Menon, and Foster, 2000) used focus groups to identify specific benefits and barriers to CRC screening. Benefits identified by participants were similar to those for breast cancer screening and included finding cancer early, decreasing chances of dying from the cancer, freedom from worry, and reassurance when no cancer is found. Barriers identified included lack of knowledge, inconsistent recommendations from health care providers, and embarrassment associated with the tests. Reliability was measured by using Cronbach's alpha and was .65 for fecal occult blood test (FOBT), .67 for flexible sigmoidoscopy, and .70 for colonoscopy. Exploratory factor analysis identified dimensions for benefits of FOBT, sigmoidoscopy, and colonoscopy, with respective items loading at .54 to .78 for FOBT, .35 to .58 for flexible sigmoidoscopy, and .62 to .72 for colonoscopy.

Most recently, Wardle and colleagues developed a seven-item benefits scale specific to sigmoidoscopy (Wardle and others, 2003). Items demonstrated construct validity by loading at .40 or above; internal consistency reliability was .83. Constructs were salience and coherence, cancer worries, perceived susceptibility, response efficacy, and social influence. Perceived susceptibility was identical to that used in the original HBM definition. Response efficacy mirrored benefits, in that items related to decreasing the risk of disease threat. Cancer worries were identified as barriers to completing the behavior. Confirmatory factor analysis supported the identified constructs for males and females, as well as African Americans and Caucasians. Cronbach's alpha ranged from .60 to .64 (Marcus and others, 2005).

A major method of testing construct validity is to test theoretical relationships. Ambiguity about the relationships among theoretical constructs in the HBM makes tests of construct validity more difficult. HBM relationships between constructs have not been well described. It is possible that one of the variables may mediate relationships between the others. Temporality of relationships is also an issue. When health beliefs and behaviors are measured concurrently, apparent relationships between them might well turn out to be spurious. These factors may have contributed to the frequent lack of scientific rigor in measuring HBM constructs.

APPLICATIONS OF THE HBM TO MAMMOGRAPHY AND AIDS-RELATED BEHAVIORS

The HBM has been used extensively to determine relationships between health beliefs and health behaviors, as well as to inform interventions. A comprehensive review of all work using the HBM to address health behaviors is beyond the scope of this chapter. In this section, we discuss use of the HBM in two important areas: (1) breast cancer screening and (2) AIDS-related behaviors.

The HBM and Mammography

Association of HBM Constructs with Mammography Behavior. The HBM predicts that women will be more likely to adhere to screening mammography recommendations if they feel susceptible to breast cancer, think breast cancer is a severe disease, perceive barriers to screening as lower than perceived benefits, have higher self-efficacy for

obtaining mammograms, and receive a cue to action. Indeed, many studies have found these expected relationships between HBM constructs and mammography adherence. Adherence has been significantly associated with greater perceived susceptibility, lower barriers, higher benefits, and cues in the form of recommendations from health care providers (Champion, 1984; Champion and Menon, 1997; Champion, Ray, Heilman, and Springston, 2000; Friedman, Neff, Webb, and Latham, 1998; Phillips and others, 1998). Because early studies found little variation in perceived severity, this construct has been less frequently measured in more recent mammography studies.

Studies conducted among diverse samples have found some differences in the specific types of beliefs about susceptibility, benefits, and barriers among different racial and ethnic groups. Different groups have different beliefs about the causes of breast cancer, which can affect perceived susceptibility. An example is the belief common among some groups of older African Americans that breast cancer is caused by an injury to the breast (Guidry, Matthews-Juarez, and Copeland, 2003; Skinner, Arfken, and Sykes, 1998); women who have not had such an injury may conclude that their susceptibility is quite low. Beliefs associated with lower perceived benefit from early detection, such as the notion that surgery causes cancer to spread and that cancer means death, are more common among African Americans than white women (Guidry, Matthews-Juarez, and Copeland, 2003; Skinner, Champion, Menon, and Seshadri, 2002). Certain types of barriers are more or less important for particular cultural or ethnic subgroups. Modesty is a special barrier associated with lack of adherence among Asian American women (Tang, Solomon, and McCracken, 2000). Fear, embarrassment, and cost are more likely to be barriers to adherence among African American women (Thompson and others, 1997). Finally, in addition to differences in specific perceptions about susceptibility, benefits, and barriers among racial or ethnic groups, researchers have found differences by race in explanatory power of HBM constructs. In 2004, Vadaparampil and colleagues used structural equation modeling to examine HBM constructs and differences in adherence for African American and Caucasian women, and found that HBM constructs explained only a small amount of variance in both groups—approximately 13 percent for Caucasians and 9 percent for African Americans (Vadaparampil and others, 2004). However, differences in some specific constructs had the greatest explanatory power. Whereas barriers were significantly related to adherence in both racial groups, higher perceived benefits were significantly related to adherence among African Americans and higher self-efficacy was significant only for whites.

Mammography-Promotion Interventions Based on the HBM. A number of mammography-promotion interventions have addressed at least one HBM construct—usually perceived barriers—and have had significant effects on mammography outcomes (Allen and Bazargan-Hejazi, 2005; Carney, Harwood, Greene, and Goodrich, 2005; Costanza and others, 2000; Crane and others, 2000; Duan, Fox, Derose, and Carson, 2000; Lauver, Settersten, Kane, and Henriques, 2003; Lipkus, Rimer, Halabi, and Strigo, 2000; Rakowski and others, 2003; Valanis and others, 2003). This section summarizes findings from several different types of interventions based on the HBM.

Perhaps because constructs in the HBM are fairly intuitive, they have been used in a number of community-based interventions conducted among underserved groups with lower education levels. Lay health advisers have been equipped to assess their peers' HBM-related perceptions and then craft messages and plans to address those factors and facilitate mammography use (Earp and others, 2002). In the *Learn, Share and Live* intervention, Skinner and colleagues used the HBM to inform community-based education sessions for older, urban minority women (Skinner and others, 1998). The goal was to change perceptions and practices among the program participants and enable them, in turn, to address mammography-related perceptions and constructs effectively among their peers. Learning objectives guiding the three core education sessions are shown in Table 3.3, along with the HBM constructs each addressed.

To help women realize the benefits of early detection (Objective 1), program leaders distributed necklaces of wooden beads of graduated sizes (from 6 to 28 mm) so that women could actually see and feel differences in sizes of the average lump found by women in their own breasts versus the much smaller sizes of lumps that can be

TABLE 3.3. Learning Objectives Used to Change Mammography Perceptions and Practices Among Urban Minority Women.

Learning Objectives	Theoretical Constructs
1. Recognize that breast cancer screening is effective for finding early cancers.	Benefits (Health Belief Model) Response efficacy
2. Be aware of increased likelihood of favorable outcomes with early detected breast cancers.	Benefits (Health Belief Model)
3. Be aware that the risk of breast cancer increases with age.	Susceptibility (Health Belief Model)
4. Recognize that a number of factors may act as barriers to breast cancer screening.	Barriers (Health Belief Model)
5. Identify questions that can be used to determine women's perceived benefits and barriers to breast cancer screening.	Health education principles of behavioral diagnosis
6. Choose relevant messages for various perceptions.	Health education principles of message tailoring
7. Feel increased confidence that participant can encourage breast cancer screening among peers.	Self-efficacy (Social Cognitive Theory)

Source: Based on Skinner and others, 1998.

found via mammograms. To further communicate benefits of early detection, the program used a dandelion analogy, comparing the importance of pulling up dandelions before their seeds spread across a whole yard to the benefit of "taking care of the cancer before it can spread in your body and make you sick" (Skinner and others, 1998). To help the women understand how to assess and then address their peers' perceived benefits and barriers to screening, they participated in role-plays, in which they practiced asking about their friends' "reasons" for having or not having mammograms and then brainstormed ways to help their friends overcome these barriers. Whereas some barriers were related to beliefs (for example, that the radiation in mammograms actually caused cancer), others were logistical or structural (for example, costs associated with screening or not knowing how to arrange transportation to the mammography facility). To address these barriers, this intervention and others have put women in contact with community resources, such as mobile mammography units operated by local health systems or philanthropic organizations that cover costs of screening for uninsured women.

Some studies have compared the effectiveness of different media for delivering interventions addressing HBM constructs to women in clinic settings. In a longitudinal intervention study, Champion and colleagues compared HBM interventions delivered through (1) telephone counseling, (2) in-person counseling in the clinic, (3) physician letter only, (4) telephone counseling plus physician letter, or (5) in-person counseling plus letter. There were significant intervention effects on both HBM beliefs and mammography behavior. Adherence in all intervention groups, except the physician letter alone, was significantly different from standard care, with the combination of in-person and physician letter being the most significant (Champion and others, forthcoming).

Just as the HBM has guided community-based interventions to deliver information or persuasive messages to change perceptions and reduce barriers to screening, it has also guided interventions delivered through minimal contact with the intervention recipient. The most common and successful of these minimal-contact strategies have used printed materials and telephone calls to enhance perceived benefits for mammography screening and reduce perceived barriers. For example, a telephone counselor may ask, "What might keep you from having a mammogram?" and, depending on the woman's answer, deliver a message designed to reduce that barrier. Some of these intervention studies have resulted in mammography rates more than twice as large as those of a no-intervention comparison group (King and others, 1994).

Several studies have used HBM variables to tailor mammography interventions for particular recipients. In these tailored interventions, computer algorithms use women's interview data to select, from a library of potential messages, unique combinations for each individual recipient, based on her specific reported perceptions of susceptibility, benefits, barriers, and self-efficacy. In general, tailoring messages for breast cancer screening using the HBM constructs of susceptibility, benefits, and barriers has been found to increase mammography adherence.

In the first of these studies, 435 family practice patients were randomly assigned to receive mammography recommendation letters tailored to their specific HBM per-

ceptions or a nontailored version of the letter (Skinner, Strecher, and Hospers, 1994). For example, tailored letters had paragraphs specifically addressing up to three barriers cited by women as holding them back from getting a mammogram; the nontailored version included messages about three common barriers but not the particular barriers mentioned by the recipient. Among subgroups with low adherence at baseline (African American and lower-income women), mammography adherence at follow-up was significantly higher among women who received letters tailored on HBM constructs.

Building on the tailored print mammography intervention findings, Champion and Skinner compared effects of letters with telephone counseling (Champion and others, 2007). Both were tailored on HBM constructs, meaning that women received messages about their susceptibility to breast cancer that mentioned their specific risk factors (for example, their current age and family history), and the messages about benefits and barriers were selected to address their specific concerns and to correct perceptions. For example, women whose survey responses indicated that they did not understand or appreciate the benefits of early detection got messages explaining and emphasizing these benefits. Telephone counseling plus mailings resulted in the highest adherence (40 percent), but telephone alone (36 percent) and mailed print alone (37 percent) also were significantly better than standard care. Similarly, Rimer and colleagues tested print and telephone interventions tailored on constructs from the HBM, as well as other models, and found superiority in the combination of phone and print (Rimer and others, 2002).

HBM variables have also formed the basis for tailoring interactive computer programs that include video segments. One of these—tailored on perceived susceptibility, benefits, and barriers—was testing among more than 300 low-income African American women. In the program, a narrator asked questions about HBM constructs, and women touched the screen to indicate their responses. The video clips that followed used narrative episodes, for example, to model a woman overcoming the barrier that had been selected by the user. Also included in the intervention was an in-person counseling session addressing each woman's perceived susceptibility, benefits, and barriers to mammography screening. For women who had never had mammograms, adherence was significantly higher in the HBM-based interactive intervention group (50 percent) than in the comparison group (18 percent) (Champion and others, 2006).

In summary, HBM constructs generally have been found to predict participation in breast cancer screening. In addition, a large number of intervention studies addressing HBM constructs have resulted in increased mammography use. This has been true for interventions delivered in community-based and minimal-contact settings. Finally, interventions tailored to address recipients' specific HBM beliefs have been found to be particularly effective. It is entirely consistent with the HBM that interventions will be more effective if they address a person's *specific* perceptions about susceptibility, benefits, barriers, and self-efficacy. Women who already believe they are at risk for developing breast cancer don't need messages trying to convince them of their susceptibility; those who know where to get a free mammogram but can't find a way to get there need interventions addressing transportation, not cost.

Just as it is important to be able to validly *measure* HBM constructs, tailoring technology has allowed interventions to *address* HBM constructs most relevant for particular individuals.

The HBM and Risky Sexual Behaviors

Association of HBM Constructs with Risky Sexual Behaviors. The HBM hypothesizes that AIDS-protective behavior decisions are a function of perceived risk of contracting the disease, perceived severity of the disease, and perceptions of benefits and barriers to specific AIDS-protective behaviors. The HBM suggests that, for individuals who exhibit high-risk behaviors, perceived susceptibility is necessary before commitment to changing these risky behaviors can occur. For individuals who do not believe they are at risk, the benefits or barriers to an action are irrelevant. Self-efficacy has been studied in relation to HIV-protective behaviors and defines an individual's perceived ability to carry out a behavior believed to be necessary to prevent infection with HIV (Janz and Becker, 1984). Studies addressing relationships between HBM constructs and risky sexual behaviors have focused on adolescents and young adults in the United States and on more general populations in Africa, where AIDS is a significant health problem.

The relationship between perceived susceptibility to negative outcomes of risky sexual behavior, such as becoming HIV-positive or contracting sexually transmitted diseases (STDs), varies across studies. Some researchers have found a significant relationship between condom use and perceived susceptibility (Basen-Engquist, 1992; Hounton, Carabin, and Henderson, 2005; Mahoney, Thombs, and Ford, 1995; Steers and others, 1996), whereas others haven't found the relationship (Hounton, Carabin, and Henderson, 2005; Volk and Koopman, 2001). Measurement issues may explain some of the discrepancy. Research by Ronis (1992) suggests that susceptibility questions should be clearly conditional on action or inaction. Some articles used a behavioral anchor in their susceptibility measures, for example, asking the question, "*If you do not practice safer sex,* how likely are you to become infected with the AIDS virus?" as opposed to simply, "How likely are you to become infected with the AIDS virus?" Not specifying conditions of action versus inaction could lead to a personalized interpretation (for example, respondents who indicate that their risk of infection is great, largely *because* they are not practicing safer sex). Therefore, comparisons of the predictive ability of perceived susceptibility across studies may be inconsistent.

Perceptions of AIDS severity address the perceived costs of being HIV-positive. Perceived seriousness, in this case, refers to personal evaluations of the probable biomedical, financial, and social consequences of contracting HIV and developing AIDS. Some might argue that asking about AIDS severity would be a waste of respondents' time, as it might be assumed that everyone would report AIDS to be an extremely severe disease. Most studies in the research literature have not included measures on HIV/AIDS perceived severity (Rosenstock, Strecher, and Becker, 1994).

Associations of perceived benefits and barriers to AIDS are identified, but results with behaviors are inconsistent. Reported condom use among Central Harlem youth