reality (Chaiken et al. 1989). Defense and accuracy motives have been popular in analyses of how people process attitude-relevant information (Chaiken et al. 1996; Eagly et al. 1999; Johnson and Eagly 1989; Prislin and Wood 2005; Wyer and Albarracín 2005). *Defense motivation* can be defined as the desire to defend one's existing attitudes, beliefs, and behaviors; *accuracy motivation* is the desire to form accurate appraisals of stimuli (Hart et al. 2009). Although previous theorists also proposed a third motive (e.g., see Lundgren and Prislin 1998), which here we term *social motivation*, the desire to form and maintain positive interpersonal relations, Hart and colleagues did not include this motive because it was not well represented in their synthesized research. This motive, however, is included in this chapter due to its role in the inherently social character of information transmission through emerging electronic systems.

Defense motivation is stronger when people who just engaged in a behavior or reported an attitude or belief receive challenging (versus supporting) information before selecting new information (Frey 1986; Hart et al. 2009). If people encounter a challenge to recently expressed attitudes, beliefs, or behaviors, their effort to diminish the cognitive conflict may increase the selection rate of congenial information (Beauvois and Joule 1996; Festinger 1964). Defense motivation is also enhanced when attitudes are linked to enduring values (e.g., on controversial issues such as euthanasia or abortion) and when people commit to the relevant attitude, belief, or past behavior (Brehm and Cohen 1962; Kiesler 1971). Researchers have operationalized commitment by directly assessing participants' loyalty (e.g., Jonas and Frey 2003) or by asking them to dedicate more or less time or effort to attitude-relevant behavior (e.g., Betsch et al. 2001) or publicly affirm or withhold their opinions (e.g., Sears and Freedman 1965). In addition, individual personality differences may affect the extent to which people are motivated to defend their views and behaviors. Closed-minded people may view challenging information as a threat, whereas open-minded people may view it with curiosity (Adorno et al. 1950; Altemeyer 1981; 1998). Furthermore, people who view themselves as incapable of resisting or counterarguing challenging information may be more motivated to proactively guard against such threats (e.g., Albarracín and Mitchell 2004). If so, the congeniality bias should be stronger for people with less confidence in their attitude, belief, or behavior (e.g., Berkowitz 1965; Brechan 2002; Brodbeck 1956; Feather 1962; Micucci 1972; Thayer 1969).

Accuracy motivation increases attention to and elaboration of attitude-relevant information and preference for valid information, regardless of its consistency with prior views (Chaiken et al. 1989, 1996; Kunda 1990). For example, people who are held accountable for their judgments about a target individual consider and integrate more of the person's characteristics and hence can predict that person's future behavior more accurately

(Tetlock and Kim 1987). Also, when accuracy motivation is higher, people who lack sufficient diagnostic evidence are less likely to form an impression of another person (Kassin and Hochreich 1977). Generally, any issue that could have foreseeable effects on future personal outcomes (i.e., high outcome relevance) is likely to increase accuracy motivation (Albarracín 2002; Eagly et al. 1999; Johnson and Eagly 1989; Kruglanski and Freund 1983; Petty and Cacioppo 1986; Tetlock and Kim 1987; but see Darke and Chaiken 2005) and thus engender unbiased exposure to both congenial and uncongenial information.

Any increase in the utility of uncongenial information also diminishes the congeniality bias by enhancing accuracy motivation. Researchers have manipulated utility by assigning participants to either debate an issue or write an essay in support of their attitudes, beliefs, or behaviors (e.g., Canon 1964; Freedman 1965). Expecting to participate in a debate enhances participants' selection of uncongenial information that may be more useful for the debate (Canon 1964). Correspondingly, the expectation of supporting one's view in an essay enhances the selection of congenial information that may facilitate constructing stronger supporting arguments (Canon 1964). In addition, people may select novel information, regardless of its position, because new information is typically of greater value than familiar information (Frey and Rosch 1984). Finally, any increase in information quality can potentially increase the probability that it will be selected. Contrary to defense motivation, accuracy motivation should direct people to the highest quality information despite the potential negative consequences for cognitive conflict. Hence, congeniality biases in selective exposure may diminish when the uncongenial information is high in quality but be accentuated when the congenial information is low in quality.

Hart and colleagues' (2009) meta-analysis thoroughly examined defense motivation as a source of the congeniality bias. In this synthesis, the congeniality bias was weaker when there was support for the attitude (rather than no challenge or no support) prior to information selection, even though the two latter conditions did not differ from each other. Also, the congeniality bias was larger when the uncongenial or congenial information available for selection was high or moderate in quality than when it was low; it was also larger for samples with high rather than moderate commitment to an attitude, belief, or earlier behavior. Last, the congeniality bias was larger when the value relevance of the issue was high rather than low, samples were high (versus moderate) in closed-mindedness, and participants were low or moderate (versus high) in confidence in the attitude, belief, or behavior.

Hart and team's meta-analysis also found support for the role of accuracy motivation in attitudinal selectivity. First, the congeniality bias was larger when the congenial information was highly useful than when there was no experimental goal, and an uncongeniality bias appeared when the congenial information was not useful. Second, the congeniality bias was weaker when the uncongenial information was high in utility than when the congenial information was low in utility or when there was no goal. Contrary to the moderating role of accuracy motivation, the congeniality bias was larger when the uncongenial information was high or moderate in quality rather than low in quality. This finding suggests that high-quality uncongenial information is threatening because defense motivation dominates decisions.

Various past perspectives have emphasized that attitudes and decisions are used to manage social relationships (Johnson and Eagly 1989; Prislin and Wood 2005; Schlenker 1980; Tetlock and Manstead 1985). Selecting information in public settings can facilitate or hinder social goals (Katz 1960; Tetlock and Manstead 1985). For example, the desire to communicate an attitude to a social group may lead to publicly selecting congenial information (e.g., Katz 1960). In contrast, the desire to appear as motivated by accuracy or openness may lead to the public selection of uncongenial information.

Defense, accuracy, and social motives are also important in information transmission or dissemination, another critical contributor to exposure. An investigation of exposure decisions made for others (Earl et al. 2009) was based on the notion that selective exposure *for others* may follow the same mechanisms as selective exposure for one's self. To the extent that selective exposure for others operates under similar principles, people may choose information guided by their own defense and accuracy motivations. For example, merely choosing congenial information to be presented to others may reduce the selector's cognitive dissonance and generate pleasant affective states. Likewise, people making the choice may feel they are disseminating accurate information, thus satisfying their own need for accuracy. More so than with decisions for the self, selective transmission is likely to be in the service of social motives like relationship maintenance, generating tendencies to meet the goals of the target person in making the selection.

Suppose people disseminate information that is expected to meet the defense motivation of the receivers of the information. This bias may be larger for people we like rather than dislike, since people are more likely to intuit the motives someone they like rather than a neutral or disliked other (Heider 1958). Examples of the probability of experiencing the motives and emotions of liked others include vicarious experiences of pain for liked others (Krebs 1975) and vicarious embarrassment and dissonance for in-group members (Miller 1987; Norton et al. 2003). Consistent with this possibility, Earl and her colleagues (2009) found that people are aware that others prefer to receive congenial to uncongenial information. Furthermore, in making dissemination decisions, selectors honor the assumed or known preferences of others both spontaneously and on command. Interestingly, this selective dissemination occurs even when no interaction with the target is expected, suggesting that the same biases may occur for anonymous Internet audiences.

The research by Earl and colleagues (2009) suggests that the motivation to maintain or enhance social relationships underlies information transmission, producing dissemination of information expected to be congenial to the recipients. However, the defense motivation for the selector and the recipient can suggest very different decisions. For example, if the recipient's attitude is opposite to the selector's attitude, the selector may choose information that meets the defense motivation of the selector or the recipient. Future research needs to establish which of these motivational forces carries the day. Perhaps the recipient's motivation drives decisions when the social motivation is higher than the selector's defense motivation, but this possibility needs to be empirically tested in the future.

Like with many other health behaviors, preaching to the choir can be a significant problem in the area of physical activity as well. As shown by Steel and colleagues (2007a), however, online tools can present significant advantages when it comes to exposure. In their

study of adults randomized to different types of programs, the Internet-mediated and Internet-only groups were more likely to have been exposed to at least 75% of the program compared to the face-to-face group. Thus, little doubt exists that emerging information technologies can ensure better exposure and relatively cost-effective capturing and retention of audiences in need of physical activity promotion.

Finally, exposure to emerging media also depends on message factors that have been reviewed elsewhere (Cappella et al. 2015), including utility, novelty, and the type and intensity of emotions evoked by the information. For instance, Thorson (2008) examined news articles providing advice on such issues as medical problems, real estate, finance, personal relationships, and jobs. Findings indicated that articles that remained on the *New York Times*' most e-mailed list were longer, supposedly containing more information (see also Berger and Milkman 2012). Novel content is also more likely to be transmitted than well-known content. Likewise, studies of *New York Times* news articles have shown that surprising articles are more frequently shared than unsurprising ones (Berger and Milkman 2012; Thorson 2008), and individual retransmission of information has been shown to correlate with evaluation of the information as novel (Kim et al. 2013). Further, positive emotionality and emotional intensity both seem to correlate with virality (Berger and Milkman 2012; Carter et al. 2011; Eckler and Bolls 2011).

Determinants of Attitude and Behavior Change

Whether online information and emerging systems influence physical activity depends on the persuasiveness of the information and the degree to which that information is tightly linked to the behaviors being targeted. Like exposure, the persuasiveness of the information depends on defense, accuracy, and social motives, such that information that agrees with the recipients' values is perceived as strong, factually accurate information and data are perceived as strong, and information aligned with social norms is perceived as compelling (see e.g., Hart et al. 2009). However, the ultimate behavioral influence of the information depends on the linkage of the information with the recommended behavior. For example, one may change the perception that exercise helps people to relax, but this belief will be inconsequential for those who do not care about relaxing. Or a message may state that exercise is enjoyable, but such a belief will have no effect in people who fail to exercise because it is difficult or they lack structural opportunities to do so. Therefore, efficacious information connects with the determinants of the behavior.

Considerable past research and theorizing support the point that the ultimate effect of the information depends on its potential to influence immediate determinants of behavior. Several theoretical models have identified motivational and cognitive antecedents of health behaviors (lettered *a* through *e*), including physical activity (see Albarracin et al. 2005). For example, the theory of reasoned action (Fishbein and Ajzen 1975) and the theory of planned behavior (Ajzen and Madden 1986; for a meta-analysis, see Albarracín et al. 2001) state that health behaviors stem from *(a)* the perceived desirability of the behavior (i.e., positive attitudes and expectancies about physical activity) and *(b)* the normative pressure to engage in the behavior (i.e., social norms). The theory of planned behavior also includes *(c)*

perceptions that physical activity is easy and up to the individual (i.e., perceived behavioral control). Social cognitive theory (Bandura 1986, 1989, 1994) assumes that feeling capable of performing a behavior is central to implementing that behavior, implying that feeling efficacious in the area of physical activity should increase compliance with exercise recommendations. Furthermore, social cognitive theory (Bandura 1989) and the information-motivation-behavioral skills model (Fisher and Fisher 1992) both state that people are more likely to perform a behavior once they acquire relevant *(d)* knowledge and *(e)* behavioral skills.

Although other determinants of health behavior have been proposed (see e.g., Janz and Becker 1984; Floyd et al. 2000; Rogers 1975; Rosenstock 1974; Rosenstock et al. 1994; for a review, see Albarracin et al. 2005), attitudes, norms, self-efficacy, and behavioral skills appear to be the strongest, most consistent pathways leading to intentions and actual behavior. Evidence also exists that interventions containing components for inducing change in these determinants are more efficacious than programs lacking these elements. For example, a health-promotion intervention may attempt to motivate recipients by increasing favorable attitudes and norms. Further, a persuasive communication may not only tout the benefits of the advocated behavior (i.e., attitudinal arguments) or mention groups that support it (i.e., normative arguments), but also describe how success in meeting health goals depends on preparatory actions (i.e., behavioral skills arguments), such as scheduling physical activity in advance. As another example, a widely accepted strategy is to have people role-play skills, including resistance to the behavior by people close to them (i.e., behavioral skills training). Presumably, behavioral practice and instructional feedback facilitate the acquisition of key behavioral skills.

The effect of different intervention strategies has been most intensely investigated in a meta-analysis of the effects of HIV-prevention interventions. As part of this project (Albarracín et al. 2005), more than 350 interventions and around 100 control groups were selected comprising a large number of countries, U.S. states, and years. For each of these groups or conditions, the researchers calculated amount of change in behavior (e.g., increases in condom use frequency) as well as change in various psychological variables as a function of intervention strategies consistent with the theories outlined previously. Messages that mentioned outcomes of the target behavior were coded as including attitudinal messages. Messages that mentioned who in the recipient's network might support the behavior were coded as including normative arguments. Messages that mentioned how recipients may feel more in control of the behavior were classified as including control arguments. Programs with active behavioral skills training were coded as such.

One important conclusion from the meta-analysis by Albarracín and colleagues (2005) was that the inclusion of attitudinal, normative, and control arguments was beneficial, but interventions that included behavioral-skills training had the greatest effect. Furthermore, the benefits of each type of strategy also depended on the degree of control people had over the behavior. Consistent with the possibility that women had less control over condom use than did men, the effect of self-management skills training was stronger for women than for men. Similarly, populations with lower education, ethnic minorities, and younger

populations benefitted more from behavioral skills training than did their more educated, older counterparts. Presumably, the lack of resources associated with lower education, ethnic minority status, and younger age created a greater need for behavioral skills to offset obstacles and facilitate compliance with the behavioral recommendation.

Systematic reviews of the efficacy of face-to-face interventions for increasing physical activity suggest that information provision and social support can be effective, but many interventions are dismal failures (Kahn et al. 2002; O'Reilly et al. 2011). A recent meta-analysis reported a positive effect of online interventions (Davies et al. 2014), which suggests the need to continue to invest in the use of technology for reducing physical inactivity. Several online programs have been designed to influence physical activity using the same theoretical constructs that have proved advantageous in other health-promotion domains. For example, a study by Marshall and associates (2003) revealed that a stage-based physical activity website significantly decreased sitting time and increased motivational readiness for physical activity. Steele and colleagues (2007b), however, conducted a randomized trial comparing intervention delivery modes for a 12-week physical activity intervention based on social cognitive theory (Health-eSteps). Results indicated no differences between intervention groups and no increases in activity over time for any group. However, a later study by the same authors (2007a) showed that ensuring exposure led to significant increases in physical activity. Overall, though, there is sufficient interest in making emerging technologies successful in this domain and a need to systematically review the characteristics and efficacy of emerging systems, as we do presently.

Information Systems

The Internet era arrived with the intent to use websites to deliver informational and counseling interventions in all domains, including the promotion of physical activity. Various platforms associated with social networks (e.g., Twitter, Facebook, blogs) allow for delivery of information and social normative influences that can affect physical activity and other health behaviors. Many monitoring and tracking systems have been designed to provide accurate feedback and reinforcement of physical activity and often involve social networks to strengthen social monitoring and normative pressures. Gamification can be used with social networking and monitoring purposes and search engines enable active, deliberate information seeking. Finally, both search engines and expert recommendation systems influence information exposure through two modes: *push* and *pull*. In the push mode, the information is pushed to a user by a system (e.g., the advertisement displayed by a search engine, or recommendation of movies), whereas in the pull mode, the user takes initiative to seek the relevant information (e.g., seeking relevant information types in a query in a search engine or browsing a collection of items). In general, in the pull mode, a user has a clear information need and thus can be assumed to pay more attention to the information than in the push mode, in which the user can easily choose to ignore the recommended information. Sometimes, however, the boundaries between push and pull are not that clear. For example, a search engine can manipulate the search results to embed

recommended information directly in the search results. Such an *implicit* recommendation in response to an information need likely enables effective influences on the user, perhaps even stronger influences than those obtained through direct push-type recommendations. Internet users tend to be unaware of the inevitable bias in the results returned by a search engine, which suggests the possibility to leverage search engines to intentionally tailor content to correct people's sedentary behavior. Table 27.1 describes how each system relates to the stages of exposure, attention, and behavior change. We review details of the systems and available efficacy data in the upcoming sections.

Table 27.1 Electronic Information Systems and Likelihood of Influence at the Stages of Exposure, Attention, and Behavior Change

Psychological stage	Exposure to information and messages and materials	Attention to information and messages and materials	Behavior change
<tch2>Information delivery systems	Can make information accessible, particularly if presented in ways that highlight congeniality with prior attitudes and behaviors.	Can increase attention if the material is novel and emotionally interesting.	The evidence is mixed. Can occur but depends entirely on the design of the materials.
Social networks	Can make information accessible, particularly if presented in ways that highlight congeniality with prior attitudes and behaviors. Can leverage the social network to ensure information relevance.	Can increase attention if the material is novel and emotionally interesting.	Has not been tested for all platforms. Available evidence for Facebook is mixed.
Monitoring and tracking tools	Not applicable	Not applicable	Evidence is mixed. Depends entirely on the design of the materials.
Search engines	Excellent tool for making information available. Biases are prioritizing positive responses to	Can increase attention if the material is novel and emotionally interesting.	Can probably occur but depends entirely on the design of the materials.

	questions, clicks from other users, and negative health outcomes.		
Recommender systems: *implicit or embedded*	Excellent tool for tailoring information exposure to user.	Can increase attention if the material is novel and emotionally interesting.	Can probably occur but depends on the materials.
Recommender systems: *explicit, standalone*	Excellent tool for tailoring information exposure to user.	Can increase attention if the material is novel and emotionally interesting. Depends on user's trust in the system. It can increase reactance because it is obvious.	Can probably occur but depends on the materials and trust in the system. System can increase reactance because it is obvious.
Gamification systems	Can make information accessible, particularly if presented in ways that highlight congeniality with prior attitudes and behaviors.	Can increase attention if the material is novel and emotionally interesting.	Depends on the materials. Systems often present simple information but could evolve to include more complex programs. Ideal for training skills if designed with a strong behavioral science basis.

Websites as Information Delivery Systems

Since the advent of the Internet, there has been exponential growth in the use of websites to deliver interventions previously delivered in person or on the phone. The main rational is that online information is accessible irrespective of location, and offers the possibility of greater engagement and tailoring relative to a print presentation (see table 27.1). A large number of empirical studies have tested the efficacy of these programs in the domain of physical activity, and the resulting evidence shows that many programs are effective but many are not. Our literature review identified 16 studies showing at least some improvements in physical activity as a result of an Internet-delivered intervention. Spittaels and others (2007) examined the efficacy of an Internet-delivered physical activity intervention that provides computer-tailored feedback to a general population sample. The researchers compared recipients of Internet-based interventions with or without repeated feedback (two intervention groups) with a no-intervention control group. Results revealed significant increases favoring the intervention group for active transportation and leisure-

time physical activity and a decrease for minutes sitting on weekdays, with no significant differences resulting from feedback provision. Irvine and colleagues (2013) evaluated the efficacy of a 12-week Internet intervention for helping sedentary older adults over 55 years of age adopt and maintain an exercise regimen. At post test, intervention participants showed significant improvements in 13 of 14 outcome measures compared to the control group. Glasgow and others (2010) conducted a randomized trial to evaluate minimal and moderate contact versions of an Internet-based diabetes self-management program compared to an enhanced-usual-care condition. The Internet-based intervention produced significantly greater physical activity improvements than the enhanced usual care condition, but the improvements were independent of intervention dosage. Gow and colleagues (2010) evaluated an Internet intervention with first-year college students randomly assigned to one of four treatment conditions: no treatment, 6-week online intervention, 60-week weight and caloric feedback only (through e-mail), and 6-week combined feedback and online intervention. Following the intervention administration, the combined intervention group had lower BMI at post-testing than the other three groups. Carr, both individually (2009) and with colleagues (2008), sought to determine whether the Active Living Every Day Internet-delivered physical activity program was effective (intervention versus delayed intervention control) and found that the intervention increased physical activity. Similarly, promising results were reported in other studies (De Bourdeaudhuij et al. 2010; Carr el al. 2013; Dunton et al. 2008; Huang et al. 2009; Lau et al. 2012; Liebreich et al. 2009; Mailey et al. 2010; Napolitano et al. 2003; Winett et al. 2007; Schwinn et al. 2014; Van Wier et al. 2011), suggesting that online interventions can be efficacious at inducing physical activity.

In addition to the successful studies suggesting the efficacy of Internet-delivered programs, we also identified 12 showing null effects and 3 reversals for which the intervention decreased physical activity. For example, Cullen and colleagues (2013) tested the influence of a website promoting nutrition and physical activity for adolescents. Over 8 weeks, participants were asked to weekly log on to either an intervention or a control condition website to review web content and set goals to improve dietary and physical activity behaviors. At a post test occurring after 8 weeks, a greater proportion of intervention-group participants reported eating three or more daily vegetable servings in the past week compared to the control group. Although both groups reported significant increases in physical activity and significant decreases in TV watching, there were no differences across conditions (for similar results, see Bosak 2007; Cooperberg 2014; Kosma et al. 2005; Leung 2011; Morgan et al. 2009; Maher et al. 2010; Pekmezi et al. 2010; Skår et al. 2011; Van Genugten et al. 2012; Webber et al. 2008; Whittemore et al. 2013). Studies showing boomerang effects of online physical activity interventions are rarer but not inexistent. For example, Marks and colleagues (2006) compared the effectiveness of a web-based physical activity intervention with identical content delivered in a printed workbook among a sample of adolescent girls. Both groups had significant changes in physical activity self-efficacy and intentions, but the print group demonstrated greater increases in intentions and self-reported activity than the Internet group. Thus, online programs offer promise but must be carefully pretested; they are as good as the materials they present (see table 27.1).

Social Networks as Information Delivery Systems

Because social networks have great capacity to diffuse innovations, it is not surprising that online communities have been touted as a sort of magic bullet for the promotion of all kinds of health behaviors, including physical activity. Networks can effectively disseminate information by tapping interpersonal connections; they are also a repository of information (see table 27.1). In this section, we review these platforms and their potential, which is clearly vast if the associated programs can ensure attention and behavior change efficacy.

Twitter

Twitter is a platform that allows for rapid dissemination of information in a network. Born in 2006, Twitter now has more than 200 million active users who post more than 300 million tweets per day. Not surprisingly, as with any emerging media that acquires popularity, people use it to find and spread information and to network with others. The delivery of short and frequent messages and the easy and casual access to information that does not require approval or ad hoc mutual connections have made Twitter an effective and powerful platform for delivering health information and promoting public health awareness and positive behavior change. By following existing social networks (e.g., friends, colocated users), health providers (Chretien, Azar, and Kind 2011), and government users such as state health departments (e.g., CDC) (Neiger et al. 2012), Twitter users may receive a wide range of health-related information on various topics such as promoting dental health (Heavilin et al. 2011), improving sleeping habits (Jamison-Powell et al. 2012), smoking cessation (Prochaska et al. 2012), managing diabetes and cancer (De la Torre-Díez et al. 2012), and treating concussions (Sullivan et al. 2012). Twitter has also been shown to be useful for patients with chronic diseases, who seek advice, discuss treatment options, and find support and role models that would otherwise be unavailable (Jamison-Powell et al. 2012; Sullivan et al. 2012). For instance, researchers have examined the discussion of antibiotics on Twitter and found that the relevant conversations cover a wide range of topics related to the treatment such as general use, advice, as well as side effects and misuse (Scanfeld et al. 2010). Moreover, Twitter-based interventions (e.g., from the CDC) directly target behavior change by delivering information or reminders through Twitter updates. Twitter can thus increase exposure to very brief messages or links to more complex programs through websites. The ultimate attention and exposure depend on the content of the disseminated materials (see table 27.1).

Facebook

Facebook is currently the most popular form of online social media. It allows users, groups, and organizations to create their own web pages, publish various content (e.g., texts, external links, images, video), and connect with each other by either adding someone as a friend (mutual connection) or following another user (one-sided connection). Facebook was founded in 2004 and currently has more than 1 billion active users.

Unlike Twitter, Facebook is based on users' existing ties, such as family members and friends. As a result, social motivations play a prominent role in users' information sharing

and seeking. For example, research has shown that Facebook is often used to update others about one's health goals and progress toward goals, increasing personal accountability as well as seeking and providing emotional support. These characteristics make Facebook ideal for maintaining behavior change and inducing self- and social monitoring, although the public nature of information sharing may lead to greater reporting of successes than failures (see e.g., Newman et al. 2011). Facebook, however, is less frequently used to seek information advice compared to presently discussed social media surrounding specific health issues (e.g., a health forum; Skeels et al. 2010; Newman et al. 2011).

Up to now, however, the effects of Facebook-based programs are mixed at best. On the one hand, there is a comparison between a 12-week Facebook-based intervention aimed at increasing moderate- to vigorous-intensity physical activity (MVPA) and a Facebook-based self-help comparison condition. Over 12 weeks, both groups increased self-reported weekly minutes of MVPA, but there was no significant difference between groups. However, increases in light physical activity were greater relative to the control group, and the experimental group reported significant weight loss over time (Valle et al. 2012). On the other hand, a test of the efficacy and feasibility of a social support intervention primarily delivered through Facebook revealed no differences in physical activity outcomes across groups (Cavallo 2013).

Specialized Online Health Communities

Online health communities are made up of groups formed around common health interests or concerns. They offer the benefits of asynchronous communication and thus wide temporal access to the information, anonymity, and ample accessibility regardless of isolation and mobility (White and Dorman 2001; Farnham et al. 2002; Hwang et al. 2010). For example, PatientsLikeMe is an online social platform that can automatically identify and suggest connections with others sharing similar concerns or background information (for its effects, see Wicks et al. 2010).

Content analysis of online health communities has shown them to be important sources of informational support and emotional support (Fogel et al. 2002; Rodgers and Chen 2005; Mo and Coulson 2008; Ziebland and Wyke 2012). Users can exchange information about the course of diseases, treatments, side effects, communication with physicians, financial and other burdens, and treatment outcomes (Rodgers and Chen 2005; Coulson 2005). Users can also obtain emotional support, including encouragement and compassion from other members, a greater sense of community, reduced feelings of isolation, as well as improved self-confidence (Salem et al. 1997; Preece 1998; White and Dorman 2001; Klemm et al. 2003). A longitudinal content analysis on a breast cancer online community revealed a positive shift in patients' affect toward the disease and treatments, as well as improved psychosocial outcomes (Blanchard et al. 1995; Rodgers and Chen 2005).

Online health communities also provide first-person accounts from people with similar experiences or with more experience dealing with particular health issues. The communities can satisfy patients' information needs, especially for people with low health literacy and the desire to learn from others who have actual experience in an area (Hibbard and Peters 2003). From an informational perspective, peer patients' accounts of disease and treatment

may make the information more relevant (Sillence et al. 2007), facilitate comprehension (Hibbard and Peters 2003), and provide contexts to support reasoning about disease causes and outcomes (Rothman and Kiviniemi 1999). Sharing and learning about personal experience in online health communities can also contribute to behavior change (Ziebland and Wyke 2012). Online social groups that aim at facilitating behavior change, such as those focusing on weight loss, smoking cessation, and chronic disease management, can increase confidence and self-efficacy (Anderson-Bill et al. 2011), provide social support for making changes, increase social pressure and competition to promote adherence (Hwang et al. 2010), and enhance attention to and comprehension of information (Ziebland and Wyke 2012).

The effects of a specialized online community were examined in a study of an Internet-mediated program to promote physical activity (Richardson et al. 2010). The study compared an Internet-mediated walking program (participants could post and read messages from other participants) with no online community. Both arms significantly increased their average daily steps between the baseline and the post test, but there were no significant differences in increase in step counts between the two arms. Online health community interventions, however, are in their infancy, and their contents and methods must be refined before solid efficacy conclusions can be reached (see table 27.1).

Blogs and Vlogs

Blogs and vlogs (video blogs) are sites typically created and maintained by an individual, or a group of people, who posts original entries presented in reverse chronological order. These posts are read by users who can make online comments. These days, many patients, health professionals, health issue activists, and organizations use blogs to record experiences, express views, and promote public health awareness. Compared to online health communities, blogs provide more author control over the information, and are easy to set up, but they often require a high level of commitment to regular posting and response monitoring. Blogs and vlogs also help to disseminate information by sharing external links to website repositories, linking to and citing from other blogs, and encouraging communication between authors and audiences (e.g., by commenting on the posts).

Blogs provide many informational and social benefits for health promotion and management. For example, by surveying bloggers who write about chronic pain and illness, Ressler and colleagues (2012) found that by providing opportunities to articulate illness narratives, blogs increased connection with others, decreased isolation, promoted social accountability, and created opportunities to help others and gain new insights. For example, cancer patients (Chung and Kim 2008) use blogs for emotion management, information sharing, and problem-solving on issues such as seeking alternative care options. Recently, video blogging has become popular. Patients with chronic illnesses, such as HIV, diabetes, and cancer, vlog to create rich and strong connections with viewers, engage in a form of self-therapy, and seek and provide social support (Liu et al. 2013; see also Hoff et al. 2008).

Computer-Mediated Communication Tools

The wide adoption and frequent, often daily, use of computer-mediated communication tools, such as e-mail, texting, and instant messaging, make them convenient and useful for delivering health-related information. For instance, by sending regular messages to consented or subscribed users, e-mail-based interventions have been shown to be effective in promoting physical activities and healthy diets (Franklin et al. 2006). Patients widely use computer-mediated communication to communicate with providers, family members, friends, and other patients. By offering fewer communication barriers and greater flexibility, computer-mediated communication can lead to higher satisfaction with communication, more sharing of psychosocial content, and better health outcomes than traditional communication channels such as the telephone (Lin et al. 2005). Disease-specific mailing lists are an important tool for patients with chronic diseases such as cancer or rare diseases such as primary biliary cirrhosis (Lasker et al. 2005). Patients can seek advice on treatment-related issues, receive validation and support from peers, learn about the experiences of others, receive suggestions on how to communicate with health care providers, obtain information for problem management, and learn to cope with disease recurrence. All computer-mediated communication is helpful for patients with limited mobility, communication difficulties, chronic diseases, and mental health problems (see e.g., Burke et al. 2010).

However, evidence is mixed about the efficacy of using computer-mediated technologies such as e-mail for the promotion of physical activity. For example, Wadsworth (2006) evaluated the efficacy of an e-mail intervention based on social cognitive theory to increase physical activity in college women. In this study, the intervention group received e-mails every week for 6 weeks and then every other week until 22 weeks. They also received access to an e-counselor and a Blackboard account. Meanwhile, the control group received paper information on starting an exercise program and information from their baseline physical activity measurements. Results indicated that the intervention increased behavioral skills and days of self-reported moderate physical activity at 6 weeks, but no difference for vigorous physical activity and no effects were found at 22 weeks. Similarly, a web-based physical activity intervention showed some effects at 6 weeks but no effects at 13 months (Wanner et al. 2009). Other programs have had similarly disappointing results (Kelders et al. 2011; Spittaels et al. 2007).

Other studies, however, show greater promise. Oenema and colleagues (2008) evaluated the short-term efficacy of an Internet-delivered, computer-tailored lifestyle intervention targeting saturated fat intake, physical activity, and smoking cessation, compared with a wait-list control. This intervention resulted in significantly lower self-reported saturated fat intake and a higher likelihood of meeting the physical activity guidelines among the respondents who were insufficiently active at baseline. Likewise, an evaluation of a 12-week intervention for sedentary patients recovering from breast cancer performed by Hatchett (2009) showed that receiving e-mails and being e-counseled increased days of self-reported moderate physical activity at 12 weeks and days of self-reported vigorous physical activity at 6 and 12 weeks. This intervention was based on social cognitive theory,

suggesting that the content of the associated materials is key to behavior change (see table 27.1).

Electronic Monitoring and Tracking Systems

Many technologies have been developed to measure and track physical activity, weight loss (Purpura et al. 2011), sleep (Kim et al. 2008), biometric data, disease management, and mental health (Bardram et al. 2012; Matthews et al. 2008). Computer-based monitoring and tracking tools often focus on improving self-management and adherence by providing timely feedback through enhanced records presentation and summarization. For example, visualization technology is often used to make the results easy to comprehend but sometimes also serves to motivate users through nudges such as progress made, goals, and social comparison. For example, *UbiFit Garden* (Consolvo et al. 2006) used a garden metaphor to help users visualize activity and complete goals. *Breakaway* (Jafarinaimi et al. 2005) used an ambient display on a computer screen—a sculpture slumping over time—responsive to deficits in physical activity.

Social sharing, typically in the form of light-hearted comments, accompanies many of the tracking and monitoring applications in the market. In many monitoring applications, users can choose to broadcast to their social network by reporting progress, initiating discussion, and seeking social support. For example, *BuddyClock* (Kim et al. 2008) tracked users' sleeping status and enabled users to share data with others with the objective of increasing health awareness and motivate healthy behavior. MAHI (Mobile Access to Health Information) was a mobile monitoring application that tracked food intake and also served as a social platform for users to share and discuss information with peers (Mamykina et al. 2008). Research has found that sharing such information promotes awareness and can increase motivation, adherence to plans, and reflection about health behavior (Maitland et al. 2006). Social sharing of tracked results may also provide incentives in the form of social support, feedback, positive reinforcement, and social pressure.

The degree to which monitoring systems have demonstrated effects on the promotion of physical activity seems less clear, however. On the positive side, Lubans and colleagues (2009) evaluated the effect of a school-based intervention incorporating pedometers and e-mail support on physical activity in adolescents and found that the intervention group increased step counts more than the control group. In contrast to this success, however, failures abound. For instance, Slootmaker and others (2009) evaluated the feasibility and efficacy of a 3-month intervention in which Dutch office workers were provided with a personal activity monitor coupled to simple and concise web-based advice on physical activity. After 3 months, there were no significant effects on sedentary behavior or any physical activity outcome. Likewise, Cavallo (2013) tested the efficacy of a physical activity intervention that combined education, physical activity monitoring, and online social networking (Facebook) to increase social support for physical activity compared to an education-only control. Although participants experienced increases in social support and reported increased physical activity over time, no differences were noted across monitoring and control conditions. In a third illustrative failure, Robroek and colleagues (2012) evaluated the cost-effectiveness of a long-term workplace program promoting

physical activity. The intervention included online action-oriented feedback, self-monitoring, a forum to ask questions, and monthly e-mail messages, but did not differ from the standard program (physical health check with face-to-face advice and personal feedback on a website). Overall though, a meta-analysis of pedometer interventions (Kang et al. 2009) showed moderate increases in activity as a result of electronic monitoring. Therefore, more sophisticated tracking systems that can be built in with other components offer promise.

Search Engines

The most influential information systems are various search engines, notably web search engines like Google and Bing, which are used routinely by many people in the world every day. A major Internet search engine like Google processes more than 1 million queries daily and delivers content that can have significant influences on users and their health. According to a recent survey by the Pew Internet and American Life Project (Fox and Duggan 2013), 59% of U.S. adults have looked for health information online in the past year, primarily using search engines such as Google, Bing, and Yahoo. Moreover, a survey of health-information-seeking practices (Sillence et al. 2006) found that more than 73% of respondents used the World Wide Web for health advice, support, or preparation for a medical appointment. Moreover, online contents influence people's decisions regarding whether to visit their general practitioner or a medical specialist (Baker et al. 2003; White and Horvitz 2009a; 2013).

A recent study involving a combination of web search log analysis and user studies showed that web searchers exhibit their own biases and are also subject to biases introduced by the search engine (White 2013). White studied search-related biases through multiple probes in the health domain, including an exploratory retrospective survey, human labeling of the captions results returned by a web search engine, and a large-scale log analysis of search behavior on that engine. Results revealed that users of web search engines tend to seek evidence to confirm a belief that they already held before searching, a clear form of congeniality bias (see Cappella et al. 2015; Hart et al. 2009; see table 27.1). Furthermore, most seekers of health information are searching for answers to questions, but search engines strongly favor a particular, usually affirmative, response irrespective of the truth. This bias is introduced when searchers click through on links that confirm information when they ask a question, a practice that induces propagation of both the positional bias (i.e., users tend to click on highly ranked results regardless of whether they are really relevant; Joachims et al. 2005; Pan et al. 2007) and the tendency to seek information that agrees with the initial belief that guided the question (another form of the congeniality bias).

\qqBegin special element

Cyberchondria

Another bias introduced by search engines favors emotionally negative, anxiety-provoking information. Specifically, people are often overly concerned with serious diseases and thus click on fear-inducing items, leading to that information being featured more prominently online than in traditional media (White and Horvitz 2009b). The bias in search engine results in the medical domain leads to a phenomenon referred to as *cyberchondria*, the unfounded escalation of concerns about common symptomatology based on the review of search results and literature online. This bias further shows the great potential of a web search engine to influence users and, in particular, to influence people's sedentary behavior in a positive way. Search engines outside the Web operate in a similar way and also hold the potential to be leveraged to promote physical activity. The degree to which they can ignite behavior change, however, ultimately depends on the information and programs users find (see table 27.1).

\qqEnd special element

Recommender Systems

Recommender systems (Ricci et al. 2011) can take different forms, including stand-alone platforms that e-mail recommendations to users and embedded systems (e.g., the advertising components in a web search engine) that push information through a search engine (i.e., contextual advertising; Broder et al. 2007). Regardless of its specific form, a recommender system generally attempts to infer a user's interests or information needs, matches users' interests with a set of recommendations, and chooses and delivers well-matched items. Relevant to the theme of this book is the recommendation of such products as exercise equipment or health information to promote physical activity. Recommender systems can also be used to suggest interventions and online materials that have the potential to change the user's physical activity patterns (see table 27.1).

In contrast to a search engine that responds to a user's request, a recommender system simply imposes the information on a user. As a result, in general terms, exposure to the recommended information may not be as effective as exposure when the user has taken the initiative to seek relevant information. However, if relevant and interesting to a user, a recommended item might be particularly influential because the information may not be what the user expected to find or even knew existed. A key technology barrier for recommender systems is ensuring that the recommended information is sufficiently interesting and novel to capture users' attention (see table 27.1). Many computational techniques can be leveraged to achieve this goal, notably information retrieval (Shen et al. 2005; Zhai 2008) and machine learning technologies (Liu 2009; Wang et al. 2013).

Although little research exists on how users respond to recommended online information, information recommended by a trusted friend may have more influence on a person than information directly recommended by a system. For example, Berger and Milkman (2010) have shown why some online content is more viral than others. Using a news data set, they

examined how emotion shapes virality and found that positive content tends to be more viral than negative content and that information of both positive and negative valence (items evoking either awe or anger and anxiety) more frequently becomes viral than depressing information. These findings suggest that online social networks can be potentially leveraged to recommend selected positive content to users who need to change their sedentary behavior.

To facilitate behavior change, recommender systems can also work as a persuasive technology by pushing forward healthier and more beneficial information or choices to users (Felfernig et al. 2013). For instance, a substantial amount of research exists on the development of recommender systems that encourage healthier food choices (Mankoff et al. 2002; Lee et al. 2011; Wagner et al. 2011). Recent research has also started to explore activity recommender systems that can facilitate physical activity and lifestyle changes. For example, Hammer and colleagues (2010) proposed a recommender system to support diabetes patients' self-management by providing recommendations on food intake and exercise. In particular, Bielik and others (2012) developed *Move2Play*, a system designed to make activity recommendations that also has tracking, evaluation, and gamification elements. Although most of these studies so far have focused on developing relevant recommendation algorithms, preliminary user evaluation has revealed positive user reception. Recommender systems can be hoped to ultimately increase exposure to physical activity programs, although the ultimate effects on attention and behavior change will be driven by the nature of the materials users access (see table 27.1).

Gamification Systems

Besides its use for entertainment, a game may deliver various benefits that depend on how the game is designed. This has led to the emergence of a new field called *gamification* (Deterding et al. 2011), which refers to the use of game thinking and game mechanics in non-game contexts with the objective of engaging users in problem-solving. The reported benefit of gamification systems for business corporations spans a wide spectrum, including improving employee training, attracting talent, and enhancing motivation, productivity, and innovation (Object Frontier 2013). Quite a few games have been created to promote well-being and physical fitness, such as *SuperBetter* (www.superbetter.com) and *Zombies, Run!* (www.zombiesrungame.com).

With the increasing adoption of smartphones, such games can become easily available in mobile contexts and ubiquitous. Moreover, compared with search engines and recommender systems, gamification systems have the significant advantage of going beyond exposing users to the desired content to further enable longer-term engagement of users. Many games use stories, fantasy, and visual and audio experience, to attract and maintain attention, create an immersive experience, and engage users through interactivity, emotions, and persuasion (e.g., tailored messages, goal setting; Baranowski et al. 2008).

In term of their content, gamification systems that focus on health behavior change include games promoting physical activity, diet intervention games, and educational games on health and disease management. Among games that promote physical activity, exergames are best received. These are typically video games that use players' energy

expenditure from physical activity as input to drive the games, achieved by mapping the physical input into points or rewards in the virtual games (Orji et al. 2013). Many of these games use sensors to track users' movement, but some use biometric data such as heart rate (De Oliveira and Oliver 2008). Popular exergames include *Dance Dance Revolution* (DDR) and various video games played on *Nintendo Wii* and Xbox *Kinect*. Previous research has found that exergames contribute to fitness and weight loss (Biddiss and Irwin 2010; Staiano and Calvert 2011; Unnithan et al. 2006). In a meta-analysis, Peng and colleagues (2011) concluded that playing exergames leads to increases in heart rate, oxygen consumption, and energy expenditure comparable to light- to moderate-intensity physical activity. Exergames have also been reported to have psychosocial and cognitive benefits such as increased self-esteem, social interaction, motivation, attention, and visual-spatial skills (Gao and Mandryk 2012; Staiano and Calvert 2011). Encouraging sustained use is likely the challenge for these systems, so integrating them into daily life tasks may be the next item of the agenda.

Another category of virtual games focuses on promoting users' daily life activity. These rely on pedometer or mobile devices to track users' steps or movements and integrate gamification elements such as goal setting, rewarding, and reinforcement. Moreover, an emerging trend in these applications is to use social gameplay to elicit social facilitation, social comparison, normative influence, and social learning (Maitland and Chalmers 2011). For instance, *Fish 'n' Steps* (Lin et al. 2006) tracked users' physical activities and mapped them onto the activity of a virtual fish in a virtual tank. In a 14-week evaluation study, the game was found to act as a catalyst for promoting exercise beyond the trial period and improving game players' attitudes toward physical activity. *American Horsepower Challenge* is a web-based game that follows users' daily activity and translates activity amounts into points in a virtual race (Poole et al. 2011). A large-scale field trial with 61 schools found that the game significantly increased the number of steps in youth.

Diet-intervention games attempt to promote healthy eating behavior for weight control and improved health. Some focus on tracking and monitoring food intake, some provide just-in-time information or messages to remind users to make appropriate food decisions at the time of eating, and others educate users about healthy eating habits (Consolvo et al. 2006; Grimes et al. 2010; Orji et al. 2013). For instance, *OrderUP!* is a goal-based role-playing game in which the player (assuming the role of a waiter) recommends healthy food to customers (Grimes et al. 2010). *LunchTime* was a role-playing multiplayer game in which a group of users with specific health goals collaboratively chooses food from a restaurant menu (Orji et al. 2013). Past evaluations of these games has shown positive effects on learning, reflection, and attitude and behavior change (Consolvo et al. 2006; Grimes et al. 2010; Orji et al. 2013).

Video games may provide several advantages over didactic education and disease management, including vicariously practicing behavioral skills, facilitating complex problem-solving and contingency-based learning, and acquiring procedural knowledge in an interactive manner (Thomas et al. 1997). Previous studies have examined the effects of video games for stroke rehabilitation (Brown et al. 2009), physical therapy (Herndon et al. 2001), mental-health care (Wilkinson et al. 2008), pain management (Hoffman et al. 2001), and management for such conditions as diabetes, cystic fibrosis, cancer, and asthma

(Bartholomew et al. 2006; Brown et al. 1997; Davis et al. 2004; Kato et al. 2008; Lin et al. 2005; Mamykina et al. 2008). The scientific evidence so far promises to link game use to effective disease management, medication adherence, self-efficacy, disease-related knowledge, and health service use. The ultimate efficacy, however, will be driven by efficacious contents informed on the science of behavior change (see table 27.1).

Summary

In this chapter, we use a psychological framework to systematically examine the potential effects of various technological systems, namely delivery systems such as websites, social networks, monitoring and tracking tools, search engines, recommender systems, and gamification systems. Our general conclusion is that all these forms offer opportunities to potentially influence people's beliefs, attitudes, and behaviors, but each requires different strategies (see table 27.1). Several important recommendations follow from the information reviewed in this chapter.

1. Social networks can potentially be leveraged to create a viral effect and ensure high exposure and attention, but the ultimate effect on exposure, attention, and behavior change depends on the degree to which the content influences those stages. More novel information will attract more attention and materials that successfully improve behavioral skills will likely reduce inactivity.
2. Search engines can be modified to encourage physical activity by promoting specific content at the top of search results, thus increasing exposure to efficacious content and demoting unhealthy messages. These innovations can decrease the negative effects and potentially increase the positive effects of the congeniality bias. For example, search items may be described as confirming the question of a user who seeks information that negates the need for physical activity even though the contents ultimately refute the user's belief.
3. Recommender system technologies can be exploited to automatically infer a user's need and adapt the recommended content or products to those needs. Such technologies, however, are likely to be most effective in combination with search engine results or embedded in a social network that increases the trustworthiness of the content relative to delivery from an explicit, stand-alone recommender system.
4. Gamification systems are among the most effective ways to influence people through online games or interactions or with a combination of online games and physical activities. Nevertheless, how to motivate people to play a game may be a challenge that requires creativity and ongoing updates to a constantly evolving game.
5. It is also desirable to combine multiple strategies whenever possible. For example, games recommended through a social network or through a search engine in the right search context are more likely to be adopted.

In closing, the efficacy of emerging communication systems depends on the availability of intelligent information processing technologies developed in the computer science field, particularly in relation to information retrieval, data mining, human–computer interaction,

and machine learning. Fortunately, all these areas have made significant progress in the last two decades, and many useful technologies are available for intelligently modeling and inferring a user's interests and preferences, analyzing and understanding online contents, and recommending information in a context-sensitive and personalized way. These technologies are now available to maximize the efficacy of behavioral interventions for curbing physical inactivity and its associated health risks.

\qqBegin special element

Key Concepts

- **Accuracy motivation:** The desire or goal to hold accurate information and reach factually correct conclusions.
- **Behavior change**: Modification of the intensity and duration of a behavior performed at an earlier (arbitrary) time.
- **Defense motivation:** The desire to approach and disseminate information that is consistent with prior beliefs and thus feels personally validating or reassuring.
- **Electronic intervention delivery:** Websites to deliver interventions previously delivered in person or on the phone.
- **Electronic monitoring and tracking systems:** Technologies to measure and track physical activity, weight loss (Purpura et al. 2011), sleep (Kim et al. 2008), biometric data, disease management, and mental health (Bardram et al. 2012; Matthews et al. 2008).
- **Gamification systems:** In this context, a game designed to deliver health and fitness benefits.
- **Recommender systems:** Include stand-alone platforms that e-mail recommendations to users and embedded systems that push information through a search engine. These systems attempt to infer a user's interests or information needs, match users' interests with a set of recommendations, and choose and deliver well-matched items.
- **Search engines:** Web search engines like Google and Bing are used routinely by many people in the world every day.
- **Selective exposure and dissemination:** These terms refer to biases in attention, selection, and dissemination of information on the basis of defense, accuracy, and social motives.
- **Social motivation:** The desire to create and maintain positive relationships with other people.
- **Social network information delivery systems:** Systems to develop information to networks, including Twitter, Facebook, specialized online communities, blogs and vlogs, and computer-mediated communication such as e-mail or text messaging.

Study Questions

1. How do the defense, accuracy, and social motives influence exposure to information in emerging systems?
2. Is the influence of each motive likely to be different across different platforms?
3. How are characteristics of a population likely to determine which system would you use to reduce physical inactivity?

\qqEnd special element

Chapter 27

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