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Does Tailoring Matter? Meta-Analytic Review of Tailored Print Health Behavior Change Interventions

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Although there is a large and growing literature on tailored print health behavior change interventions, it is currently not known if or to what extent tailoring works. The current study provides a meta-analytic review of this literature, with a primary focus on the effects of tailoring. A comprehensive search strategy yielded 57 studies that met inclusion criteria. Those studies—which contained a cumulative N = 58,454—were subsequently meta-analyzed. The sample size-weighted mean effect size of the effects of tailoring on health behavior change was found to be r = .074. Variables that were found to significantly moderate the effect included (a) type of comparison condition, (b) health behavior, (c) type of participant population (both type of recruitment and country of sample), (d) type of print material, (e) number of intervention contacts, (f) length of follow-up, (g) number and type of theoretical concepts tailored on, and (h) whether demographics and/or behavior were tailored on. Implications of these results are discussed and future directions for research on tailored health messages and interventions are offered.

Keywords: tailored message, health communication, behavior change, theory, intervention

According to Mokdad, Marks, Stroup, and Gerberding (2004, 2005), approximately half of all deaths that occur each year in the United States are preventable. This is the case because such deaths are caused by largely preventable and modifiable behavioral risk factors. For instance, it is estimated that 2,403,351 individuals died in the United States in 2000; nearly half of these (1,124,000) were due to largely modifiable factors, including the use of tobacco, poor diet and physical inactivity, alcohol consumption, microbial agents (such as influenza and pneumonia), toxic agents (e.g., air pollutants such as asbestos), motor vehicle accidents, firearm injuries, unsafe sexual behavior, and illicit drug use. Such behaviors are major contributors to the development of leading causes of death, such as heart disease, stroke, and numerous cancers (Mokdad et al., 2004, 2005). Moreover, the three key behaviors of tobacco use, unhealthy diet, and lack of physical activity accounted for approximately 71% of the more than 1 million preventable deaths in the year 2000 (Mokdad et al., 2004, 2005), indicating that these three behaviors deserve unique attention.

As these preventable risk factors are themselves behaviors, individuals may be able to add years to their lives as well as reduce substantial suffering if they are willing and able to make the health behavior changes necessary to potentially avoid chronic disease and premature death. Unfortunately, data on the enactment of such health behaviors in the United States are alarming. For instance, national data from the 2005 Behavioral Risk Factor Surveillance Survey indicate that among U.S. adults, only 27.4% exercise regularly (defined as 20 or more minutes of vigorous physical activity 3 or more days per week), 23.2% eat five or more servings of fruits and vegetables per day, and 79.5% are nonsmokers (Centers for Disease Control and Prevention, 2007). In addition, an analysis of Behavioral Risk Factor Surveillance Survey data from the year 2000 found that across the four key behaviors of adequate exercise, healthy diet, smoking, and maintaining a healthy weight, only 3% of U.S. adults met criteria for all four (Reeves & Rafferty, 2005). This indicates that those who engage in one health behavior may very well not engage in another. Given that trends suggest that deaths attributable to poor diet and physical inactivity increased by 22% between the years 1990 and 2000 (Mokdad et al., 2004, 2005), future trends may prove even more challenging to public health officials and those faced with the task of turning these trends around.

Thus, these data, taken together, suggest that innovative and promising approaches to health behavior change are vitally needed. In fact, one of our greatest public health challenges is developing health behavior change programs and interventions to improve the health and reduce the burden of chronic disease of Americans and individuals worldwide (Glanz, Rimer, & Lewis, 2002). This is a task that health psychologists and those in related disciplines are uniquely qualified to undertake.

A Tailored Message Approach to Health Behavior Change

The health behavior change literature is vast and includes approaches based on a number of behavioral theories as well as approaches that operate at a number of levels, including individual, interpersonal, group, and community (e.g., DiClemente, Crosby, & Kegler, 2002; Glanz et al., 2002; Institute of Medicine, 2000). A common thread that runs through all of this research has to do with

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effective health communication. How can we create and deliver messages to the public that are relevant, interesting, informative, and ultimately have the greatest chance of being persuasive?

One blossoming area of research that has attempted to address this question is the area of tailored health messages. Kreuter, Strecher, and Glassman (1999) have described the full range of types of health communication, from messages that are not at all individualized to those that are quite individualized. *Generic communication* is defined as communication that is not individualized or based on any kind of individual assessment. An example of this is a brochure on the risks of smoking that one might read in a doctor's office. *Personalized generic communication* is virtually the same as generic communication, except that it uses a characteristic, such as one's name, to personalize the message. A mass mailing from a health agency or doctor's office might be described as personalized generic communication. *Targeted communication* refers to messages that are developed with a certain segment of the population in mind, and the practice of message targeting is one that has been widely applied in the health education and health communication literature (e.g., Kreuter & Wray, 2003; Rimal & Adkins, 2003). In fact, most health education materials developed and used in interventions are best described as targeted communication, and this practice was adapted from advertising in which dividing consumers into market segments and targeting communications to those segments is an age old practice (Grunig, 1989).

Although message targeting is a staple practice within health communication interventions, recent theoretical as well as technological advances have led to a blossoming literature on *tailored communication* (e.g., Kreuter, Farrell, Olevitch, & Brennan, 2000; Revere & Dunbar, 2001; Skinner, Campbell, Rimer, Curry, & Prochaska, 1999). Kreuter, Farrell, et al. (2000) define tailoring as "any combination of strategies and information intended to reach one specific person, based on characteristics that are unique to that person, related to the outcome of interest, and derived from an individual assessment" (p. 277). Thus, tailored communication is uniquely individualized to each person, whereas targeted messages are developed to be effective with an entire segment of the population. Tailored messages, however, do require individualized assessments of members of the population to develop such communications.

In addition, although *interpersonal communication* is the most individualized form of communication and is used in a variety of health education interventions (e.g., brief counseling interventions), the potential ability to reach large audiences through computer-based tailoring of messages gives this approach major promise. In fact, Abrams et al. (1996) have argued that although individual-level psychological approaches to health behavior change have been the most efficacious, public health approaches that consider entire populations are capable of the widest reach. Tailored health message interventions have the potential to be both efficacious and, through the use of computer-based tailoring, may reach thousands of individuals (Abrams, Mills, & Bulger, 1999; Prochaska, Velicer, Fava, Rossi, & Tsoh, 2001). Although only a small number of studies has examined the cost-effectiveness of tailored interventions (e.g., Lairson, Newmark, Rakowski, Tiro, & Vernon, 2004), the existing evidence suggests that such interventions may be cost-effective as well. Thus, the ultimate impact of such interventions could be quite large.

Health Behavior Theory and Tailored Messages

A theoretical perspective that has been a driving force in the tailored message arena is the transtheoretical model (TTM) and stages of change (Prochaska & DiClemente, 1983; Prochaska, DiClemente, & Norcross, 1992). The TTM is a health behavior change theory that posits that individuals progress through five stages of change on their way toward adopting a healthy behavior or toward cessation of an unhealthy behavior. These stages include *precontemplation* (not intending to change), *contemplation* (intending to change in the foreseeable future), *preparation* (planning to change very soon and currently taking measurable steps to change), *action* (changed in the past 6 months), and *maintenance* (changed and sustained the behavior change for 6 months or more). The TTM describes the change process as cyclical rather than linear, as individuals may move forward through stages, backslide, and then continue cycling and recycling through the stages of change. A number of factors that may help propel individuals through the stages of change include increased positive perceptions and decreased negative perceptions of making the health behavior change (Prochaska et al., 1994), increased self-efficacy that one has the skills and abilities to make the change (Prochaska, Redding, & Evers, 2002), and a variety of cognitive and behavioral change strategies or processes of change (see Prochaska et al., 1992).

The TTM suggests that because individuals' attitudes, strategies, and skills differ at varying stages of the change process, interventions should be uniquely tailored to those stages. Rather than a "one size fits all" approach, interventions should be sensitive to where individuals are in the change process, and messages tailored to those stages are likely to be the most effective in moving individuals forward through the stages (Prochaska, DiClemente, Velicer, & Rossi, 1993; Velicer et al., 1993). Not surprising, a large number of tailored message interventions have been based upon the TTM or stages of change (e.g., see Kreuter, Farrell, et al., 2000; Revere & Dunbar, 2001; Skinner et al., 1999). It should be noted, however, that although the developers of the TTM advocate using the full model—including stages of change, decisional balance, self-efficacy, and processes of change (e.g., Prochaska et al., 2002)—a number of studies in the tailored message area utilize a stages of change model in which the stages are used as the sole theoretical perspective or in combination with other health behavior concepts or theories. Thus, in the current article we refer to both the stages of change model as well as the TTM, to distinguish these two perspectives from one another.

In addition, a number of other health behavior theories have been widely used as a basis for tailoring health behavior change messages (e.g., Kreuter, Farrell, et al., 2000; Revere & Dunbar, 2001; Skinner et al., 1999). These theories all suggest a number of individual-level factors that affect behavior change, and as such lend themselves to tailoring at the individual level. For instance, the health belief model (HBM; Becker, 1974; Janz & Becker, 1984) posits that a key determinant of whether an individual adopts a healthy behavior is that individual's perceived threat of a disease or negative outcome. Perceived threat is made up of two components—susceptibility, or the perception that one is at risk for a disease, as well as severity, or the perception of the seriousness of that disease. From this perspective, a prerequisite for behavior change is an individual recognizing that he or she is at risk and that

the seriousness of the disease or outcome is severe enough to motivate protective action. In addition, the model posits that weighing perceived benefits and barriers to behavior change is also important, as those viewing more benefits than barriers are more likely to take action than those viewing more barriers than benefits. Finally, more recently HBM proponents have suggested the addition of self-efficacy to the model (Rosenstock, Strecher, & Becker, 1988). *Self-efficacy* is defined as the situation-specific confidence that one can execute a behavior to achieve a desired outcome (Bandura, 1986). A large body of literature finds that those with higher self-efficacy are more likely to implement health behavior changes as compared with those with lower self-efficacy (Bandura, 1998; Strecher, DeVellis, Becker, & Rosenstock, 1986).

In addition, the theory of reasoned action (TRA; Fishbein & Ajzen, 1975) and the theory of planned behavior (TPB; Ajzen & Madden, 1986) posit that the most proximal predictor of health behavior is behavioral intention, or the perceived likelihood of performing a behavior. According to the TRA, intention is influenced by both attitudes and subjective norms regarding the behavior. Thus, the more positive one's attitude as well as the more one perceives normative pressure to engage in the behavior, the more likely it is that behavioral intentions will be strengthened and the behavior will be carried out. The TPB suggests that a third factor, namely perceived behavioral control, is an important determinant of behavioral intentions. Perceived behavioral control refers to the extent to which one believes a behavior is under one's volitional control. From the perspective of the TPB, those with more positive attitudes, perceived normative pressure, and perceived behavioral control over the behavior are more likely to form strong behavioral intentions and to engage in the behavior itself.

Finally, social cognitive theory (SCT; Bandura, 1986) is a comprehensive theory of behavior change that posits that health behaviors must be understood in the context of reciprocal determinism, or the idea that characteristics of a person, one's environment, and the behavior itself all interact and determine whether a behavior is performed. SCT suggests, however, that the most central determinant of health behavior change is self-efficacy, a concept discussed above that is now included in numerous theories of health behavior (Noar, 2005; Noar & Zimmerman, 2005). SCT suggests that in addition to confidence in performing a behavior, an individual must also believe that engaging in the behavior will lead to desirable outcomes, which are referred to as outcome expectancies. Thus, according to this perspective, individuals are most likely to engage in a health behavior if they possess the perceived ability to perform the behavior (self-efficacy) as well as the belief that engaging in the behavior will lead to expected, desirable outcomes (outcome expectancies).

Tailored Messages and Health Behavior Change: What Do We Know?

Although the evidence to date suggests that tailored messages are likely to be viewed as more relevant than more generic communications (e.g., Kreuter et al., 1999; Kreuter & Wray, 2003), a question posed in the current meta-analysis is whether such messages can result in greater health behavior change as compared with generic or targeted messages. In other words, does tailoring matter, and if so, how much does it matter? Although tailored messages may be found to be more effective, the effort that goes into creating such messages is great. Thus, the effects must be large enough to warrant the investment in tailoring technology and individualization of messages (Halder et al., 2006). If the effects are not larger than targeted communication, then the additional resources needed to create individually tailored messages might be better spent in other ways, and perhaps targeting techniques (which operate at the group level) should be used instead (Kreuter & Skinner, 2000; Kreuter & Wray, 2003; Ryan, Skinner, Farrell, & Champion, 2001).

A number of narrative reviews of the tailored health communication literature have, in fact, examined the issue of impact of tailored messages on health behavior change. Skinner et al. (1999) reviewed 13 health behavior intervention trials testing the efficacy of tailored print messages versus nontailored comparison or control conditions. They concluded that tailored messages are indeed more effective in influencing health behavior change as compared with the other conditions tested, noting that 6 of 8 studies comparing tailored messages to similar but nontailored messages resulted in significant findings. Rimer and Glassman (1999) reviewed 17 cancer communication intervention trials testing the efficacy of tailored print communications and similarly concluded that evidence suggests behavioral outcomes are more positive than they are null or negative. Kroeze, Werkman, and Brug (2006) reviewed 30 studies on computer-tailored materials for physical activity and dietary behavior change and described the evidence supporting the effectiveness of dietary computer-tailored interventions as "quite strong" (p. 208). They also concluded that too few studies existed in the physical activity domain to draw conclusions. Revere and Dunbar (2001) reviewed 37 health behavior intervention trials, including those utilizing print materials, automated telephone, computers, and mobile communications. They found that 34 of the 37 trials had statistically significant or improved outcomes and thus concluded that tailored interventions are effective. Other reviewers of this literature have similarly concluded or suggested that tailoring appears to "work" (Brug, Campbell, & van Assema, 1999; Kreuter, Farrell, et al., 2000; Strecher, 1999; Velicer, Prochaska, & Redding, 2006).

All of these conclusions about the state of the tailored message literature, however, are derived from narrative reviews, and meta-analytic scholars have often pointed to the shortcomings of the narrative review method (e.g., Johnson, Scott-Sheldon, Snyder, Noar, & Huedo-Medina, in press; Rosenthal, 1991). For instance, many narrative reviews lack systematic and thorough searches of the literature, and most rely heavily on statistical significance as the sole criterion for judging the outcomes of studies. In addition, narrative reviewers often have difficulty assessing which characteristics of studies are associated with stronger effects. Moreover, meta-analyses yield effect sizes that provide precise estimates regarding particular phenomena, and such estimates have proven to be quite useful in numerous areas of health communication (see Noar, 2006a). In fact, a small number of meta-analyses related to the current study have recently appeared in the literature. Shaw et al. (2005) meta-analyzed 15 tailored interventions directed toward health care professionals, although the results were largely inconclusive. Lancaster and Stead (2007) meta-analyzed self-help materials for smoking cessation and included 17 tailoring studies in their analysis. They found some evidence for the effectiveness of tailored materials, although the effect sizes were quite small. Finally, Edwards et al. (2007) conducted a meta-analysis on per-

sonalized risk communication (i.e., tailoring messages on risk factors) and the decision to take screening tests, again finding small effects of such communications. Although these studies have provided some insights into tailored health interventions, a comprehensive meta-analysis focused on the impact of tailored interventions on health behavior change has not yet been undertaken. Such a study could provide new information regarding the effectiveness (or lack thereof) of tailored health messages as well as shed light on moderators of intervention effectiveness.

Tailored Health Messages: What Questions Remain in the Literature?

Although narrative reviewers have suggested that tailoring is an effective health behavior change practice, and the little meta-analytic evidence that exists provides some support for this conclusion, a number of studies in the tailored message literature have provided results that are either inconclusive or inconsistent with such a conclusion. For instance, although a number of studies in this literature have yielded positive findings, a number of studies have also resulted in null or inconclusive findings with regard to effects on health behavior change (e.g., Blissmer & McAuley, 2002; Brug, Steenhuis, van Assema, Glanz, & De Vries, 1999; Bull, Jamrozik, & Blansky, 1999; Curry, McBride, Grothaus, Louie, & Wagner, 1995; Lutz et al., 1999; Meldrum et al., 1994; Naylor, Simmonds, Riddoch, Velleman, & Turton, 1999; Raats, Sparks, Geekie, & Shepherd, 1999). Further, a number of studies in this literature have compared tailored message conditions solely with no-treatment control conditions (e.g., A. H. Baker & Wardle, 2002; Champion et al., 2002; Dijkstra, De Vries, Roijackers, & Van Breukelen, 1998b; Kreuter, Caburnay, Chen, & Donlin, 2004; Prochaska, Velicer, Fava, Rossi, & Tsoh, 2001). If the tailored message condition is effective in such studies, it is not clear if this was due to the tailoring of the message or to some other factor, as such studies are not true tests of tailoring per se. Consequently, the question of whether and how much tailoring works is still somewhat open in the literature.

Moreover, although the tailored health message literature has grown rapidly and has generated much knowledge, a number of questions remain (Rakowski, 1999; Skinner et al., 1999), many of which have the potential to be answered through meta-analysis. For instance, have tailored messages outperformed similar comparison (i.e., generic, targeted) messages, and have they further outperformed no-treatment control conditions? Are tailored messages more effective with some health behaviors and/or some individuals more than others? What types of tailored print materials have been the most effective? Also, are interventions with multiple contacts with participants more effective than those with a single contact?

In addition, as previously noted, numerous behavioral theories have been used as a basis for tailored message interventions, including the TRA (Fishbein & Ajzen, 1975), TPB (Ajzen & Madden, 1986), SCT (Bandura, 1986), HBM (Becker, 1974), TTM (Prochaska et al., 2002), a stages of change model (Prochaska & DiClemente, 1983), as well as others (see Kreuter, Farrell, et al., 2000; Revere & Dunbar, 2001). Are certain theories or theoretical concepts more potent to use as a basis for tailoring messages as compared with others? Is tailoring on 10 theoretical concepts better than tailoring on 5? All of these questions bring to light the fact that we know very little about what is in the "black box" of tailoring (Abrams et al., 1999). In other words, when tailored interventions work, we know very little about why. It remains a high priority to understand if we can unpack the components within such interventions to discover (a) whether tailoring works and (b) what variables moderate effects within tailored message interventions.

Purpose of This Study

The purpose of the current study was to conduct a meta-analytic review of the literature on tailored print health behavior change studies. Tailored print communication has been described as the "first generation" of tailoring studies (Skinner et al., 1999), and it serves as a large and powerful literature for examining the theoretical question of the effects of tailoring. In addition, although newer technologies, such as web-based interventions, hold much promise in this area, there are far fewer studies that use such technologies, and these types of studies introduce numerous factors (e.g., sound, interactivity) that make the basic question of the effects of tailoring more difficult to examine. Thus, the current meta-analysis focused solely on *tailored print communication*. Such print communication is typically developed with computerized algorithms and is sometimes referred to as computer-tailored or computer-generated communication.

In the current meta-analysis, we sought to examine whether tailored print messages have affected health behavior change as well as to examine several sets of moderators that may impact the effects of tailoring, including the following:

1. *Participant features*: Have outcomes of tailored message studies varied with regard to demographic characteristics, such as age, gender, race, education level, and country of sample?
2. *Type of behavior*: Have outcomes of tailored message studies varied by health behavior and/or health behavior type (i.e., preventive vs. screening vs. vaccination)?
3. *Intervention and methodological features*: Have outcomes of tailored message studies varied when the comparison condition was a comparison (i.e., generic/targeted) message versus when it was a no-treatment control condition? What is the effect of tailoring (i.e., tailored message vs. comparison message)? Have outcomes varied based on the use of differing types of print materials, number of intervention contacts with participants, type of recruitment strategy, length of follow-up, and publication year?
4. *Theoretical concepts*: Have outcomes of tailored message studies varied depending on which theoretical concepts have been tailored upon? In addition, does tailoring on more theoretical concepts and other variables (e.g., demographics, behavior) result in better outcomes?

Method

Search Strategy

To ensure a comprehensive search, we undertook a detailed strategy to search for journal articles and book chapters relevant to this meta-analysis. The intent was to locate all published articles through the end of 2005 that were applicable to the meta-analysis. First, comprehensive searches of the PsycINFO, Medline, and Cinahl computerized databases were conducted. Numerous key-

words were used in combination in the search, including tailor(ed), print, message, communication(s), intervention, feedback, individualized, and health. All articles from this search that had the possibility of being relevant were located and examined to determine the extent of relevancy. In addition, 14 scholars whose names often came up in searches for tailored message articles were also searched in PsycINFO, Medline, and Cinahl to be sure all articles conducted by these research groups were included.

Second, reference lists of a number of reviews in the area of tailored interventions were examined (including Kreuter et al., 1999; Revere & Dunbar, 2001; Rimer & Glassman, 1999; Skinner et al., 1999; Strecher, 1999). All articles that had the potential to be relevant were located. Finally, all issues (through the end of 2005) of *Preventive Medicine*, *Health Psychology*, *Health Education Research*, *Annals of Behavioral Medicine*, and *Patient Education and Counseling* were searched for relevant articles. These journals were chosen because initial searches identified these particular journals as publishing a large number of studies on tailored health messages.

A decision was made to include only work published in peer-reviewed journals, books, or book chapters. This decision was made for two reasons. First, published work tends to be peer-reviewed and is potentially of greater quality than unpublished work. Secondly, much of the work in the tailored message area was funded by a variety of agencies (e.g., National Institutes of Health). Because of this, the evaluations tended to be very strong even if the results of some studies were weak. In fact, many of the studies were published in top-tier journals even when intervention effects were minimal or nonexistent. Thus, a publication bias in favor of significant findings did not appear to be present in this literature.

All articles that were considered for inclusion had to meet the following criteria to be included in this meta-analysis:

1. Studies had to include at least one print-only tailored intervention condition; studies focused only on telephone, brief counseling, or web-based interventions were excluded as were studies that mixed these modalities with print materials in study conditions in which the independent effects of the print materials could not be separated.

2. In addition to at least one print-only condition, studies had to include a nontailored message condition, a no-treatment control condition, or a "less tailored" condition than in Criterion 1 above that could serve as a comparison condition.

3. Studies had to use an experimental design in which individuals were randomized to conditions or a quasi-experimental design with a matched comparison group.

4. The tailored condition had to include feedback on at least one theoretical, behavioral, or demographic variable.

5. Studies had to include health behavior as a dependent variable. Studies that measured only knowledge, attitudes, beliefs, perceptions of risk, intentions, stage of change transition, personal involvement, or other dependent variables were excluded.

6. Studies had to be published in English language journals or books.

Initial searches resulted in hundreds of abstracts that were examined for relevance. Approximately 178 articles that had the potential to be included in the meta-analysis were located and examined for relevance. Of these,

(a) 43 studies (24%) were excluded because they did not include any print-based condition or included a print condition that was confounded because of the presence of other intervention activities, such as tailored counseling (e.g., Valanis et al., 2003);

(b) 27 studies (15%) were excluded because they did not measure health behavior but rather measured another dependent variable, such as behavioral intentions, readiness to change, perceived risk, or personal involvement (e.g., Webb, Simmons, & Brandon, 2005);

(c) 20 studies (11%) were excluded because they did not contain original data but rather were discussions or reviews of the literature (e.g., Bental, Cawsey, & Jones, 1999);

(d) 16 studies (9%) were excluded because they contained data that was published in more than one report (e.g., Dijkstra, De Vries, & Roijackers, 1998; Dijkstra, De Vries, Roijackers, & Van Breukelen, 1998a)—in these cases, the article that met all previous inclusion criteria and reported on short-term effects was utilized;

(e) 8 studies (4%) were excluded because they did not include a control group (e.g., Dyer, Fearon, Buckner, & Richardson, 2004); and

(f) 8 studies (4%) were excluded because they did not tailor messages as the term is applied in this particular literature and meta-analysis (e.g., Anderson, 1978).

As a result, a final set of 56 articles contributing 57 studies (1 article reported data from 2 studies) met criteria and were included in the meta-analysis.

Article Coding

Articles were coded on numerous dimensions by two independent coders. Basic descriptive information from each study was coded along with characteristics representing the moderators under examination. A list was developed with a number of theoretical concepts from the health behavior change theories, which was used as a guide in coding those characteristics. Concepts were added to the list as coding progressed, and early on in the coding process decisions were made regarding how to code differing descriptions of theoretical concepts. Concepts were coded into common categories that numerous scholars have agreed are unique behavioral theory concepts, as some theories contain identical or nearly identical concepts but refer to them by different names (Bandura, 1998; Fishbein et al., 2001; Noar & Zimmerman, 2005; Weinstein, 1993). For instance, studies that tailored on decisional balance (pros, cons), benefits and/or barriers, outcome expectancies, or other attitudinal concepts were all coded as having tailored on "attitudes." Coding concepts into common categories also had the additional effect of increasing statistical power in moderator analyses comparing the effects of tailoring on specific theoretical concepts. The concepts most frequently encountered in studies included stage of change, self-efficacy (or perceived behavioral control), behavioral intentions, social norms, attitudes (including decisional balance, benefits and barriers, outcome expectancies, behavioral beliefs), perceived susceptibility, processes of change, and social support.

Each theoretical concept was counted once when coding. For instance, even though there are 10 processes of change, if a study tailored on that concept, it was counted once. In addition, if a study tailored on two types of self-efficacy, this was also counted once, because it comes from the same theoretical concept. Finally, any

demographic (e.g., gender, age, race) or behavioral characteristics (i.e., feedback on the behavior itself) used in tailoring were also coded. These categories were also counted once (i.e., yes or no) regardless of how many demographic or behavioral characteristics were tailored on.

This approach to coding the theoretical content was taken for a number of reasons, including the following:

1. Early on in the examination of articles it became clear that although authors discussed particular health behavior change theories as theoretical bases for interventions, which theoretical concepts were tailored on were often inconsistent across studies, and in some cases interventions did not show "fidelity" to particular theories. Thus, it became clear that a focus on theoretical concepts rather than entire theories was appropriate.

2. Authors of articles often did not provide the kind of detail necessary to code the exact number of messages based on a particular theoretical concept (e.g., two self-efficacy messages). They did, however, provide detail on which theoretical concepts were tailored on, which allowed for coding of this feature of interventions.

3. Finally, the very nature of tailored interventions is such that different individuals may receive tailored feedback on differing types of variables, depending on, for instance, what stage of change they are in. Thus, coding on the exact number of theoretical messages is not possible, because Participant A may receive feedback on three processes of change, and Participant B may receive feedback on four different processes of change. Coding on the theoretical category "processes of change," however, is possible.

The coders and Seth M. Noar met to discuss each article after it was coded to compare the two coders' work and discuss any discrepancies that were present. Intercoder reliability was calculated for each characteristic that was coded. Percentage of agreement was calculated by dividing the number of agreed upon coding instances by the total, and was calculated for each coding category. For example, in the case of the comparison condition category, the coders agreed on 56 of the 57 studies, or 98% agreement. Cohen's (1960) kappa for intercoder reliability, which corrects for chance categorizations, was also calculated. Percentage of agreement ranged from a low of 89% to a high of 100%, with a mean percent agreement of 97% (most categories had 100% agreement). Cohen's kappa ranged from a low of .77 to a high of 1.0, with a mean kappa of .93. These figures indicated very good agreement among the coders. All discrepancies between coders were resolved through discussion between the two coders and Seth M. Noar.

Effect Size Extraction and Calculation

The Pearson correlation coefficient *r* was used as an effect size indicator (Rosenthal, 1991). We calculated effect sizes from data reported in the article (e.g., *t* test, summary statistics, *p* value) using appropriate formulas (Rosenthal, 1991). We first converted articles that reported results in terms of percentages to odds ratios, and then we converted them to *r* using the formula provided in Sanchez-Meca, Marin-Martinez, and Chacon-Moscoso (2003). To keep effect sizes consistent and interpretable, we gave all studies in which the tailored message condition outperformed the comparison/control condition a positive sign (+), whereas we gave all studies in which the comparison/control condition outperformed the tailored message condition a negative sign (−). In cases in which a study reported outcomes on more than one behavior (e.g., intervention on smoking cessation, diet, and exercise), one of the behaviors was randomly chosen to be included in the meta-analysis. All effect sizes were calculated from data based on the first follow-up time point (the most immediate outcome point) in which data were reported and effect size could be calculated. The first follow-up point was used for two reasons. First, if there are effects of an intervention, one would expect those effects to be present at short-term follow-up. Second, the primary focus of the current meta-analysis was to compare tailored and comparison messages with one another, and coding effect size at first follow-up minimized the passage of time and the potential impact of other variables.

Meta-Analytic Approach

Rosenthal's (1991) approach to meta-analysis was utilized. Once study characteristics were coded and effect sizes were extracted, a Fisher *r* to *z* transformation was performed on all *r*s. Those values were then weighted by each study's sample size, so that effect sizes based on larger samples were given more weight than effect sizes based on smaller samples. Next, all analyses were conducted on the data, including basic and moderator analyses. Finally, once all analyses were complete, effect sizes and 95% confidence intervals (CIs) were transformed back to *r*s for presentation.

For moderator analyses, we calculated effect sizes for hypothesized categorical moderators along with their 95% CIs, and then we statistically compared those effect sizes with one another using pairwise *Z* tests (Rosenthal, 1991). When multiple pairwise comparisons were made, a Bonferroni correction was made to control for Type 1 error (Dunn, 1961). We followed Keppel (1991) in keeping familywise error rate at $p < .10$ for sets of comparisons. In addition, in the case of continuous (i.e., interval–level) moderator variables, correlations were calculated between particular moderator variables and effect size.

Description of Studies

Fifty-six published articles met study criteria and were coded accordingly. Because one article had two published studies within it, the meta-analysis included 57 studies, with a cumulative $N = 58{,}454$ participants (median N per study = 535). All of the studies were published between 1989 and 2005, with a median publication year of 1999. Forty-two studies (74%) included combined male/female samples, whereas the remainder ($k = 15$, 26%) were studies of female participants only. Across the $k = 38$ studies that reported the gender breakdown of combined samples, mean proportion of female participants was 63%. Mean age across the $k = 52$ studies in which age was reported was 44.65 years. Studies included predominantly Caucasian participants. In fact, of the $k = 54$ studies that reported race/ethnicity, the mean proportion of Caucasians in samples was 82% ($SD = 28.94$). Additionally, of the $k = 30$ studies that were able to be coded on educational level, the mean proportion of those having a high school degree or more education was 77% ($SD = 20.48$). Finally, $k = 39$ studies (68%) involved U.S. samples, whereas $k = 18$ (32%) involved samples from primarily European countries, such as the United Kingdom ($k = 5$), the Netherlands ($k = 11$), and Australia ($k = 2$).

Table 1 lists each of the 57 studies along with various characteristics, including health behavior under study, theories utilized, whether the comparison condition was a no-treatment control or message condition, number of concepts tailored on, number of intervention contacts, length of follow-up, sample size, and effect size. In addition, Table 2 summarizes selected descriptors of the meta-analytic data set. As can be seen, the most widely studied behaviors in this literature were smoking cessation, dietary change, and mammography screening, although a number of other behaviors were also represented in this set of studies. Also, the most widely used theoretical models were the stages of change model, TTM, HBM, and SCT. Studies were also grouped into behavior "types," and it was found that most (67%) were preventive behaviors, whereas 28% were screening behaviors, and the remaining studies (5%) were of vaccination/immunization behavior.

Results

The first question examined was one of overall magnitude of effect. The sample size-weighted mean effect size was $r = .074$ (95% CI = .066, .082). This revealed that tailored messages had a greater impact on health behavior than did comparison/control conditions, and that the magnitude of this relation was slightly less than Cohen's (1988) conventional standard for a small effect size ($r = .10$). To examine whether there was heterogeneity among the effect sizes that made up the $r = .074$ overall effect size, we conducted a chi-square test of heterogeneity. Results indicated that there was significant heterogeneity among the effect sizes, $\chi^2(56, N = 58{,}454) = 412.02$, $p < .001$.

Moderator Analyses: Participant Features

The first set of analyses focused on how participant features were related to variability in effect sizes. Gender was examined first. As can be seen in Table 3, studies of female participants had slightly greater effect sizes when compared with studies with combined male/female samples. A pairwise Z test calculated to compare these effect sizes indicated that this difference was statistically significant, $Z = 1.69$, $p < .05$. This analysis should be interpreted with caution, however, because gender is confounded with behavior in these studies. That is, most of the female-only studies were studies of mammography screening (73%) or pap tests (13%). To account for this, we removed studies that included only female participants and examined how proportion of female participants in the combined samples correlated with effect size. Results indicated a small, nonsignificant correlation between greater proportion of female participants in samples and effect size, $r = -.10$, $p = .470$. This suggested a nonsignificant trend toward larger effect sizes in samples with fewer female participants.

Age group was examined next, followed by educational level. Mean age of study participants ranged from 11.5 to 67.2 years, with a mean of 44.65 and standard deviation of 12.20. A correlation calculated between age and effect size was found to be small and nonsignificant, $r = -.065$, $p = .645$, suggesting a nonsignificant trend toward larger effect sizes in younger samples. In addition, as reported above, the $k = 30$ studies that reported categories of educational levels had a mean proportion of participants with high school degrees or more education of 77% ($SD = 20.48$), suggesting fairly educated samples overall. A correlation calculated between proportion of those with high school or more education and effect size was found to be small and nonsignificant, $r = -.17$, $p = .372$, suggesting a nonsignificant trend toward greater effect sizes in samples with less educated participants.

Finally, racial/ethnic make-up of study participants and country of sample were examined. As already reported, studies primarily included Caucasian participants, with a mean proportion across studies of 82% ($SD = 28.94$). A correlation calculated between proportion of Caucasians in study samples and effect size was found to be small and nonsignificant, $r = .05$, $p = .709$, suggesting a nonsignificant trend toward greater effect sizes in samples with more Caucasian participants. Next, whether studies conducted in the United States had effect sizes that differed from those conducted in other, largely European countries was examined. As can be seen in Table 3, studies conducted outside the United States ($r = .116$) had greater effect sizes than those conducted in the United States ($r = .057$), and this difference was statistically significant, $Z = 6.46$, $p < .00001$.

Moderator Analyses: Type of Behavior

The next set of moderator analyses focused on the behaviors being intervened upon within studies. Effect sizes were calculated for the five health behaviors in which there were at least two studies, and these results are presented in Table 3. To date, tailored print interventions that have attempted to persuade women to get a pap test have been the most effective ($r = .138$), but this result should be interpreted with caution because it is based on only two studies. Print tailored interventions have also been effective with cessation of smoking ($r = .086$), adoption of a healthy diet ($r = .084$), mammography screening ($r = .055$), and adoption of exercise ($r = .028$). Pairwise Z tests were calculated to compare these effect sizes. A Bonferroni correction was used to control for Type 1 error among the 10 pairwise comparisons that were made, with alpha level being set at $p < .01$ (.10/10). Results indicated significant differences between smoking cessation and mammography ($Z = 2.74$, $p < .003$), smoking cessation and pap test ($Z = 3.18$, $p < .001$), diet and mammography ($Z = 2.24$, $p < .01$), diet and pap test ($Z = 2.97$, $p < .002$), mammography and pap test ($Z = 5.42$, $p < .00001$), and pap test and exercise ($Z = 2.15$, $p < .016$; marginally significant). No other significant differences were found.

Next, all study behaviors were grouped into "types" based on whether they were preventive behaviors ($k = 38$), screening behaviors ($k = 16$), or vaccination behaviors ($k = 3$), to examine whether effect sizes differed based on behavior type. As can be seen in Table 3, preventive behavior ($r = .090$) and screening behavior ($r = .083$) studies have had similar effect sizes, whereas vaccination behavior studies have had the smallest effects ($r = .035$). Z tests comparing these effect sizes, which used a Bonferroni correction for the three pairwise comparisons of $p < .03$ (.10/3), confirmed this observation. Both preventive behavior ($Z = 5.21$, $p < .00001$) and screening behavior ($Z = 4.43$, $p < .00001$) studies have resulted in significantly larger effect sizes than vaccination/immunization studies, but these two behavior types do not differ from one another ($Z = 0.73$, $p = .23$).

Table 1
Study Characteristics and Effect Sizes Included in the Meta-Analysis

Study	Health behavior	Theory	Comparison	T	B	D	IC	Follow-up	*N*	*r*
Ausems et al. (2002)	Smoking prevention/cessation	Social cognitive theory Theory of reasoned action Social inoculation theory	Control	4	N	N	3	6 months	70	.177
Ausems et al. (2004)	Smoking prevention/cessation	Attitude–social influence–self-efficacy model	Control	4	N	Y	3	6 months	781	.034
Aveyard et al. (2003)	Smoking cessation	Transtheoretical model	Message	5	N	N	3	12 months	1,373	.068
A. M. Baker et al. (1998)	Flu vaccination	Health belief model	Message	1	N	N	1	NR	12,320	.021
A. H. Baker & Wardle (2002)	Diet (fruit and vegetable intake)	Stages of change model	Control	2	N	N	1	6 weeks	641	.177
Bastani et al. (1999)	Mammography screening	Adherence model	Message	3	N	N	1	1 year	753	.096
Blissmer & McAuley (2002)	Exercise (regular physical activity)	Stages of change model	Message	4	N	N	4	4 months	82	−.183
Bowen et al. (1992)	Diet (fat intake)	-	Message		Y	N	1	Immediate	206	.143
Brug et al. (1996)	Diet (fat, fruit, and vegetable intake)	Attitude–social influence–self-efficacy model	Message	4	Y	N	1	3 weeks	347	.07
Brug et al. (1998)	Diet (fat, fruit, and vegetable intake)	-	Message	2	Y	N	1	1 month	431	.09
Brug, Steenhuis, et al. (1999)	Diet (fat, fruit, and vegetable intake)	Social cognitive theory	Message	4	Y	N	1	1 month	315	0
Bull, Kreuter, & Scharff (1999)	Exercise (leisure time and daily living physical activity)	Stages of change model	Message	3	Y	N	1	3 months	105	.026
J. R. Campbell et al. (1994)	Keeping pediatric preventive medical appointments	Health belief model	Message	2	Y	N	1	1 week	183	0
M. K. Campbell et al. (1994)	Diet (fat, fruit, and vegetable intake)	Stages of change model Health belief model	Message	7	Y	N	1	4 months	270	.081
Champion et al. (2002)	Mammography screening	Stages of change model Health belief model	Control	5	N	Y	1	8 weeks	499	.162
Clark et al. (2002)	Mammography screening	Transtheoretical model	Message	4	N	N	2	14 months	688	.062
Curry et al. (1991)	Smoking cessation	Social cognitive theory	Message	3	Y	N	1	3 months	609	.135
Curry et al. (1995)	Smoking cessation	Stages of change model Social cognitive theory	Message	3	Y	N	1	3 months	659	−.044
de Bourdeaudhuij & Brug (2000)	Diet (fat intake)	Theory of planned behavior Social cognitive theory	Message	4	Y	N	1	6 weeks	140	.086
de Nooijer et al. (2002)	Passive cancer detection	Attitude–social influence–self-efficacy model	Message	5	Y	N	1	3 weeks	874	.178
Dijkstra et al. (1998a)	Smoking cessation	Transtheoretical model	Control	3	Y	N	1	10 weeks	535	.289
Dijkstra et al. (1998b)	Smoking cessation	Transtheoretical model	Message	4	Y	N	1	4 months	299	.090
Dijkstra et al. (1999)	Smoking cessation	Transtheoretical model	Message	7	Y	Y	1	6 months	381	.077
Drossaert et al. (1996)	Mammography screening	Elaboration likelihood model	Message	4	N	N	1	3 months	2,070	.040
Elder et al. (2005)	Diet (fat and fiber intake)	Lay health advisor model	Message	3	N	N	12	3 months	206	0
Greene & Rossi (1998)	Diet (fat intake)	Transtheoretical model	Control	1	N	N	1	6 months	296	.13
Heimendinger et al. (2005)	Diet (fruit and vegetable intake)	Transtheoretical model Social cognitive theory	Message	8	N	Y	1	12 months	964	.04
Jibaja-Weiss et al. (2003)	Cervical cancer screening (Pap test)	Health belief model	Message	1	N	N	1	1 year	984	−.270
Kreuter & Strecher (1996)	Seat belt usage	Health belief model	Message	5	Y	N	1	6 months	535	.016
Kreuter, Oswald, et al. (2000)	Weight loss (includes diet and exercise)	Social cognitive theory	Message	6	Y	Y	1	1 month	198	.091
Kreuter et al. (2004)	Childhood immunizations (various)		Control	1	N	Y	1	9 months	642	.190
Kreuter et al. (2005)	Mammography screening	Stages of change model Health belief model	Message	8	Y	N	6	18 months	288	.157
Lipkus et al. (2000)	Mammography screening	Transtheoretical model	Message	3	N	N	1	1 year	732	−.016
Lutz et al. (1999)	Diet (fruit and vegetable intake)	Social cognitive theory Stages of change model Health belief model	Message	4	Y	N	4	6 months	276	.011
Marcus et al. (1998)	Exercise (regular physical activity)	Transtheoretical model Social cognitive theory Decision-making theory	Message	5	N	N	1	1 month	150	.161
Marcus et al. (2005)	Colorectal cancer screening	Transtheoretical model Health belief model	Message	3	N	N	1	6 months	2,192	.066
McCaul & Wold (2002)	Mammography screening	Health belief model	Control	1	Y	N	1	6 months	1,177	.065
Meldrum et al. (1994)	Mammography screening		Message		Y	N	1	1 year	3,083	.018

Table 1 (*continued*)

Study	Health behavior	Theory	Comparison	T	B	D	IC	Follow-up	*N*	*r*
Nansel et al. (2002)	Pediatric injury prevention	Health belief model	Message	6	N	Y	1	3 weeks	213	.231
Naylor et al. (1999)	Exercise (regular physical activity)	Stages of change model	Message	1	N	N	1	2 months	80	0
Owen et al. (1989)	Smoking cessation	Stages of change model Social cognitive theory	Message	3	Y	N	1	1 week	168	.063
Paul et al. (2004)	Cervical cancer screening (Pap test)	Social cognitive theory	Message	3	N	N	1	1 month	5,125	.214
Prochaska et al. (1993)	Smoking cessation	Transtheoretical model	Message	5	Y	N	1	6 months	360	0
Prochaska, Velicer, Fava, Rossi, & Tsoh (2001)	Smoking cessation	Transtheoretical model	Control	5	Y	N	2	6 months	4,144	.093
Prochaska, Velicer, Fava, Ruggiero, et al. (2001)	Smoking cessation	Transtheoretical model	Control	5	Y	N	1	6 months	727	.111
Prochaska et al. (2004)	Sun protection	Transtheoretical model	Control	5	Y	N	2	1 year	1,802	.137
Prochaska et al. (2005)	Diet (fat intake)	Transtheoretical model	Control	5	N	N	2	1 year	2,814	.095
Raats et al. (1999)	Diet (fat intake)	Stages of change model Theory of planned behavior	Control	9	Y	Y	2	18 weeks	103	.040
Rimer et al. (1994)	Smoking cessation	Transtheoretical model	Message	2	N	Y	1	3 months	1,048	.079
Rimer et al. (2001)	Mammography screening	Transtheoretical model Precaution adoption process model	Message	6	N	Y	1	1 year	804	−.049
Saywell et al. (2004)	Mammography screening	Stages of change model Health belief model	Control	5	N	Y	1	18 weeks	560	.136
Scholes et al. (2003)	Condom use	Stages of change model	Control	8	Y	Y	2	6 months	1,046	.137
Skinner et al. (1994)	Mammography screening	Stages of change model	Message	4	Y	N	1	8 months	496	.166
Strecher et al.'s (1994) Study 1	Smoking cessation	Stages of change model Health belief model	Message	5	Y	N	1	4 months	51	.292
Strecher et al.'s (1994) Study 2	Smoking cessation	Stages of change model Health belief model	Control	5	N	N	1	6 months	197	.032
Velicer et al. (1999)	Smoking cessation	Transtheoretical model	Message	5	Y	N	1	6 months	716	.076
Weaver et al. (2003)	Flu vaccination		Control	2	N	N	1	1 year	1,646	.077

Note. T = number of theoretical concepts tailored upon; B = behavior tailoring; D = demographic tailoring; IC = number of intervention contacts; *N* = total sample size; *r* = effect size; N = No; Y = Yes; NR = not reported.

Moderator Analyses: Intervention and Methodological Features

The effects of tailoring were considered next. In the current meta-analysis, there were two types of tailored print message studies: those that compared tailored messages with comparison messages (70%, $k = 40$) and those that compared tailored messages with no-treatment control conditions (30%, $k = 17$). Effect sizes and 95% CIs for studies with comparison message conditions are plotted in Figure 1, whereas effect sizes and 95% CIs of those studies with no-treatment control conditions are plotted in Figure 2. The sample size-weighted mean effect size for those studies in which the comparison group was another message condition was $r = .058$, whereas for those studies in which the comparison condition was a no-treatment control group, the effect size was $r = .111$. These effect sizes were significantly different from one another, $Z = 5.89$, $p < .00001$. Thus, tailored messages within these intervention studies have outperformed comparison (e.g., generic/targeted) messages and even further outperformed no-treatment control conditions.

Type of print materials was considered next. Print tailored messages have been delivered to participants in the form of letters (63%, $k = 36$), manuals/booklets (21%, $k = 12$), pamphlets/leaflets (7%, $k = 4$), newsletters/magazines (7%, $k = 4$), and calendars (2%, $k = 1$). Effect sizes were calculated among these different types of materials and compared (see Table 4). The single study that used calendars was not included in the analysis because of the lack of frequency of this type of print material. Results indicated that interventions that used pamphlets/leaflets had the largest effect sizes ($r = .168$), followed by newsletters/magazines ($r = .106$), letters ($r = .058$), and manuals/booklets ($r = .039$). We next calculated *Z* tests statistically comparing these effect sizes using a Bonferroni correction for the six pairwise comparisons of $p < .02$ (.10/6). Results demonstrated that the effect size for pamphlets/leaflets was significantly larger than for letters ($Z = 9.09$, $p < .00001$), manuals/booklets ($Z = 8.12$, $p < .00001$), and newsletters/magazines ($Z = 2.42$, $p < .007$). In addition, the effect size for newsletters/magazines was significantly larger than for letters ($Z = 2.00$, $p < .02$) and manuals/booklets ($Z = 2.56$, $p < .005$). No other significant differences were found.

Next, whether number of intervention contacts was associated with effect size was examined. Although most studies included a single intervention contact ($k = 44$, 77%), contacts ranged from 2 to 12 (median = 3) among the remaining $k = 13$ studies. Studies with a single intervention contact were compared with those with more than one intervention contact (see Table 4). Results indicated that interventions with more than one contact ($r = .092$) had significantly larger effect sizes than those with only one point of contact ($r = .068$), $Z = 2.46$, $p < .007$.

Length of follow-up was examined next. Length of follow-up ranged from immediate (data collected right after tailored message was presented) to 18 months later. The mean follow-up period was 23.09 weeks ($SD = 18.74$), or approximately 6 months. A small to

Table 2
Summary of Theories and Health Behaviors in the 57 Studies

Study Characteristic	*k*	%
Behavioral theories		
Stages of change model	18	32
Transtheoretical model	17	30
Health belief model	16	28
Social cognitive theory	11	19
Attitude–social influence–self-efficacy model	3	5
Theory of reasoned action	2	4
Theory of planned behavior	2	4
Other (one of each of the following: adherence model, elaboration likelihood model, lay health advisor model, precaution adoption process model, decision-making theory, social inoculation theory)	6	11
Behaviors		
Smoking cessation	15	26
Diet	13	23
Mammography screening	12	21
Exercise	4	7
Vaccination/immunization	3	5
Pap test	2	4
Other (one of each of the following: sunscreen use, safer sex, passive cancer detection, seatbelt use, colorectal cancer screening, injury prevention, routine medical appointments, diet and exercise)	8	14
Behavior Types		
Preventive behavior	38	67
Screening behavior	16	28
Vaccination/immunization behavior	3	5

Note. The behavioral theories percentages sum to greater than 100 because some studies used more than one theory. *k* = number of studies.

medium-sized and statistically significant correlation between follow-up time period and effect size was observed, $r(55) = -.22$, $p < .05$. As expected, studies with shorter follow-up time periods had larger effects on health behavior.

Type of recruitment was examined next. A small number of studies took place at universities (5%, $k = 3$), schools (4%, $k = 2$), or worksites (2%, $k = 1$). The predominant studies in this literature, however, enrolled participants onsite at a clinic or health center (26%, $k = 15$), from households using "reactive recruitment" strategies, such as newspaper, radio, television ads, or hotline callers (25%, $k = 14$), or from households using "proactive recruitment" strategies, such as telephone or mail (38%, $k = 22$). These latter three recruitment strategies contained enough studies for meaningful comparison, and the effect sizes for these three categories were calculated and compared (see Table 4). Results indicated that both proactive ($r = .094$) and reactive ($r = .094$) recruitment-based studies had identical effect sizes, whereas clinic-based studies had smaller effect sizes ($r = .042$). Pairwise *Z* tests that compared these effect sizes and that used a Bonferroni correction for the three pairwise comparisons of $p < .03$ confirmed this observation. Namely, both proactive ($Z = 5.68$, $p < .00001$) and reactive ($Z = 4.07$, $p < .00001$) studies had significantly larger effect sizes than did clinic-based studies.

Finally, whether publication year was associated with effect size was examined. A near-zero and nonsignificant correlation between publication year and effect size was observed, $r(55) = .01$, $p = .93$, indicating no significant relationship among these two variables.

Moderator Analyses: Theoretical Concepts

Both the number and type of theoretical concepts that informed the tailoring of print messages varied greatly among the studies. Nearly every study tailored on at least one concept from a behavioral theory (96%, $k = 55$). In fact, studies tailored on between zero and nine theoretical concepts, with a mean of 3.96 concepts ($SD = 2.04$) per study. Tailoring on the behavior took place in just over half of the studies (54%, $k = 31$), whereas only 18% ($k = 10$) of studies tailored on demographic variables. Particular studies, however, utilized differing combinations of these tailoring variables and concepts. Thus, to examine whether any particular combination of theoretical, behavioral, and demographic factors was most potent in tailoring, we grouped studies according to which factors they tailored on. These groupings indicated that 4% ($k = 2$) of studies tailored on behavior only, 33% ($k = 19$) tailored on theoretical concepts only, 12% ($k = 7$) tailored on theoretical concepts and demographics, 46% ($k = 26$) tailored on theoretical concepts and behavior, and 5% ($k = 3$) tailored on theoretical concepts, behavior, and demographics. Effect sizes were calculated within each of these groupings and can be seen in Table 4. As can be seen, a trend emerged suggesting a growing effect of tailoring with increasing concepts/factors that are tailored on, including behavior only ($r = .026$), theoretical only ($r = .065$), theoretical plus demographics ($r = .087$), theoretical plus behavior ($r = .092$), and finally theoretical plus behavior and demographics ($r = .122$; see Figure 3). Pairwise *Z* tests that compared these effect sizes and that used a Bonferroni correction for the 10 pairwise comparisons of $p < .01$ revealed that the theoretical only ($Z = 2.13$, $p < .016$), theoretical plus demographics ($Z = 2.69$, $p < .003$), theoretical plus behavior ($Z = 3.46$, $p < .002$), and theoretical plus behavior and demographics groupings had significantly larger effect sizes than the behavior only grouping. In addition, the theoretical plus behavior grouping ($Z = 2.84$, $p < .002$) and the theoretical plus behavior and demographics grouping ($Z = 2.08$, $p < .018$; marginally significant) had significantly larger effect sizes than the theoretical only grouping. No other significant differences were found.

As the above analysis does not take into account the number of theoretical concepts that are tailored on, we next examined whether number of theoretical concepts tailored on was related to effect size. There was a clear group of studies that tailored on four or five theoretical concepts. Thus, studies were broken into three groups—those that tailored on 0–3 concepts (38%, $k = 22$), 4–5 concepts (46%, $k = 26$), and 6–9 concepts (16%, $k = 9$). Effect sizes calculated on these three groups can be seen in Table 4. Pairwise *Z* tests that compared these effect sizes and that used a Bonferroni correction for the three pairwise comparisons ($p < .03$) revealed that those studies tailoring on 4–5 concepts ($r = .093$) had significantly larger effect sizes than those tailoring on 0–3 concepts ($r = .062$), $Z = 3.51$, $p < .001$. No other significant differences were found.

Finally, we examined whether tailoring on particular theoretical concepts was associated with larger or smaller effect sizes in studies. For this analysis, only concepts that were included in multiple studies were examined. For instance, a number of con-

Table 3
Sample Size-Weighted Effect Sizes by Participant Characteristics, Health Behavior, and Health Behavior Type

Variable	*N*	*k*	*r*	95% CI	Pairwise comparisons[a]
Gender					
Female-only samples	18,511	15	.084	.070, .098	Combined < female
Combined samples	39,943	42	.069	.059, .079	
Total	58,454	57			
Country of sample					
U.S. studies	41,638	39	.057	.047, .067	U.S. < non-U.S.
Non-U.S. studies	16,816	18	.116	.101, .131	
Total	58,454	57			
Health behavior					
Smoking cessation	11,921	15	.086	.068, .104	Mammography < smoke
Diet	7,009	13	.084	.061, .107	Mammography < diet
Mammography screening	11,347	12	.050	.032, .068	Smoke, diet < pap
Exercise	417	4	.028	−.069, .125	Mammography < pap
Pap test	6,109	2	.136	.111, .161	Exercise < pap
Total	36,803	46			
Health behavior type					
Preventive behavior	23,324	38	.090	.077, .103	Vaccination < preventive
Screening behavior	20,522	16	.083	.069, .097	Vaccination < screening
Vaccination/immunization	14,608	3	.035	.019, .051	
Total	58,454	57			

Note. N = sample size; k = number of studies; r = sample size-weighted mean effect size; CI = confidence interval.
[a] Statistically significant pairwise comparisons. Alpha level differs by comparison due to Bonferroni corrections—see text for details.

cepts, including goal setting, relapse prevention, knowledge, locus of control, perceived importance, need for change, and reinforcement were only included in a single study and thus were not analyzed. As already mentioned, although it was of interest to compare studies that used entirely different theories to one another, and in that manner compare all studies to one another in a single analysis, this was not possible because many studies used multiple theories, and those that chose a single theory often did not show "fidelity" to that particular theory in terms of tailoring concepts. Thus, we instead used a more limiting but still potentially fruitful bivariate approach to analyzing theoretical concepts, focusing on the presence or absence of individual theoretical concepts in the tailored message studies. Although this approach is limiting in part because some studies (i.e., those with more concepts) are included in more analyses than others, it still has the potential to provide clues to effective concepts on which to tailor.

Table 5 lists all of the concepts that were tailored on in enough studies to be meaningfully analyzed and reports effect sizes of studies that did and did not tailor on these concepts. As can be seen, a pattern emerged such that nearly every study that tailored on the theoretical concepts had larger effect sizes that those that did not. The sole exception to this pattern was perceived susceptibility, which showed the reverse pattern, with studies tailoring on this concept showing smaller effects than those that did not. We conducted pairwise Z tests comparing each effect size pair using a Bonferroni correction for the eight pairwise comparisons ($p < .01$). Results indicated that studies tailoring on attitudes ($Z = 2.38$, $p < .003$), self-efficacy ($Z = 4.40$, $p < .00001$), stage of change ($Z = 2.64$, $p < .004$), social support ($Z = 9.88$, $p < .00001$), and processes of change ($Z = 2.17$, $p < .016$; marginally significant) had significantly larger effect sizes than those that did not tailor on these concepts. Studies tailoring on perceived susceptibility ($Z = 6.87$, $p < .00001$) had significantly smaller effect sizes compared with those that did not. No other significant differences were found.

Discussion

The overriding purpose of the current study was to quantitatively synthesize the literature on tailored print health behavior change interventions to provide answers to the question of whether tailoring enhances the effects of health promoting messages. To our knowledge, this is the first meta-analysis of its kind. The sample size-weighted mean effect size was $r = .074$, indicating that tailored messages have been effective in stimulating health behavior change with an effect size of slightly less than "small" magnitude (Cohen, 1988). A number of studies in this literature, however, have compared tailored messages with no-treatment control conditions, which is not a true test of tailoring per se. Perhaps the most compelling finding was the effect size calculation of just those studies that compared a tailored message with a comparison message (i.e., generic or targeted message). The $k = 40$ studies with this type of comparison had a mean sample size-weighted effect size of $r = .058$, which can also be represented by a $d = 0.12$ or an odds ratio = 1.21. This suggests that tailored messages have in fact outperformed comparison messages in affecting health behavior change, lending support to claims made by narrative reviewers that tailoring does in fact "work" (e.g., Kreuter, Farrell, et al., 2000; Rimer & Glassman, 1999; Skinner et al., 1999).

Why might tailored communication be more effective in persuading individuals to change their health behavior as compared with more generic messages? One explanation is provided by Petty and Cacioppo's (1981) elaboration likelihood model (also see Petty, Barden, & Wheeler, 2002). This model suggests that individuals engage in two types of processing of messages—central and peripheral route processing. Central route processing is char-

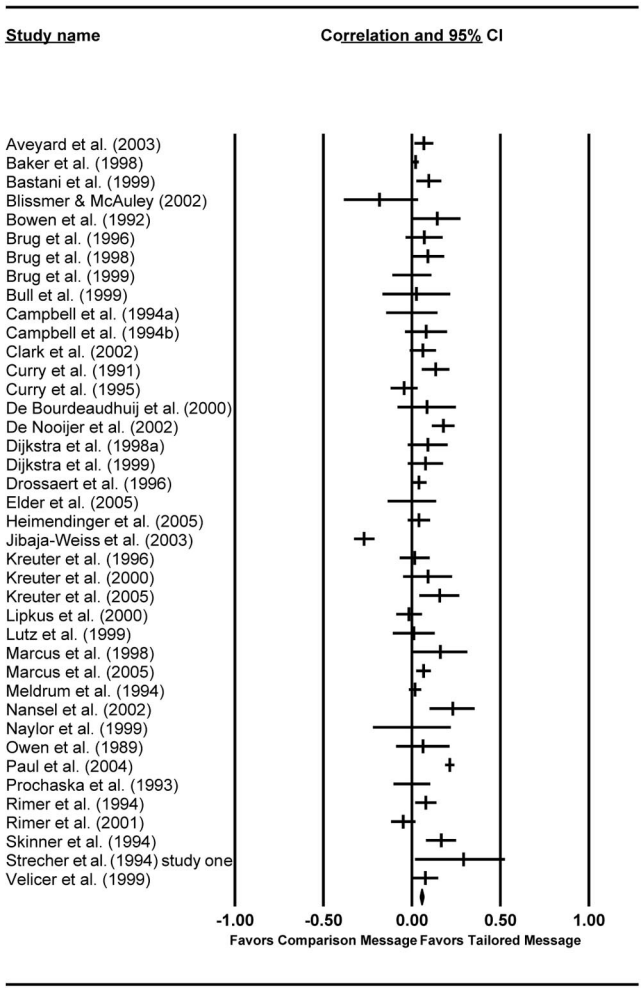

Figure 1. Forest plot displaying effect sizes and 95% confidence intervals (CIs) of studies comparing a tailored message with a comparison message. Brug et al. (1999) = Brug, Steenhuis, van Assema, Glanz, and De Vries (1999); Bull et al. (1999) = Bull, Kreuter, and Scharff (1999).

acterized by a careful examination of the arguments contained within a message, whereas peripheral route processing is characterized by a reliance on heuristics or cues that may be persuasive (in the short term) but tend to be unrelated to the core arguments contained within a message. Central route processing results in attitudes which are more likely to remain stable over time and to be related to future behaviors as compared with peripheral route processing. The model suggests that the extent to which individuals are motivated to "elaborate" with regard to a message and engage in central processing is heavily influenced by personal involvement with a message. Tailored messages have the advantage of being customized to individuals to increase the chances that the message will be viewed as personally relevant, central processing will take place, and an individual will be persuaded. This theoretical explanation is also consistent with both reviews of the literature that demonstrate that tailored messages are more likely to be read, understood, recalled, rated highly, and perceived as credible (Kreuter, Farrell, et al., 2000; Kreuter & Holt, 2001; Rimer & Glassman, 1999; Skinner et al., 1999), as well as with empirical studies that show greater impact of health education materials that are perceived as a better "fit" by participants (Kreuter, Oswald, Bull, & Clark, 2000; also see Kreuter & Wray, 2003).

In addition, narrative reviews of the tailored message literature have consistently remarked that we need to learn a great deal more about the mechanisms underlying effective tailoring and tailored interventions, or the so called "black box" of tailoring (Abrams et al., 1999; Kroeze et al., 2006; Skinner et al., 1999). Thus, another major aim of the current study was to examine which features of tailored interventions related to larger effect sizes, which was achieved through the examination of a number of potentially important moderating variables. Results indicated that participant characteristics (e.g., gender, race, education level) were generally unrelated to effect size. This result is not surprising, as the overriding concept of tailoring is one of customization of a message to a particular individual. Thus, whether participants are men or women, African-American or Caucasian, a carefully tailored message should be relevant and potentially effective with the individual for whom it was created. These findings suggest that tailoring is an appropriate health communication strategy for numerous target populations.

One unexpected finding related to participant characteristics was that studies conducted in non-U.S. countries, namely the Netherlands, United Kingdom, and Australia, had a mean effect size of double that of studies based in the United States. One potential explanation is that non-U.S. studies also had other characteristics that were found to be related to larger effect sizes. For instance, whereas the mean length of follow-up period for U.S. studies was 26.89 weeks, the mean follow-up period for non-U.S. studies was nearly half that, or 15.06 weeks. The current meta-analysis found shorter follow-up periods to be related to significantly larger effect sizes. Moreover, 14 of 18 non-U.S. studies, or 78%, focused on pap test ($k = 1$), smoking ($k = 7$), or dietary behavioral change ($k = 6$). Interventions of these three behaviors were those that were found to have the largest effect sizes in the meta-analysis. Thus, it appears that non-U.S. studies achieved larger effect sizes because of these other characteristics. We cannot rule out the alternative explanation, however, that some participant or intervention characteristic(s) (e.g., difference in base rate of health behaviors) was responsible for the greater effectiveness of non-U.S. studies.

With regard to health behaviors, the current meta-analysis suggests that print tailored interventions focused on preventive behaviors, such as smoking cessation and dietary change, and screening behaviors, such as mammography and pap tests, have been the most successful applications of print tailoring to date. Given that such behaviors contribute to many of the leading causes of death in the United States (Mokdad et al., 2004, 2005), such results are promising. Although pap test studies achieved the largest effect sizes, this estimate was based on only two studies and should be interpreted with caution. Further studies in this area may bring a better understanding of the potential of tailoring applied to this and other screening behaviors. Similarly, although vaccination studies as a group achieved the smallest mean effect sizes, there were only three such studies in our sample, which is not enough to make strong conclusions regarding the application of tailoring to this class of behaviors. Future studies of vaccination behavior may help

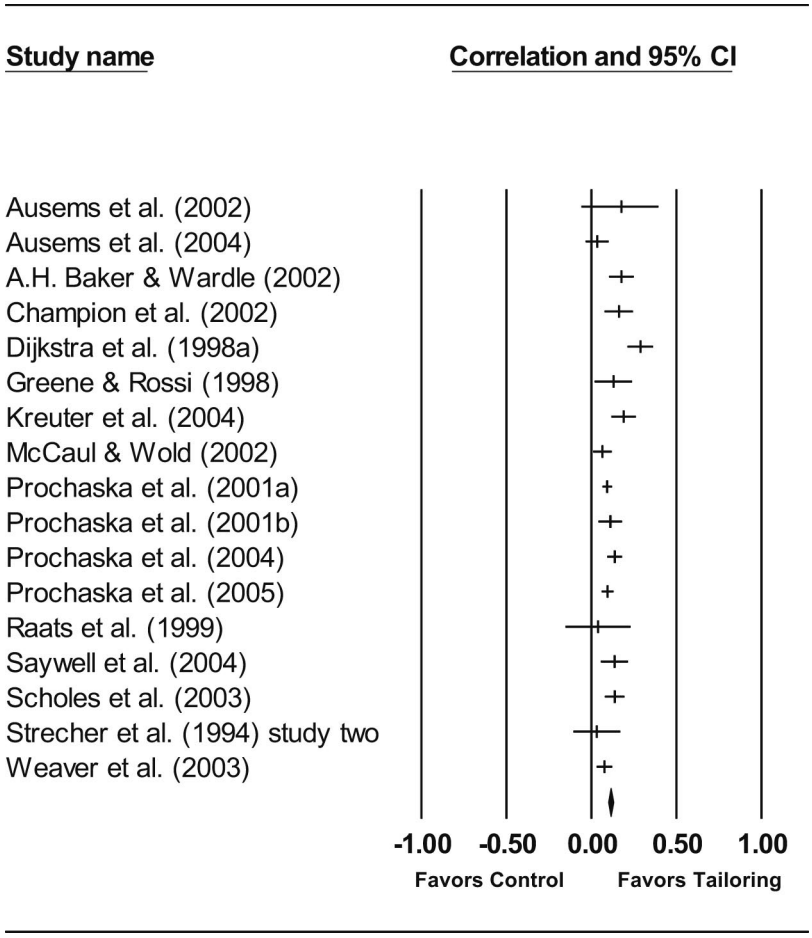

Figure 2. Forest plot displaying effect sizes and 95% confidence intervals (CIs) of studies comparing a tailored message with a no-treatment control condition. Prochaska et al. (2001a) = Prochaska, Velicer, Fava, Rossi, and Tsoh (2001); Prochaska et al. (2001b) = Prochaska, Velicer, Fava, Ruggiero, et al. (2001).

us to better understand the potential effects of tailoring on this class of behaviors.

The current meta-analysis also examined intervention and methodological characteristics as potential moderators of effect size. Analysis of the type of print materials that were used in interventions suggested that the most successful print tailored materials have been pamphlets, newsletters, or magazines, rather than letters, manuals, or booklets. Why might this be the case? Although few study authors provided details on the layout of print materials, it may be that pamphlets, newsletters, and magazines were more likely to include pictures and graphics and to have superior layout characteristics that may have helped to garner and perhaps retain the attention of participants. Donohew, Lorch, and Palmgreen (1998) argue that capturing attention is a prerequisite to persuasion with regard to health education messages. If materials are not sufficiently stimulating to attract and keep the attention of an individual, that individual may lose interest, and the content of the message will not have had an opportunity to be persuasive (Donohew et al., 1998). One empirical study of tailored print materials found evidence to support this proposition. Namely, participants who found the materials to be "attractive" were significantly more likely to pay attention to, like, and understand the health information, or what the authors referred to as "preliminary steps to behavior change" (Bull, Holt, Kreuter, Clark, & Scharff, 2001, p. 275). Others have additionally made the case that the layout of health education materials can have an effect on whether individuals pay attention to, read, and ultimately process health information (e.g., Kreuter, Farrell, et al., 2000; National Cancer Institute, 2001). In fact, in their book on tailored health messages, Kreuter, Farrell, et al. (2000) go as far as to state that with regard to tailored materials, "Good visual design can be as important to the success of a tailored communication piece as the message content itself" (p. 105). Visual design and layout includes a number of considerations, and developers of tailored interventions and other health promotion materials should seek guidance when developing such materials (see Kreuter, Farrell, et al., 2000). In addition, it should also be noted that the type of print material with the smallest effective size (i.e., manuals) also tends to be the longest in length. Length of print materials is also an important consideration when it comes to creating tailored messages, as those that are too lengthy may not be read by participants.

Table 4
Sample Size-Weighted Effect Sizes by Intervention, Methodological, and Theoretical Characteristics

Variable	*N*	*k*	*r*	95% CI	Pairwise comparisons[a]
Comparison condition					
Comparison message	40,774	40	.058	.048, .068	Comparison < control
No-treatment control group	17,680	17	.111	.096, .126	
Total	58,454	57			
Type of print material					
Letter	40,361	36	.058	.048, .068	Letter < pamphlet
Manual/booklet	7,586	12	.039	.016, .062	Manual < pamphlet
Pamphlet/leaflet	8,049	4	.168	.146, .190	Newsletter < pamphlet
Newsletter/magazine	1,816	4	.106	.060, .151	Letter < newsletter
Total	57,812	56			Manual < newsletter
Intervention contacts					
One contact	44,781	44	.068	.059, .077	One < more than one
More than one contact	13,673	13	.092	.075, .109	
Total	58,454	57			
Recruitment venue/strategy					
Clinic/health center	21,627	15	.042	.029, .056	Clinic < reactive
Reactive recruitment (e.g., newspaper, radio ads)	8,524	14	.094	.073, .115	Clinic < proactive
Proactive recruitment (e.g., telephone, mail)	26,714	22	.094	.082, .106	
Total	56,865	51			
Tailoring combinations					
Behavior only (B)	3,289	2	.026	−.008, .060	B < T, TB, TD, TBD
Theoretical concepts only (T)	32,273	19	.065	.054, .076	T < TB, TBD
Theoretical + demographics (TD)	4,730	7	.087	.058, .116	
Theoretical + behavior (TB)	16,815	26	.092	.077, .107	
Theoretical + behavior + demographics (TBD)	1,347	3	.122	.069, .175	
Total	58,454	57			
Theoretical concepts					
0–3 concepts	32,286	22	.062	.051, .073	0–3 < 4–5
4–5 concepts	20,901	26	.093	.079, .107	
6–9 concepts	4,267	9	.073	.043, .103	
Total	58,454	57			

Note. *N* = sample size; *k* = number of studies; *r* = sample size-weighted mean effect size; CI = confidence interval.
[a] Statistically significant pairwise comparisons. Alpha level differs by comparison due to Bonferroni corrections—see text for details.

We also found that studies in which participants were recruited proactively and reactively, respectively, had identical effect sizes. Given that many of the studies in this literature were large funded trials, it may be that studies that used reactive recruitment methods achieved reasonably representative samples that were similar in many ways to samples achieved through proactive recruitment. In addition, studies that used proactive and reactive recruitment methods had larger effect sizes than studies taking place at clinics and health centers. An explanation for this finding may be the following: Those in the clinic-based samples may have had lower socioeconomic status (SES) as compared with the other samples, including a higher proportion of racial/ethnic minorities and less education. As SES is positively associated with health status (Adler & Ostrove, 1999), it is likely that the clinic-based samples included more disadvantaged populations who had more challenges to changing their health behavior as compared with the other samples. We do not interpret this to mean that tailored materials cannot be effective with those of lower SES. Rather, it may be important to pay increased attention to relevant issues, such as health literacy (e.g., Bernhardt & Cameron, 2003) and structural barriers to change (e.g., Blankenship, Bray, & Merson, 2000), in the creation of such materials.

Further, analyses revealed that another important moderating variable was number of intervention contacts. This is particularly important in the tailoring area given that many studies are based on a stage of change perspective that suggests that individuals may move slowly through the stages and may cycle and recycle through the stages numerous times before ultimately maintaining a behavior change (Prochaska et al., 1992). Thus, such a model suggests that individuals may need multiple points of contact in which feedback is dynamically tailored to their current stage of change, attitudes, and so forth. Moreover, studies with additional intervention contacts have the opportunity not only to give additional feedback but to give a different type of feedback. Studies with one point of contact typically give individuals *normative feedback*, or tailored messages based on a comparison of one's responses to those of their peers. Studies with multiple contacts, however, have the opportunity to give individuals so called *ipsative feedback*, or messages based on a comparison of one's current responses with their responses at the previous intervention time point (Prochaska et al., 1993; Velicer et al., 1993). The current meta-analysis suggests that studies that utilized more intervention contact points, many of which included ipsative feedback, were more effective in stimulating health behavior change than those that did not.

The primary focus of the current meta-analysis was on comparing tailored with comparison messages to examine whether tailoring increased the efficacy of health-related messages. To avoid introducing a number of potentially confounding variables into this analysis, we focused only on print materials and only on short-term effects of interventions. A future meta-analysis in this area, how-

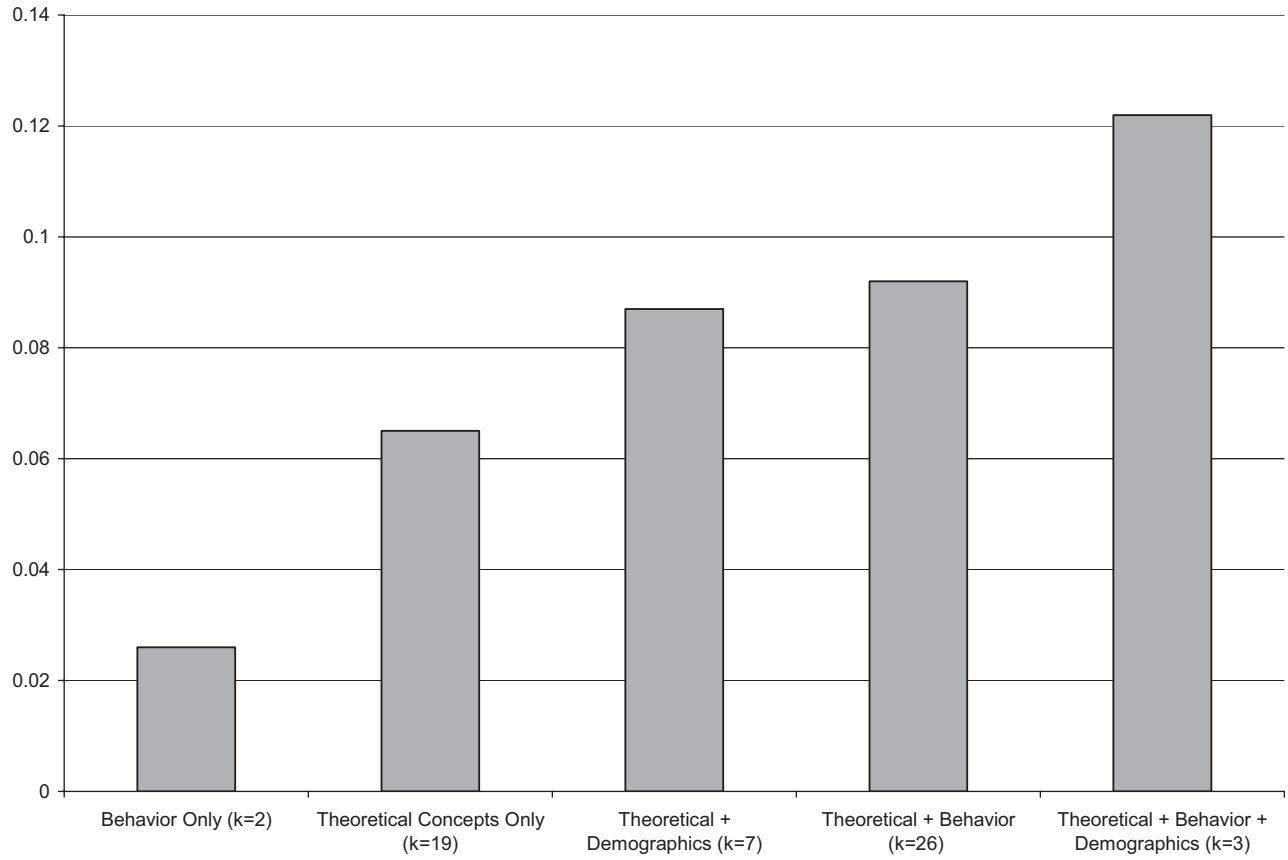

Figure 3. Comparison of effect sizes of differing combinations of tailoring factors, including theoretical concepts, behavior, and demographics.

ever, might give more focus to the longer term outcomes of tailored interventions and perhaps include other modes of intervention. This would allow for a more in depth examination of the impact of additional intervention contacts and ipsative feedback on longer term outcomes as well as the effects of differing tailoring modalities on intervention outcomes. Although some studies in the tailored literature have compared numerous tailored components in one condition with a usual care or comparison condition (e.g., Brinberg, Axelson, & Price, 2000; Jacobs et al., 2004; Kristal, Curry, Shattuck, Feng, & Li, 2000), which does not allow the independent contribution of the tailored components to be examined, many studies have examined the impact of additional modes of intervention in separate conditions that do allow for comparison. For instance, whether tailored telephone counseling adds to the effectiveness of tailored print materials has been examined in several studies (e.g., Jacobs et al., 2004; Prochaska et al., 1993; Prochaska, Velicer, Fava, Ruggiero, et al., 2001; Rimer et al., 1999), and such a question could be examined in a future meta-analysis of this literature.

Finally, the issue of which theoretical concepts and other variables informed tailoring was examined in the current meta-analysis. Results suggest that tailoring on 4–5 theoretical concepts (or perhaps more) is more effective than tailoring on 0–3. In addition, the specific concepts most clearly associated with larger effect sizes included attitudes, self-efficacy, stage of change, processes of change, and social support (although the social support analysis was based on only four studies). This suggests that health behavior theories that put a central focus on these concepts might be the most fruitful conceptual basis for tailored interventions, including such theories as SCT, TPB, TTM, the integrated model (Fishbein, 2000), and the attitude–social influence–efficacy model (De Vries, & Mudde, 1998). The only theoretical concept found to be associated with significantly decreased effect sizes was perceived susceptibility. Why was this the case? It may be that in a number of health domains, messages that focus on increasing positive views and feelings toward a health behavior (i.e., attitudes) and those that increase one's confidence in performing the behavior (i.e., self-efficacy) are more motivating to health behavior change than messages that raise the threat of a disease. In fact, a recent meta-analysis examining the impact of theoretical strategies in persuasive health communications found just that result (Albarracin et al., 2003). Namely, messages that presented attitudinal information and/or modeled behavioral skills (i.e., raised self-efficacy) were found to affect condom use, whereas messages aimed at raising the threat of HIV/AIDS had no such effect. The literature on perceptions of risk and their relation to health behavior remains mixed, with some meta-analyses finding no association (Gerrard, Gibbons, & Bushman, 1996), others finding a modest association (Harrison, Mullen, & Green, 1992), and still others finding a stronger association (Brewer et al., 2007). It may be that

Table 5
Sample Size-Weighted Effect Sizes by Theoretical Concepts

Variable	*N*	*k*	*r*	95% CI
Theoretical concepts				
Attitudes				
No	22,968	10	.059	.046, .072
Yes	35,486	47	.083*	.073, .093
Social norms				
No	53,163	50	.073	.064, .082
Yes	5,291	7	.085	.058, .112
Self-efficacy				
No	34,396	25	.059	.048, .070
Yes	24,058	32	.096*	.083, .109
Perceived susceptibility				
No	31,700	20	.100	.089, .111
Yes	26,754	37	.043*	.031, .055
Processes of change				
No	44,360	42	.069	.060, .078
Yes	14,094	15	.090*	.073, .107
Behavioral intentions				
No	54,255	49	.073	.065, .081
Yes	4,199	8	.082	.052, .112
Stage of change				
No	32,870	23	.064	.053, .075
Yes	25,584	34	.086*	.074, .098
Social support				
No	52,676	53	.060	.051, .069
Yes	5,778	4	.197*	.169, .219

Note. N = sample size; k = number of studies; r = sample size-weighted mean effect size; CI = confidence interval.
* Pairwise comparison is statistically significant at $p < .01$.

important moderators are important to take into account with regard to understanding this association, including the behavior and population under study. Moreover, if most individuals in a given study concede that they have high perceived susceptibility but continue the behavior despite this, then perceived susceptibility may not be the most effective concept for tailoring because of a lack of variability. That is, variables that are good candidates for tailoring are those that exhibit much variability at the individual level, as those that do not will result in most or all individuals receiving the same message. In that case, the message is essentially targeted rather than tailored (see Kreuter, Farrell, et al., 2000; Kreuter & Wray, 2003).

In addition, a trend was found suggesting a growing effect of tailoring in which studies that tailored on only behavior had the weakest effects, followed by theoretical concepts only, followed by theoretical concepts plus demographics or plus behavior, and followed by studies that tailored on theoretical characteristics, behavior, and demographics. This conclusion is preliminary both because the first and last of these groupings had only two and three studies in them, respectively, as well as the fact that significance tests did not find differences between each and every one of these groupings. Conceptually, however, such a pattern would be consistent with effects that might be expected from tailoring. Providing feedback on the behavior by itself is typically the minimal amount of tailoring that has been conducted in this literature (e.g., one or two sentences of feedback about the behavior). In contrast to this, tailoring on theoretical concepts from behavioral theories has been embraced by the literature and has become a staple practice (e.g., Kreuter et al., 1999; Kroeze et al., 2006). Such tailoring is typically more elaborate and contains more feedback than studies tailoring on the behavior by itself. In fact, in the current meta-analysis, the typical study was found to tailor on approximately four theoretical concepts, resulting in much more feedback than studies tailoring only on the behavior as well as potentially more potent feedback, given that it is theory based. Thus, one would expect greater effects from theoretical tailoring than behavior only tailoring.

Further, there is some support in the literature for the idea that although theoretical tailoring may be effective, additional types of tailoring in combination with theoretical tailoring may enhance its effectiveness. For instance, Kreuter et al. (2005) examined the impact of tailored health magazines on African American women's mammography and dietary behaviors, comparing theoretical tailoring only, cultural tailoring only, and theoretical plus cultural tailoring. Results indicated that the theoretical plus cultural tailoring condition significantly outperformed the theoretical tailoring only condition on both mammography and dietary behavioral change. Although few additional studies have examined the "value added" of other tailoring strategies over and above theoretical tailoring, the current meta-analysis suggests that carefully tailoring on demographic characteristics (e.g., gender, race, age) and giving feedback on the behavior itself may enhance the effectiveness of theoretical tailoring. Future studies should consider the broad range of sociodemographic, psychosocial, biological, and clinical variables that can be tailored on (see Rakowski, 1999), and studies might formally test the "value added" of additional forms of tailoring over and above that achieved by theoretical tailoring alone.

Moreover, the idea of tailoring on variables other than theoretical concepts is related to the findings above that certain print materials, perhaps those with greater visual elements, were more effective in stimulating health behavior change as compared with other materials. Within tailored interventions, one cannot only tailor text-based messages, but images and other visual elements can be tailored as well. Rimer and Glassman (1999) have suggested that "No reason exists to believe that a letter with a few tailored elements would be as effective as a brochure with information and graphics tailored to the reader" (p. 145). The results of the current meta-analysis appear to support this conclusion. Future studies, however, might more formally test the "value added" of tailoring on graphics and other visuals to provide a more clear empirical test of this proposition. Although studies in the current meta-analysis tailored on variables that lend themselves to tailoring images, such as gender (e.g., Kreuter, Oswald, et al., 2000) and race/ethnicity (e.g., Scholes et al., 2003), authors were unclear exactly how tailoring on these elements was achieved and whether this included visual elements. Future studies of tailoring might better report the details of how tailoring was enacted and, in particular, whether visual elements were (a) included or not, and (b) tailored on or not.

Population-Level Application of Tailoring

The current study suggests that tailoring health behavior change messages, which refers to customization of health messages/materials at the individual level, is an effective health behavior change practice. In addition, a combination of three factors makes this approach particularly promising: (a) the potential for

population-level impact, (b) individual tailoring of messages, and (c) economies of scale once the tailored program is created. That is, a unique aspect of tailored interventions is their ability to be delivered at the population level while being tailored at the individual level. For instance, Velicer et al. (2006) have argued that even if in-person, clinic-based interventions are more efficacious than population-level tailored interventions, population-level interventions are capable of far greater impact given their potential for wide reach (impact = efficacy times reach; Abrams et al., 1996). Unlike intervention approaches that require in-person visits and/or those that are reactive in nature (e.g., telephone hotlines), tailored interventions can be delivered in a proactive manner and are capable of reaching entire populations (see Abrams et al., 1999; Strecher, 1999; Velicer et al., 2006). Tailored materials are also developed utilizing computer-based algorithms, and once the initial work of developing materials is done the tailored program may yield dividends over time, as the costs of using the interventions once they are developed is quite small (see Lairson et al., 2004). Finally, unlike targeted mass media campaigns in which every individual in the target audience receives the same message (e.g., Noar, 2006b), tailored interventions provide customization of messages at the individual level, likely increasing personal relevance of messages and the possibility of persuasion (Kreuter & Wray, 2003). This combination of factors results in a unique and promising health education strategy for potential population-level public health impact.

Conclusion and Implications

The current meta-analysis provides evidence of the effectiveness of tailoring health behavior change messages as well as suggests numerous factors that appear to moderate the effects of tailoring. Many of these factors may be crucial in informing future interventions in this area. In particular, the strongest print tailored health behavior change interventions to date are those that (a) intervened on preventive or screening behaviors; (b) generated pamphlets, newsletters, or magazines (perhaps including visual elements); (c) utilized more than one intervention contact; (d) were conducted with non-U.S. participants; (e) had shorter periods between intervention and follow-up; (f) recruited participants from households rather than clinics or health centers (perhaps because of differences in SES); (g) tailored on 4–5 theoretical concepts (or more) as well as behavior and demographics; and (h) used a behavioral theory that includes concepts such as attitudes, self-efficacy, stage of change, processes of change, and perhaps social influences (such as social support). These might include SCT, TPB, TTM, the integrated model, and the attitude–social influence–efficacy model.

The current meta-analysis has also suggested a number of future directions for print-based tailoring studies, and many of these future directions have applicability to tailored interventions conducted with new media technologies as well (e.g., Cassell, Jackson, & Cheuvront, 1998; Etter, 2005; Neuhauser & Kreps, 2003). Clearly, with new technologies—including Internet websites, instant messaging, electronic mail, personal desktop assistants, cell phones with text messaging and graphics capabilities, and computerized kiosks—there is seemingly limitless potential for tailored messages and interventions well into the 21st century. Interventions utilizing such modalities will only have the greatest chance of being effective, however, if we understand the basic participant, intervention, methodological, and theoretical characteristics associated with effective tailoring. The current meta-analysis provides answers to some of these questions from the "first generation" of tailored health behavior change interventions.

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