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Extending TTM-Based Quantitative Predictions to HIV Prevention Among MSM

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EXTENDING TTM-BASED QUANTITATIVE PREDICTIONS TO HIV PREVENTION AMONG MSM

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ABSTRACT

The purpose of this study was to extend the Testing Theory-based Quantitative Predictions approach (TTQP) using the transtheoretical model of behavior change (TTM) to condom use behavior in a sample of men who have sex with men (MSM). The TTQP approach employs the theory to generate effect size predictions, then the observed effect sizes can be calculated and compared to the predicted effect sizes.

The effect size predictions in this study were made: 1) based on the omega squared reported in previous TTQP studies of other health behavior changes (e.g., smoking cessation); 2) based on theoretical considerations; and 3) calculated from the data reported in previous TTM condom use studies. The study design was a secondary analysis using data from a cross-sectional study. The final sample size was 185. However, the number of participants who were limited to membership in the first three stages (i.e., at-risk participants) was 85. The observed ω^2 across the first three stages and their 90%, 95%, as well as 99% confidence intervals were calculated using SAS.

Results demonstrated that when 90% CI was used, 4 of 10 predictions were confirmed for predictions based on previous TTQP studies of other health behavior changes, 8 of 17 predictions were confirmed for predictions based on theoretical considerations, and 13 of 16 predictions were confirmed for predictions based on previous TTM condom use studies; when 95% CI was used, 4 of 10 predictions were confirmed for predictions based on previous TTQP studies of other health behavior changes, 9 of 17 predictions were confirmed for predictions based on theoretical considerations, and 13 of 16 predictions were confirmed for predictions based on previous TTM condom use studies; when 99% CI was used, 6 of 10 predictions were

confirmed for predictions based on previous TTQP studies of other health behavior changes, 14 of 17 predictions were confirmed for predictions based on theoretical considerations, and 15 of 16 predictions were confirmed for predictions based on previous TTM condom use studies. The explanations of failed predictions for this study included sample fluctuation (near misses), a need for prediction/theory revision, and a need for further recalibration of the effect size categories.

Findings suggested that the first two prediction methods (i.e., predictions based on theoretical considerations and predictions based on previous TTQP studies of other health behavior changes) did not do well at predicting effect size estimates for MSM condom use behavior when 90% CI or 95% CI was used. However, the third prediction method (i.e., predictions calculated from the data reported in previous TTM condom use studies) did very well at predicting effect size estimates for MSM condom use behavior, no matter which CI was used. The inadequate fit of predictions based on previous studies of other health behavior changes and the good fit of predictions derived from previous TTM condom use studies indicated that TTM constructs for condom use have different effects across the first three stages of change compared to other health behavior changes (e.g., smoking, sun protection, or diet), and that future studies should use previous empirical data based on the same health behavior change to generate effect size predictions whenever possible. The present study provides empirical data for future research making TTM-based quantitative predictions to condom use behavior. Moreover, the present study supports the need to further calibrate the effect size categories and the need to revise theory using empirical data. Replication of this study using independent samples would be very helpful to refine theoretical predictions.

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PREFACE

This dissertation was prepared in standard format.

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INTRODUCTION

Traditional Null Hypothesis Significance Testing (NHST) focuses on the rejection of a null hypothesis based on a conditional probability of the data (p value), given that the null hypothesis is true. This methodology has many limitations. For example, p values do not provide information on the alternative hypothesis; a lack of power can lead to incorrect conclusions and lead to a rejection of the theory; the rejection of a null hypothesis provides no information on the magnitude of a difference and doesn't allow for straightforward comparisons; the failure to reject the null hypothesis can occur for numerous reasons, such as inadequate sample size, poor measures, and failure to properly operationalize the theory; NHST focuses on ordinal tests instead of more precise quantitative predictions, which limits the information gained (Brick, Velicer, Redding, Rossi, & Prochaska, 2015; Velicer, Brick, Fava, & Prochaska, 2013; Velicer et al., 2008; Velicer, Norman, Fava, & Prochaska, 1999). Thus, reliance on p values is arbitrary and can lead to incorrect conclusions.

An alternative approach that is more appropriate for theory testing is using effect size predictions which can be called Testing Theory-based Quantitative Predictions (TTQP; Brick et al., 2015; Velicer et al., 2013). TTQP employs the theory to generate effect size predictions, then the observed effect sizes can be calculated and compared to the predicted effect sizes. Confidence intervals (CIs) are used to determine if the predictions are confirmed or not. If the CI of the observed effect size contains the

predicted effect size, then the prediction is confirmed. If the predicted effect size falls outside of the CI, then the prediction is not confirmed and explanations for failed predictions should be examined.

TTQP is more direct, informative and stronger than NHST. It requires researchers to clarify what the theory predicts and specify what was previously vague about the theory, and then improve the theory. Moreover, this quantitative approach emphasizes the magnitude of a difference and allows for straightforward comparisons by using a common effect size metric. In addition, TTQP can be used to guide decision making for more effective behavioral interventions, because it can determine which psychological constructs lead to greater effects at certain points during the behavior change process (Rossi, 2001). The TTQP approach has only been applied to the Transtheoretical Model of Behavior Change (TTM) so far.

The Core Constructs of TTM

The TTM describes the process of intentional behavior change that includes both cognitive and performance-based components (Prochaska & DiClemente, 1983).

Stages of Change

TTM is based on a stage paradigm that defines behavior change as an incremental process through five stages, Precontemplation, Contemplation, Preparation, Action, and Maintenance. Stages usually begin with Precontemplation and progress to Maintenance. Progression through the stages involves periods of recycling back to an earlier stage (Grimley et al., 1997; Gullette et al., 2009; Prochaska, Redding, & Evers, 2002; Redding et al., 2011).

Precontemplation is the stage in which a person is neither thinking nor planning on adopting (e.g. condom use) or ceasing (e.g. smoking cessation) the target behavior anytime soon, usually quantified as within the next six months (Prochaska et al., 2002). Individuals in this stage often do not perceive a need to change their behavior, avoid information regarding the harmful consequences of their behavior, and do not report thinking about or discussing the harmful consequences of their behavior (Prochaska, DiClemente, & Norcross, 1992).

Contemplation is the stage in which a person is thinking about adopting or ceasing the target behavior sometime soon, usually quantified as within the next six months but not sooner than 30 days (Prochaska et al., 2002). Individuals in this stage perceive a need to change but are unsure how to succeed at changing (Prochaska et al., 1992).

Preparation is the stage in which a person is actively planning on adopting or ceasing the target behavior in the near future, usually quantified as within the next 30 days (Prochaska et al., 2002). Individuals in this stage perceive a need to change, openly state their intention to change, and have actually taken steps toward changing (Prochaska et al., 1992). The Preparation stage is viewed as a transition stage in that individual will either relapse to an earlier stage or advance to the next stage, Action.

The Action stage is the stage in which a person has adopted or ceased the target behavior, but has done so only recently usually quantified as changed within the past six months (Prochaska et al., 2002). Individuals in this stage perceive their change as beneficial, hold high self-efficacy beliefs, and are actively taking step to support their recent change.

The Maintenance stage is the stage in which a person has successfully adopted or ceased the target behavior for a substantial amount of time, usually quantified as six months or longer (Prochaska et al., 2002). Some efforts may still be required during this stage, depending on the behavior, to avoid relapse and to sustain the changes that have been made. Individuals in this stage continue to perceive their change as beneficial, report high levels of self-efficacy, and low levels of temptation to relapse.

Studies applying the TTM to condom use have revealed that participants can be staged regarding their intentions and actions in practicing protected sex (Brown-Peterside et al., 2000; Galavotti et al., 1995; Grimley et al., 1995, 1996, 1997; Larson, 2012; Redding et al., 2011; Redding & Rossi, 1999; White, 2003). Since MSM may engage in both insertive and receptive anal sex, they could possibly need different sets of skills, attitudes, beliefs, or behavioral strategies for acts of receptive anal sex and acts of insertive anal sex in order to predict consistent condom use. However, because consistent condom use readiness as measured by stages of change has not been thoroughly studied in samples of MSM, it is not clear if the more general construct of condom readiness for anal sex differs in its utility as a predictor variable when compared to the more specific constructs of condom readiness for receptive anal sex and condom readiness for insertive anal sex (White, 2003). In order to decrease response burden for participants, a test of the utility of a general assessment of condom readiness for anal sex would be an important first step prior to any research recommendations to assess condom readiness for insertive and receptive anal sex separately (White, 2003).

Decisional Balance

Decisional balance involves an individual's ratings of the importance of various benefits (pros) and costs (cons) of changing (Prochaska et al., 1994). The TTM's construct of decisional balance was based on the decision making theory of Janis and Mann (1977) and was expanded to a dozen health behaviors by 1994 (Prochaska et al., 1994).

A cross-sectional analysis of twelve different health behaviors (e.g., smoking, condom use, sunscreen use, exercise, etc.) demonstrated the importance of decisional balance in relationship to stages of change (Prochaska et al., 1994). For individuals in the precontemplation stage, the cons of changing outweighed the pros of changing. The opposite was true for individuals in the action and maintenance stages. This pattern has been replicated in TTM research specific to condom use (Galavotti et al., 1995; Grimley et al., 1995, 1997; Larson, 2012; White, 2003). Individuals in the precontemplation stage for consistent condom use reported that the cons were more important to them than pros for using condoms, whereas individuals in the action and maintenance stages reported that the pros were more important to them than cons for using condoms.

Two mathematical relationships were derived from this observed pattern between the pros and cons of change cross-sectionally across the stages of change (Prochaska, 1994; Prochaska et al., 1994): Differences between the precontemplation stage and the action stage for a specific problematic health behavior was associated with an approximately one standard deviation difference in the Pros (i.e., the strong principle of change) and a one-half standard deviation difference in the Cons (i.e., the weak

principle). Hall and Rossi (2008) re-examined the strong and weak principles more comprehensively by including studies conducted between 1984 and 2003 across 48 health behaviors. The findings demonstrated that for the 48 health behaviors, the average effect size for the pros was one standard deviation and for the cons was approximately one-half standard deviation, which were consistent with the original findings for the strong and weak principles from the Prochaska et al. study (1994).

Besides, some condom use studies (Galavotti et al., 1995; Grimley et al., 1995, 1997; White, 2003) found that although the pros of condom use always increased significantly across the stages, the cons of condom use did not decrease significantly across the stages. This was hypothesized to be more characteristic of adoption behaviors (e.g., condom use) than cessation behaviors (e.g., smoking cessation).

Situational Self-Efficacy

Situational self-efficacy includes an assessment of one's temptation to engage in the unhealthy behavior (situational temptation) along with an assessment of one's confidence to engage in the healthy target behavior, despite temptations (situational confidence).

Situational self-efficacy can be used as a single general scale that measures confidence or temptation, or be assessed at situational levels. In some previous research, the self-efficacy scale was used as one global construct to measure one's confidence to engage in the healthy target behavior (Galavotti et al., 1995; Grimley et al., 1995, 1996, 1997). Redding and Rossi (1999) developed two questionnaires, the Confidence in Safer Sex (CSS) and the Temptation for Unprotected Sex (TUS), to assess self-efficacy for condom use. Each questionnaire has five subscales, sexual

arousal, substance use, partner pressure, negative affect, and perceived low risk. Redding and Rossi (1999) stated that the CSS and TUS can be used either as a single general scale that measures confidence or temptation, or as five separate subscales, which provided empirical support for studies that used self-efficacy as one global construct (Galavotti et al., 1995; Grimley et al., 1995, 1996, 1997) and studies that assessed self-efficacy at situational levels (Murphy, Multhauf, & Kalichman, 1995). In addition to the five subscales for confidence and temptation, White (2003) included a sixth factor, power imbalance, to assess possible impact on one's confidence in condom use and one's temptation for unprotected sex when a perceived interpersonal power differential exists.

A nearly linear cross-sectional relationship has been found between situational self-efficacy and stages of change. For example, confidence to use condoms increased almost linearly across the stages (Galavotti et al., 1995; Grimley et al., 1996; Grimley, G. Prochaska, & J. Prochaska, 1997; Grimley, J. Prochaska, Velicer, G. Prochaska, 1995; Gullette, Wright, Booth, Feldman, & Stewart, 2009) whereas temptation for unprotected sex decreased almost linearly across the stages (Larson, 2012; Redding & Rossi, 1999).

Processes of Change

The processes of change are defined as strategies an individual employs to help motivate or maintain change. Generally, the processes of change are classified as experiential or behavioral (Grimley et al., 1997; Prochaska, DiClemente, & Norcross, 1992; Prochaska, Velicer, DiClemente, & Fava, 1988).

The experiential processes of change include consciousness raising, dramatic relief, environmental reevaluation, self-reevaluation, and social liberation. Consciousness raising involves seeking out exposure to information, ideas, events, or experiences that result in increased awareness that change is warranted or needed. Dramatic relief involves being exposed to or seeking out circumstances, experiences, or events that result in increased awareness of the negative emotions or risks associated with not changing. Environmental reevaluation involves an increased understanding of and appreciation of how changing would benefit society or others. Self-reevaluation involves an increasing sense of seeing oneself as a healthier person, more responsible person, or better citizen if change would occur. Social liberation involves an increasing awareness of societal norms that support changing.

The behavioral processes of change include stimulus control, counterconditioning, helping relationships, reinforcement management, and self-liberation. Stimulus control involves implementing cues to remind one to engage in the new healthy behavior and/or removing triggers that tempt one to engage in the old unhealthy behavior. Counterconditioning is substituting new thoughts or behaviors in attempt to fade out old thoughts or behaviors for the purpose of supporting one's new behavior change. Helping relationships involves utilizing social support for maintaining one's new behavior change. Reinforcement management involves rewarding oneself or being rewarded for the positive behavior change. Self-liberation involves making a firm commitment to changing and often involves making the commitment public. Some TTM research on condom use adds a sixth behavioral process of change, eroticizing

condoms, which is making efforts to make condom use more pleasurable (Noar, Morokoff, & Redding, 2001; White, 2003).

In addition, the interpersonal processes of change, which include partner communication, partner support, interpersonal systems control, and condom assertiveness, were also used in some studies of condom use (Noar, Morokoff, & Redding, 2001; White, 2003). Partner communication involves communication with one's sexual partner about consistent condom use. Partner support involves seeking out or having support from one's partner for consistent condom use. Interpersonal systems control involves actively seeking out people, places, or situations that support one's behavior change (i.e., consistent condom use). Condom assertiveness involves insisting on using a condom in a sexual encounter.

Some cross-sectional research found that experiential processes of change were more beneficial to individuals in the early stages of change as individuals plan to or prepare for change while the behavioral processes of change were more beneficial to individuals in the latter stages of change as individuals attempt to sustain their change (Blaney et al., 2012; Horiuchi, Tsuda, Prochaska, Kobayashi, & Mihara, 2012; Prochaska et al., 1992). However, Rosen (2000) conducted a meta-analysis examining the cross-sectional relationships between processes of change and stages of change and found that the sequencing of processes was not consistent across health behaviors (e.g., smoking, exercise, diet, and substance abuse), although condom use was not examined. White (2003) examined if the utilization of experiential, behavioral, and interpersonal processes of change would emerge and vary depending upon the stages

of condom use in a cross-sectional sample of MSM, and found that MSM at increasing stages of change increased their use of all the processes of change.

When applied to condom use, the processes of change have received less attention from researchers than other TTM constructs (Grimley et al., 1997). Further exploration of the processes of change for condom use, especially in MSM is warranted.

Previous Research Testing TTM-Based Quantitative Predictions

Some previous studies have applied the TTQP approach using the TTM to smoking cessation (Brick et al., 2015; Velicer et al., 2013, 2008, 1999), sun protection (Brick et al., 2015), and diet (Brick et al., 2015).

Velicer et al. (1999) tested 40 TTM-based effect size predictions in a longitudinal sample of smokers. These predictions involved comparisons from one of three initial stages (PC, C, and PR) to stage membership 12 months later. There was a total of 40 effect size predictions made for five TTM variables, Pros, Cons, Positive/Social, Habit/Addictive, and Negative/Affective. All effect sizes were calculated as ω^2. Results showed that 36 of the 40 effect size predictions were confirmed. However, this study didn't use confidence intervals to guide the decision making about predictions confirmed.

Velicer and colleagues (2013) replicated and extended his previous study (Velicer et al.,1999) by examining 40 TTM-based effect size predictions in another longitudinal sample of smokers and using confidence intervals to determine if these predictions were confirmed. ω^2 and 99% confidence interval were used. The 40 effect size predictions were recalibrated based on the findings of the initial study (Velicer et

al., 1999). These longitudinal predictions involved comparisons of groups moving from one of three initial stages (PC, C, and PR) to stage membership 12 months later. Results demonstrated that 32 of the 40 predictions were confirmed. Of the eight predictions that were not confirmed, four suggested a need for further recalibration of the effect size categories, one was due to sample fluctuation, and three suggested a need for prediction/theory revision. All the three misses that suggested prediction/theory revision involved the Cons scale. The failed predictions for Cons replicated a failure in the previous study (Velicer et al.,1999), indicating that the theory underlying the predicted effects for the Cons scale needed revision.

Another study by Velicer and colleagues (2008) tested 15 TTM-based effect size predictions in a cross-sectional sample of smokers and used confidence intervals of the observed effects to determine whether these predictions were confirmed or not. This study was different from the 2013 study because it used a cross-sectional sample instead of a longitudinal sample, and the effect size predictions were made between subgroups in the first three stages of change (i.e., PC, C, and PR). ω^2 was calculated for each of the 15 variables and the 95% confidence interval was calculated around the observed ω^2. The findings showed that 11 of the 15 effect size predictions were confirmed and 4 of the 15 effect size predictions were not confirmed. Predictions were confirmed for the Pros, Cons, Habit Strength, Positive/Social, Consciousness Raising, Dramatic Relief, Self-Reevaluation, Social Liberation, Stimulus Control, Self-Liberation, and Helping Relationship constructs. Predictions were not confirmed for the Negative/Affect, Environmental Reevaluation, Counter Conditioning, and Reinforcement Management constructs. The four missed predictions were examined,

and one of these misses, Reinforcement Management, was due to sample fluctuation; one of the misses, Negative/Affect, suggested a need for prediction revision; two of the misses, Environmental Reevaluation and Counter Conditioning, required a recalibration of the effect size categories.

Brick et al. (2015) applied the TTQP approach to their smoking study using a cross-sectional sample and extended this approach to two previously unexamined behaviors-diet and sun protection. Effect size predictions for each behavior were developed both from the results of previous smoking research and an expert panel. ω^2 and 99% confidence interval were used. Results demonstrated that for smoking, 13 of 15 predictions were confirmed and 2 were not confirmed; one of the two misses, Pros, was due to sample fluctuation, and the other miss, Self-liberation, suggested a need for prediction revision. For diet, 7 of 14 predictions were confirmed using smoking-based predictions and 6 of 16 were confirmed using expert panel predictions. Of the 14 smoking-based predictions, 7 predictions were not confirmed for Helping Relationships, Stimulus Control, Social Liberation, Self-reevaluation, Counter Conditioning, Negative/Affective, and Reinforcement Management; the explanations for missed predictions included sample fluctuation and a need for prediction revision. Of the 16 expert panel predictions, 10 predictions were not confirmed for Pros, Negative/Affective, Counter Conditioning, Helping Relationships, Reinforcement Management, Stimulus Control, Self-liberation, Dramatic Relief, Environmental Reevaluation, and Interpersonal Systems Control; the explanations for missed predictions included sample fluctuation and a need for prediction revision. For sun protection, 3 of 11 predictions were confirmed using smoking-based predictions and 5

of 19 were confirmed using expert panel predictions. Of the 11 smoking-based predictions, 8 predictions were not confirmed for Pros, Cons, Environmental Reevaluation, Helping Relationships, Reinforcement Management, Self-reevaluation, Self-liberation, and Social Liberation; the explanations for missed predictions included sample fluctuation and a need for prediction revision. Of the 19 expert panel predictions, 14 predictions were not confirmed for Cons, Sunscreen Use Confidence, Sun Avoidance Confidence, Counter Conditioning, Environmental Reevaluation, Helping Relationships, Health Responsibility, Interpersonal Systems Control, Reducing Exposure, Reinforcement Management, Regret, Self-reevaluation, Sunscreen Use, and Health Care Provider; the explanations for missed predictions included sample fluctuation, a need for prediction revision, and a need for recalibration of the effect size categories. The results of this study (Brick et al., 2015) indicated that both the expert panel and the previous smoking data performed poorly in developing precise cross-sectional effect size predictions in the diet and sun protection studies. Future studies should try to make effect size predictions using existing data based on that specific health behavior whenever possible.

Although the TTQP approach using TTM has been applied to smoking cessation, sun protection, and diet, it has not yet been applied to condom use in any sample, especially in a sample of men who have sex with men (MSM).

HIV Risk and Condom Use among MSM

The term “men who have sex with men (MSM)” describes not only gay men but also men who self-identify as bisexual or heterosexual but report engaging in sexual activities with other men (Stall, 2002). Although MSM are only a small proportion of

the population, they account for the majority of the estimated HIV diagnoses each year in the U. S. (Centers for Disease Control and Prevention [CDC], 2013, 2015; Johnson et al., 2002). In 2013, MSM accounted for 81% of the estimated HIV diagnoses among all males aged 13 years and older and 65% of the estimated HIV diagnoses among all people in U.S. (CDC, 2015). These proportions are alarming given their concentration in this group (MSM) believed to constitute only 2% to10% of the adult male population (Johnson et al., 2002) and approximately 2% of the U. S. population (CDC, 2015).

Engaging in unprotected anal sex is a high-risk practice that can increase the probability of HIV infection among MSM (CDC, 2013). Data from the National HIV Surveillance System (NHSS) and the National HIV Behavioral Surveillance System (NHBS) showed that unprotected anal sex increased among MSM from 48% in 2005 to 57% in 2011 and that in 2011, one third of HIV-positive MSM who were unaware of their infection reported unprotected discordant anal sex (i.e., unprotected anal sex with a partner of opposite or unknown HIV status), compared with 13% of HIV-positive MSM who were aware and 12% of HIV-negative MSM (CDC, 2013).

Koblin et al. (2006) examined risk factors for HIV acquisition using a large sample of HIV-negative MSM. The results demonstrated that younger age, lower education, being black/Hispanic, and the use of drugs and alcohol before sex were associated with an increased risk of HIV infection. In addition, men reporting having four or more male sex partners, men with an HIV-positive or unknown status primary partner or no primary partner, men who reported unprotected receptive anal intercourse with any serostatus partner, men who reported unprotected insertive anal intercourse with

HIV-positive or unknown status partners, were all at increased risk of HIV infection. Finally, self-reported sexually transmitted disease gonorrhea and self-reported symptoms of depression were also found in this study to be related to an increased risk of HIV infection.

Wejnert et al. (2013) analyzed data from the National HIV Behavioral Surveillance (NHBS) and found that HIV prevalence among MSM was highest among black MSM and MSM with lower education and income. Moreover, young MSM and minority MSM were more likely to be unaware of their positive HIV status. Additionally, black MSM had the highest HIV prevalence as well as the lowest awareness of their positive HIV status among racial/ethnic groups. Black MSM were nearly twice as likely to be HIV infected compared to white MSM and were 40% less likely to know their positive HIV status than white MSM.

From the data and research findings presented above it is clear that MSM, especially young MSM and minority MSM, remain at high risk for HIV infection. Effective strategies are needed for MSM to help reduce their risk of HIV infection. One of the most effective ways to prevent HIV transmission is consistent condom use (CDC, 1988, 2013; Roper, Peterson, & Curran, 1993). However, research has found that men, regardless of sexual orientation, do not use condoms consistently (e.g., Bauermeister, Carballo-Dieguez, Ventuneac, & Dolezal, 2009; Besharov, Stewart, Gardiner, & Parker, 1997; CDC, 2013; Koblin et al., 2003, 2006; Larson, Rossi, McGee, Redding, & Lally, 2014; Parsons, Halkitis, Bimbi, & Borkowski, 2000; Shildo, Yi, & Dalit, 2005).

Besharov et al. (1997) summarized the reasons why some males don't use condoms from condom research involving samples of heterosexually active men and samples of MSM. Both MSM and men who have sex with women reported that condoms reduce sexual pleasure; using condoms can be embarrassing in situations like putting a condom on in front of a new partner and losing an erection while putting on a condom; the frequency of condom use declines when they have intercourse with main sexual partners; they rarely use condoms for oral sex; and their partners don't like using condoms.

Parsons et al. (2000) investigated a sample of ethnically diverse male and female late adolescent college students to assess the perceived benefits and costs associated with both condom use and unprotected sex on sexual risk behaviors. The results demonstrated that for male and female late adolescents, perceived benefits of unprotected sex were better determinants of sexual risk-taking than were perceived benefits or costs associated with condom use. Larson et al. (2014) identified a scale to reflect the pros of condomless sex and compared its predictive utility to the pros of condom use on sexual risk behaviors in a sample of gay and bisexual men. The findings indicated that the pros of the condomless sex outperformed the pros (and cons) of condom use in predicting sexual risk behaviors, which was consistent with the findings of the study of Parsons et al. (2000).

Shildo et al. (2005) developed a measure which helps to identify the complex psychosocial issues that can be associated with unprotected anal intercourse and safer sex. Participants were gay and bisexual men. Five factors, Anger/Self-destructiveness/Fatalism, Pleasure Seeking/Risk-Taking/Escapism, Intimacy

Needs/Rational Choice Making, Erroneous Perception of Risk, and Condom-related Erectile Dysfunction, were identified and found to be associated with unprotected anal intercourse.

In order to better understand why MSM engage in bareback sex (i.e., intentional condomless anal intercourse), which increases the risk for HIV infection, Bauermeister et al. (2009) investigated a sample of men who bareback and explored the associations between the decisional balance to bareback (DBB) and several sex risk behaviors (i.e., unprotected receptive anal intercourse occasions, number of partners, and having one or more serodiscordant partners in the past 3 months). The results showed that MSM's decision to bareback was linked to two factors, sex as a way of coping with psychosocial vulnerabilities and sex as a way to achieve emotional and sexual connections, which indicated that MSM may avoid using condoms in order to cope with psychosocial vulnerabilities and create intimacy with other MSM.

Since consistent condom use is highly effective in preventing the transmission of HIV, but men do not use condoms consistently, research on how to best help at-risk males such as MSM become consistent condom users when needed is critical. Interventions can be used to prevent HIV infection by persuading at-risk individuals such as MSM to use condoms consistently (Chesney, 1993; Galavotti et al., 1995). TTM, a behavioral intervention model, has been shown to be effective in changing health behaviors across different health promoting behaviors (e.g., smoking cessation, physical activity, sun protection, condom use, etc.) and in different populations (e.g., Campbell et al., 1994; Peipert et al., 2008; Redding, Brown-Peterside, Noar, Rossi, & Koblin, 2011; Redding et al., 2015).

TTM Application to Condom Use

There is substantial literature applying TTM constructs to condom use and developing and evaluating TTM interventions in a variety of U.S. population, such as at-risk women/adolescents, injecting drug users, and heterosexual college students (e.g., Brown-Peterside, Redding, Ren, & Koblin, 2000; Galavotti et al., 1995; Grimley et al., 1995, 1996, 1997; Gullette et al., 2009; Peipert et al., 2008; Redding et al., 2011; Redding & Rossi, 1999; Redding et al., 2015). However, there is limited literature that focuses on TTM application to condom use among U.S. MSM (Larson, 2012; Larson, Rossi, McGee, Redding, & Lally, 2014; White, 2003). Some representative studies are discussed below.

Galavotti et al. (1995) assessed the applicability of TTM to the measurement of condom use and other contraceptive use in a cross-sectional sample of at-risk women. The relationships between decisional balance, self-efficacy (confidence), and stages of change were examined and compared to the findings of previous research. Galavotti et al. (1995) found that self-efficacy increased across the stages. For decisional balance, the cons of condom use outweighed the pros of condom use in the precontemplation stage, but in the maintenance stage the pros outweighed the cons. In addition, there was a one standard deviation difference between the pros of condom use in the precontemplation stage and those in the action stage, which was consistent with the strong principle proposed by Prochaska et al. (1994). However, the weak principle (Prochaska et al., 1994), which states that progress from the precontemplation stage to the action stage is associated with a one-half standard deviation decrease in the cons of change, was not supported in this study. The cons of condom use didn't decrease

significantly across the cross-sectional stages of change, which may be more characteristic of adoption behaviors than cessation behaviors. This finding suggested that even if people were persuaded to use condoms, there was still a high potential for them to discontinue their use, unless the perceived cons of condom use were diminished.

Grimley et al. (1995) investigated the applicability of TTM to condom use adoption and maintenance in a cross-sectional sample of heterosexual college students, and examined the relationships between decisional balance, self-efficacy (confidence), and stages of change. Results showed that confidence increased across the stages with scores being lowest in the precontemplation stage. Moreover, results demonstrated that there was an approximately one standard deviation increase in the pros of condom use as well as a one-half standard deviation decrease in the cons of condom use with a main partner between the precontemplation stage and the action stage. Therefore, the strong and weak principles for decisional balance were also supported in this study. Additionally, pros of condom use varied significantly across the stages with the pros being lowest in the precontemplation stage and highest in the action and maintenance stages. However, cons of condom use again didn't vary significantly across the stages, which indicated that the influence of the cons of condom use may persist no matter what stage of change an individual is in.

Redding and Rossi (1999) developed the situational self-efficacy scale for assessing condom use in a cross-sectional sample of college students and then examined the relationship between situational self-efficacy (situational confidence and situational temptation) and stages of change. The results demonstrated that confidence

to use condoms increased in a nearly linear fashion across the stages whereas temptation for unprotected sex decreased in a nearly linear fashion across the stages.

White (2003) validated the core TTM constructs (decisional balance, situation self-efficacy and temptation, and the processes of change) in a cross-sectional sample of sexually active MSM and explored the relationships between these constructs and the stages of change for condom use. White (2003) found that pros of condom use varied significantly across stages with pros being lowest in the precontemplation stage and highest in the maintenance stages; however, cons of condom use didn't vary much across the stages. Moreover, the strong principle of change was supported, but the results indicated no effect for the weak principle. The findings for decisional balance indicated that as MSM became consistent condom users for anal sex, they increasingly endorsed more pros of condom use but their views of the cons of condom use remained unchanged. In addition, White (2003) found that confidence to use condoms for anal sex increased in a nearly linear fashion across the stages and temptation for unprotected anal sex decreased in a nearly linear fashion across the stages. This finding suggested that as MSM became consistent condom users for anal sex, they reported being more confident in their ability to use condoms during anal sex and reported less temptation to have unprotected anal sex. White (2003) also found that experiential, behavioral, and interpersonal processes of change increased across the stages in a similar fashion. As MSM became consistent condom users for anal sex, they increased their use of all the processes of change.

Gullette et al. (2009) assessed the associations of stages of change with decisional balance and self-efficacy using a cross-sectional sample of rural African-American

stimulant users. Decisional balance was calculated by subtracting the disadvantage score from the advantage score with higher scores indicating more perceived advantages than disadvantages in using a condom. Self-efficacy here refers to one's confidence that he or she would be able use a condom consistently. Results showed that decisional balance and self-efficacy were significantly positively correlated with stages of change for condom use with a primary partner. What's more, the odds of being in an advanced stage for condom use increased by 43% if self-efficacy scores increased by one point and increased by 28% if decisional balance scores increased by one point. These findings provide support for the development of HIV prevention interventions that promote the advantages of condom use and increase one's confidence in using condoms.

Larson (2012) assessed the applicability of TTM constructs to condom use in a cross-sectional sample of gay and bisexual men and examined the relationships between stages of change and decisional balance and temptations for unprotected sex. Larson (2012) found that pros, cons, and temptations varied significantly by stages of change for condom use and the expected patterns between these TTM constructs were replicated in this study. The cons of condom use outweighed the pros of condom use in the precontemplation stage whereas in the maintenance stage the pros outweighed the cons. Moreover, temptation for unprotected sex decreased across the stages. Larson et al. (2014) found that pros of condom use were significantly lower in the precontemplation stage than in the preparation, action, and maintenance stages and that pros of condomless sex were significantly lower in the action/maintenance stage

than in other stages and significantly higher in precontemplation stage than in other stages.

Given that the published TTM-based studies for condom use either do not include MSM samples (Brown-Peterside et al., 2000; Galavotti et al., 1995; Grimley et al., 1995, 1996, 1997; Gullette et al., 2009; Redding et al., 2011; Redding & Rossi, 1999) or include relatively small-size MSM samples (Larson, 2012; White, 2003), previous findings may not generalize to TTM-based research for condom use with more representative MSM samples. More studies that apply TTM constructs to condom use in larger, more representative MSM samples are clearly needed to provide support for the development of HIV interventions to prevent the spread of HIV among MSM.

Present Study

Although the TTQP approach has been used in some health behavior change studies (Brick et al., 2015; Velicer et al., 2013, 2008, 1999), it has not yet been applied to HIV prevention or condom use research. Thus, there is limited previous data to help develop TTM-based quantitative predictions for condom use among MSM. The current study aims to extend the TTQP approach using TTM to condom use behavior in a MSM sample.

There are some different types of effect size estimates, such as Cohen's *d*, R^2, η^2, and ω^2. It is more appropriate to use R^2, η^2, and ω^2 when more than two groups are involved. However, since R^2, η^2 are uncorrected effect sizes which are positively biased overestimates of the effect in the population, it is preferable to use ω^2, which is corrected for this bias (Velicer et al., 2013, 2008). The formula for ω^2 for a one-way between-groups fixed effects ANOVA is: $\omega^2 = (SS_{BETWEEN} - (k-1) * MS_{WITHIN}) /$

(SS_{TOTAL} + MS_{WITHIN}), where $SS_{BETWEEN}$ and SS_{TOTAL} are between and total Sum of Squares, k is the number of groups, and MS_{WITHIN} is within-group Mean Squared (Velicer et al., 2013, 2008). In this study, ω^2 was used, and the 90%, 95%, as well as 99% confidence intervals for observed ω^2 were also calculated. The calculation of observed ω^2 as well as their 90%, 95%, and 99% confidence intervals were done using SAS 9.4. The interpretations of the effect size ω^2 were based on Cohen's (1988) guidelines for the population proportion of variance accounted for (i.e., a small effect is about 0.01, a medium effect is about 0.06, and a large effect is about 0.14).

The 90% CI is the most appropriate to use, compared to the 95% CI and 99% CI. Due to the "folded" nature of the F distribution (on which the CI for omega-squared is based), the interpretation of a 90% CI for omega-squared carries with it an acceptance of an alpha level of .05, which is equivalent to a CI of 95% (Steiger, 2004). However, the 95% CI and 99% CI were also calculated because first, all previous TTQP research used 95% and /or 99% CI of observed effect sizes to examine if the predictions were confirmed or not, and second, the results across different CI's can be compared to see if there are any differences. The 90% CI is narrower than the 95% CI, which is narrower than the 99% CI. A narrower interval may lead to more missed predictions as it allows for more error, and a narrower interval can provide a test more prone to misses due to sampling fluctuation (Velicer et al., 2013). The higher the confidence level, the less likely we are to get a missed prediction if sampling variability is the only cause (Velicer et al., 2008).

The previous TTQP research making TTM-based effect size predictions (i.e., Brick et al., 2015; Velicer et al., 2013, 2008, 1999) used participants whose membership was

limited to the first three stages of change, PC, C, and PR (i.e., at-risk participants). Thus, in order to make TTM-based effect size predictions based on these previous studies and in order to better compare the findings of this study to those of the previous studies, this study mainly focused on participants whose membership was limited to the first three stages of condom use.

The effect size predictions in this study were made in the following ways: 1) Based on the omega squared reported in previous TTQP studies of other health behavior changes (e.g., smoking cessation, sun protection, diet, etc.). For example, the omega squared reported in previous TTQP studies for the TTM variable, Cons, were around 0.07 and 0.05, then 0.06 was used as the predicted effect size value for Cons; the omega squared reported in previous TTQP studies for the TTM variable, Dramatic Relief, were around 0.10, 0.11, or 0.09, then 0.10 was used as the predicted effect size value for Dramatic Relief; there was no omega squared reported in previous TTQP studies for some TTM variables such as Temptation and Liberation, so "--" was used in the table for these variables. 2) Based on theoretical considerations. Theoretical considerations indicate how TTM variables are expected to behave across stages based on the findings of previous TTM studies. For instance, previous studies (Galavotti et al., 1995; Grimley et al., 1995, 1997) found that the pros of condom use always increased significantly across the stages while the cons of condom use did not decrease significantly across the stages, thus 0.06 (medium effect) was used as the predicted effect size value for Pros and 0 (no effect) was used as the predicted effect size value for Cons across the first three stages; previous studies found that the confidence to use condoms increased almost linearly across the stages so 0.01 (small

effect) was used as the predicted effect size for Confidence across the first three stages. 3) Calculated from the data reported in previous TTM of condom use studies. The statistics that could be used to calculate omega squared include means, standard deviations, and sample sizes for each stage of the first three stages (PC, C, and PR). Such data were reported in some previous TTM of condom use studies (Grimley, Prochaska, Velicer, & Prochaska, 1995; Grimley, Riley, Bellis, & Prochaska, 1993; Perez, 2002; Redding unpublished data and Perez, 2002), which were used to derive the predicted omega squared values. The omega squared for each TTM variable was calculated for each of these studies, and then the weighted average of the omega squared values was calculated and used as the predicted effect size value for each TTM variable.

Ten predictions were generated based on the omega squared reported in previous TTQP studies of other health behavior changes; seventeen predictions were generated from theoretical considerations; sixteen predictions were generated from the data reported in previous TTM of condom use studies. These predicted effect sizes are listed in Table 1 (the same can be found in Table 2 or Table 3). Although not predicted, the observed ω^2 for condom use with 90% CIs across five stages of change (i.e., PC, C, PR, A, and M) as well as the Cohen's *d* for the stage transition comparisons (i.e., PC-C, C-PR, PR-A, A-M) were also examined as exploratory analyses.

CHAPTER 2

METHODOLOGY

Study Design

A secondary analysis using data from a cross-sectional study of MSM (White, 2003).

Participants

Participants in the White (2003) study were recruited in three states, Rhode Island, Kentucky, and Missouri. Participants were screened for eligibility, and those who were eligible for this study were males that reported having had anal sex during the past two months with another male, 18-30 years old, able to read English, and willing to complete a questionnaire about sexual behaviors and condom use. Participants chose to complete the survey either at the point of recruitment or elsewhere and mail the survey back. Non-probability sampling was used, including purposive sampling (e.g., men were screened for eligibility), snowball sampling (e.g., participants were asked if they knew other males that would be eligible and willing to complete the survey and then were given survey packets to pass along), convenience sampling (e.g., participants were recruited from organizations and local businesses providing services to MSM), and proportionate quota sampling (e.g., limit recruitment of "white, not Hispanic" eligible participants to 70% with the goal of 50% of participants being of color).

A sample of 423 males were screened eligible, agreed to participate, and provided with a survey packet that included written directions, informed consent, the survey, and a request for reimbursement to complete. A total of 210 men completed and returned their survey. However, data from 25 participants were excluded due to excessive missing data or apparently careless or random responding. Thus, the final sample size was 185 (White, 2003).

Among the 185 participants, 42% completed surveys in Missouri, 39% in Kentucky, and 19% in Rhode Island; 43% reported earning less than $10,000 in the previous year; the majority were employed full time (55%), white (57%), non-Latino/Hispanic (89%), aged 18 to 25 (65%), reported having sex with only men during the past year (71%), and self-identified as gay (69%). While the majority of participants were white, 40% identified as African-American or Black, 5% identified as Native American, Asian, or Pacific Islander, and 11% identified as Latino or Hispanic. In addition, participants were classified into one of five stages of change for condom use: 26% of participants were in the precontemplation stage, 13% in the contemplation stage, 7% in the preparation stage, 6% in the action stage, and 49% in the maintenance stage. As mentioned before, participants in the present study were first limited to membership in the first three stages in order to examine the magnitude of effect sizes between subgroups in the early stages of change. The number of participants in the first three stages was 85 (46%).

Measures

Processes of Change (POC). Originally the POC was a 45-item instrument that measured 15 processes of condom adoption. The internal consistencies for each 3-item

scale averaged .81 (Evers, Saxon, Redding, Rossi, & Levesque, 1996). Three new items were added for exploratory purposes in attempt to measure participants' knowledge of or curiosity about condoms (e.g., I make sure I have the type /size of condoms I prefer on hand before I have sex.) After the measurement development conducted by White (2003), the original instrument was reduced to a measure that had 39 items and 13 subscales, including: Experiential - Consciousness Raising, Dramatic Relief, Environmental Reevaluation, and Liberation; Behavioral - Stimulus Control, Counterconditioning, Helping Relationships, Reinforcement Management, and Eroticizing Condoms; Interpersonal - Partner Communication, Partner Support, Interpersonal Systems Control, and Condom Assertiveness. Coefficient alphas ranged from .81 to .96 (White, 2003).

Self-Efficacy. This instrument included two scales - situational confidence (CONF) in condom use and situational temptation (TMPT) to have unprotected sex. Each scale had 10 items. Cronbach's Alpha for both original scales was .95 (Evers et al., 1996). Two new scale items were added for exploratory purposes to assess possible impact on both one's confidence to use a condom and one's temptation to not use a condom when a perceived interpersonal power differential exists (e.g., When I am with someone whom I am very attracted to.) After the measurement development conducted by White (2003), each scale (CONF and TMPT) included 12 items and 6 subscales- Substance Use, Partner Pressure, Sexual Arousal, Negative Affect, Low Risk Perception, and Power Imbalance. Cronbach's Alpha for the CONF was .97, and for the TMPT was .95 (White, 2003).

Decisional Balance (PROS & CONS). Originally a 12-item instrument measuring the pros and cons of condom use. Cronbach's Alpha for each 6-item scale was: Pros- .88; Cons- .82 (Evers et al., 1996). Four new items were added for exploratory purposes. Two items were added for the pros of condom use (e.g., Condoms make sex cleaner.) Two items were added for the cons of condom use (e.g., Putting on a condom would be too embarrassing.) After the measurement development (White, 2003), some items were deleted, and each scale had 5 items. Cronbach's Alpha for Pros was .88, for Cons was .90 (White, 2003).

Stages of Change for Condom Use. The stages of change algorithm consisted of a short series of parallel questions designed to assess behavioral intentions and actions for using condoms every time with both main and non-main sex partners. This measure is well-developed, has been administered to some at-risk adult male and female samples and has been strongly associated with important constructs of the TTM (e.g., Brown-Peterside et al., 2000; Evers, Harlow, Redding, & LaForge, 1998; Harlow et al., 1999). White (2003) proposed that the MSM sample was staged regarding general readiness for consistent condom use for anal sex with male partner(s), readiness for consistent condom use with main sexual partner for anal sex, readiness for consistent condom use with non-main sexual partner(s) for anal sex, readiness for consistent condom use for oral sex with male sex partner(s), readiness for consistent condom use for insertive anal sex with male sex partner(s), and readiness for consistent condom use for receptive anal sex with male sex partner(s). For this study, the staging algorithm for readiness to use condoms in general for anal

sex with male sexual partners was used. The items for this staging algorithm are listed in Appendix A.

Procedure

In the original study (White, 2003), non-probability sampling was used including purposive sampling, snowball sampling, convenience sampling, and quota sampling. The sampling procedures were purposive because first, eligibility criteria were established and men were screened for eligibility, second, recruitment focused on MSM that were young, had low social economic status and/ or ethnic minority status that research suggested were at increased risk for HIV in the United State (e.g., Koblin et al., 2006; Wejnert et al., 2013). Moreover, quota sampling was used in that this study attempted to limit recruitment of "white, not Hispanic" eligible participants to 70% with the goal of 50% of participants being of color. In Kentucky, Rhode Island, and Missouri, staff of AIDS service organizations, health departments, and community based organizations providing services to MSM bars and clubs were contacted for reaching MSM of color. Convenience sampling was used because the researcher established a regular presence in local businesses (e.g., bars, nightclubs, coffee shops, etc.) patronized by young gay men. In cooperation with the managers of each business, tables were set up making the surveys available on site. Snowball sampling was used in that participants were asked upon completion of the survey if they knew other males that would be eligible and willing to complete the survey. Those who were able to reach other potentially eligible MSM were offered survey packets with complete instructions and pre-paid postage to pass along.

For the original study (White, 2003), University of Rhode Island Institutional Review Board approval was obtained, as was a Certificate of Confidentiality from the National Institutes of Health to collect data in all three states mentioned above. Participants were given a cash value incentive of $25 for participating. For participants who chose to complete the survey at the point of recruitment, they signed the informed consent and then completed the survey, and finally signed the reimbursement verification form indicating that they had received their cash value incentives. Participants who chose not to complete the survey at the point of recruitment were provided with a survey packet that included written directions, informed consent, the survey, a request for reimbursement, and two pre-stamped envelopes to mail the survey and other documents back. Forms from all participants were kept in a locked filing cabinet. Documents with names/signatures were kept in a separate file from the survey to protect participant confidentiality.

CHAPTER 3

FINDINGS

Predicted ω^2 based on previous TTQP research of other health behavior change, based on theoretical considerations, and based on previous TTM condom use research across the first three stages of change (i.e., Precontemplation, Contemplation, and Preparation) are listed in Table 1, Table 2, and Table 3. The observed ω^2 was calculated for the TTM constructs across the first three stages, and the 90%, 95%, as well as 99% confidence intervals around the observed ω^2 were also calculated. SAS 9.4 was used for the calculation of the observed ω^2 and their 90%, 95%, as well as 99% CIs. The dependent variables were the 17 TTM constructs - Pros, Cons, Temptation, Confidence, Consciousness Raising, Dramatic Relief, Environmental Reevaluation, Liberation, Stimulus Control, Counterconditioning, Helping Relationships, Reinforcement Management, Eroticizing Condoms, Partner Communication, Partner Support, Interpersonal Systems Control, and Condom Assertiveness. The independent variable was Stage of Change (the first three stages). The values for the observed ω^2 and their 90% CIs are listed in Table 1. The values for the observed ω^2 and their 95% CIs are listed in Table 2. The values for the observed ω^2 and their 99% CIs are listed in Table 3. The observed ω^2 were then compared to the predicted ω^2 to determine if the predictions were confirmed or not. If the CI of the observed ω^2 contained the predicted ω^2, then the prediction was confirmed. If the predicted ω^2 fell outside of the CI, then the prediction was not confirmed.

The results using the 90% CI are listed in Table 1 and demonstrated in Figure 1; the results using the 95% CI are listed in Table 2 and demonstrated in Figure 2; the results using the 99% CI are listed in Table 3 and demonstrated in Figure 3. We can see from Table 1 and Figure 1 that when 90% CI was used, 4 of 10 predictions were confirmed for predictions based on previous TTQP studies of other health behavior changes; 8 of 17 predictions were confirmed for predictions based on theoretical considerations; and 13 of 16 predictions were confirmed for predictions based on previous TTM condom use studies. We can see from Table 2 and Figure 2 that when 95% CI was used, 4 of 10 predictions were confirmed for predictions based on previous TTQP studies of other health behavior changes; 9 of 17 predictions were confirmed for predictions based on theoretical considerations; and 13 of 16 predictions were confirmed for predictions based on previous TTM condom use studies. We can see from Table 3 and Figure 3 that when 99% CI was used, 6 of 10 predictions were confirmed for predictions based on previous TTQP studies of other health behavior changes; 14 of 17 predictions were confirmed for predictions based on theoretical considerations; and 15 of 16 predictions were confirmed for predictions based on previous TTM condom use studies.

In addition, although not predicted, observed ω^2 for condom use with 90% CIs across all five stages of change (i.e., Precontemplation, Contemplation, Preparation, Action, and Maintenance) as well as Cohen's *d* for the stage comparisons were calculated as exploratory analyses. These results are listed in Table 4. The values of the ω^2 and the 90% CIs across five stages can be used as the basis for predictions of future studies making cross-sectional or longitudinal TTM-based effect size

predictions across five stages. When comparing the observed omega squared for each TTM construct across three stages (under 90% CI) to those across five stages, we can see that the ω^2 across five stages were larger, indicating larger effects across five stages for each TTM construct than across the first three stages.

Cohen's *d* was also calculated for every pair of adjacent stages (i.e., PC-C, C-PR, PR-A, A-M) for each TTM construct listed. Adjacent stage effect size is consistent with the emphasis on the TTM as a model of behavior change that focuses on helping people to move from one stage of change to the next and to do so one stage at a time; therefore, the cross-sectional adjacent stage effect sizes give us an idea of how much effort would be required for people to move over time from one stage to the next (Blissmer et al., 2010; Redding et al., 2011). The values obtained from this study can be used as the basis for future studies interested in adjacent stage effect sizes. Cohen's *d* is determined by calculating the mean difference between two groups and then dividing the result by the pooled standard deviation. The formula is Cohen's $d = (M_2 - M_1) / SD_{pooled}$. The means and pooled standard deviation values were obtained from SAS. Then the Cohen's *d* for each stage comparison was calculated using the formula. The general guidelines of Cohen's *d* are small-0.2, medium-0.5, and large-0.8 (Cohen, 1988).

Table 1

Predicted ω^2 Based on Previous TTQP Research, Theoretical Consideration, and Previous TTM Condom Use Research across the First Three Stages and Observed ω^2 for Condom Use with 90% CIs

TTM Measures	Previous TTQP Research		Theoretical Consideration		Previous TTM Condom Use		Observed Data		
	ω^2_{pred}	Confirm	ω^2_{pred}	Confirm	ω^2_{pred}	Confirm	ω^2_{obs}	L-CI	U-CI
Pros	.03	Yes	.06	Yes	.097	Yes	.095	.020	.221
Cons	.06	No	.00	Yes	.000	Yes	-.024	.000	.000
Temptation	--		.01	Yes	.107	No	-.018	.000	.040
Confidence	--		.01	Yes	.107	Yes	.019	.000	.120
Consciousness Raising	.08	No	.06	No	.171	Yes	.246	.126	.378
Dramatic Relief	.10	Yes	.06	Yes	.044	Yes	.100	.023	.227
Environmental Reevaluation	.03	No	.06	No	.168	Yes	.214	.100	.347
Liberation	--		.14	No	--		.290	.165	.419
Stimulus Control	.07	No	.06	No	.122	Yes	.205	.094	.338
Counterconditioning	.05	No	.01	No	.145	Yes	.227	.111	.360
Helping Relationships	.02	Yes	.01	No	.046	Yes	.080	.013	.203
Reinforcement Management	.04	No	.01	No	.111	No	.290	.164	.419
Eroticizing Condoms	--		.14	Yes	.098	No	.247	.127	.379
Partner Communication	--		.14	Yes	.063	Yes	.083	.014	.206
Partner Support	--		.06	No	.161	Yes	.226	.110	.359
Interpersonal Systems Control	.08	Yes	.06	Yes	.097	Yes	.059	.004	.177
Condom Assertiveness	--		.06	No	.265	Yes	.218	.103	.351

Figure 1 *Comparison of Predicted Estimates Based on Theoretical Consideration, Previous TTQP Research, and Previous TTM Condom Use Research with Observed Estimates Surrounded by 90% CIs*

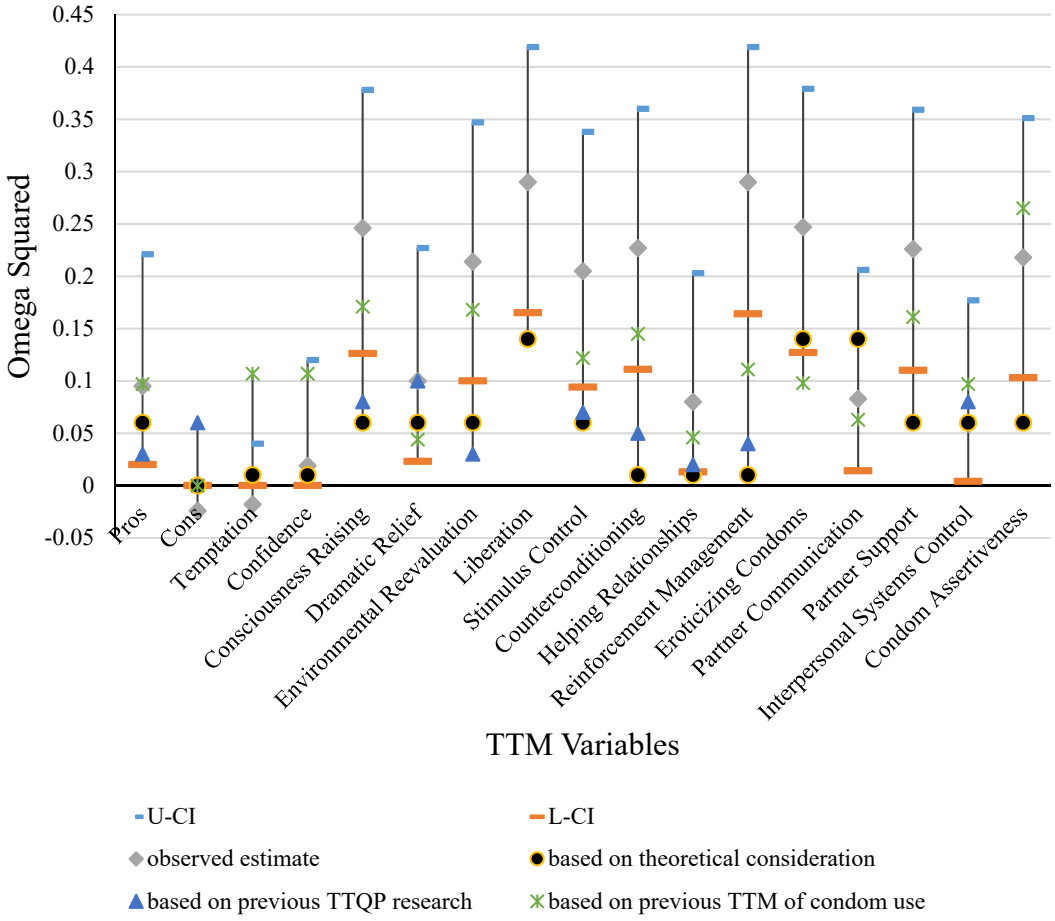

Table 2

Predicted ω^2 Based on Previous TTQP Research, Theoretical Consideration, and Previous TTM Condom Use Research across the First Three Stages and Observed ω^2 for Condom Use with 95% CIs

TTM Measures	Previous TTQP Research		Theoretical Consideration		Previous TTM Condom Use		Observed Data		
	ω^2_{pred}	Confirm	ω^2_{pred}	Confirm	ω^2_{pred}	Confirm	ω^2_{obs}	L-CI	U-CI
Pros	.03	Yes	.06	Yes	.097	Yes	.095	.010	.244
Cons	.06	No	.00	Yes	.000	Yes	-.024	.000	.002
Temptation	--		.01	Yes	.107	No	-.018	.000	.058
Confidence	--		.01	Yes	.107	Yes	.019	.000	.141
Consciousness Raising	.08	No	.06	No	.171	Yes	.246	.104	.400
Dramatic Relief	.10	Yes	.06	Yes	.044	Yes	.100	.012	.250
Environmental Reevaluation	.03	No	.06	No	.168	Yes	.214	.080	.370
Liberation	--		.14	No	--		.290	.141	.441
Stimulus Control	.07	No	.06	No	.122	Yes	.205	.075	.361
Counterconditioning	.05	No	.01	No	.145	Yes	.227	.090	.383
Helping Relationships	.02	Yes	.01	Yes	.046	Yes	.080	.005	.226
Reinforcement Management	.04	No	.01	No	.111	No	.290	.140	.441
Eroticizing Condoms	--		.14	Yes	.098	No	.247	.105	.402
Partner Communication	--		.14	Yes	.063	Yes	.083	.006	.230
Partner Support	--		.06	No	.161	Yes	.226	.089	.382
Interpersonal Systems Control	.08	Yes	.06	Yes	.097	Yes	.059	.000	.200
Condom Assertiveness	--		.06	No	.265	Yes	.218	.083	.374

Figure 2 *Comparison of Predicted Estimates Based on Theoretical Consideration, Previous TTQP Research, and Previous TTM Condom Use Research with Observed Estimates Surrounded by 95% CIs*

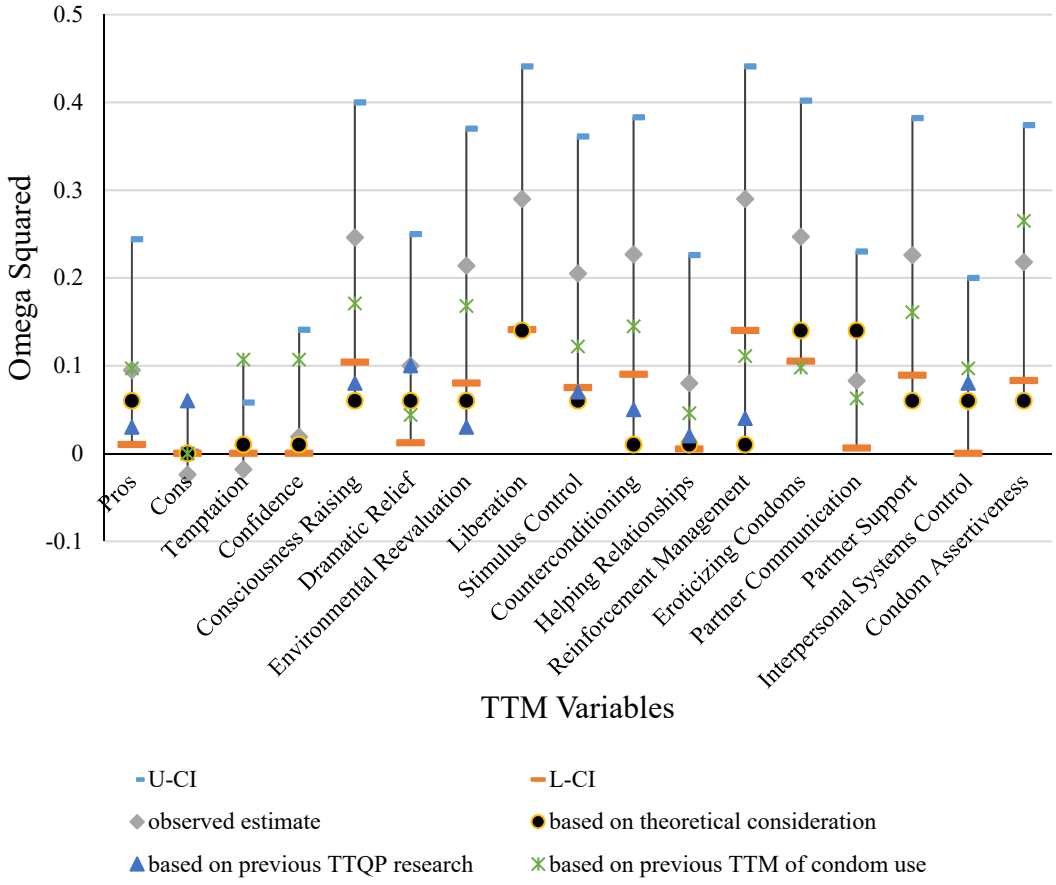

Table 3

Predicted ω^2 Based on Previous TTQP Research, Theoretical Consideration, and Previous TTM Condom Use Research across the First Three Stages and Observed ω^2 for Condom Use with 99% CIs

TTM Measures	Previous TTQP Research		Theoretical Consideration		Previous TTM Condom Use		Observed Data		
	ω^2_{pred}	Confirm	ω^2_{pred}	Confirm	ω^2_{pred}	Confirm	ω^2_{obs}	L-CI	U-CI
Pros	.03	Yes	.06	Yes	.097	Yes	.095	.000	.291
Cons	.06	No	.00	Yes	.000	Yes	-.024	.000	.040
Temptation	--		.01	Yes	.107	No	-.018	.000	.096
Confidence	--		.01	Yes	.107	Yes	.019	.000	.185
Consciousness Raising	.08	Yes	.06	No	.171	Yes	.246	.066	.443
Dramatic Relief	.10	Yes	.06	Yes	.044	Yes	.100	.000	.296
Environmental Reevaluation	.03	No	.06	Yes	.168	Yes	.214	.046	.414
Liberation	--		.14	Yes	--		.290	.097	.482
Stimulus Control	.07	Yes	.06	Yes	.122	Yes	.205	.042	.405
Counterconditioning	.05	No	.01	No	.145	Yes	.227	.054	.426
Helping Relationships	.02	Yes	.01	Yes	.046	Yes	.080	.000	.272
Reinforcement Management	.04	No	.01	No	.111	Yes	.290	.097	.481
Eroticizing Condoms	--		.14	Yes	.098	Yes	.247	.067	.444
Partner Communication	--		.14	Yes	.063	Yes	.083	.000	.276
Partner Support	--		.06	Yes	.161	Yes	.226	.053	.425
Interpersonal Systems Control	.08	Yes	.06	Yes	.097	Yes	.059	.000	.245
Condom Assertiveness	--		.06	Yes	.265	Yes	.218	.048	.417

Figure 3 *Comparison of Predicted Estimates Based on Theoretical Consideration, Previous TTQP Research, and Previous TTM Condom Use Research with Observed Estimates Surrounded by 99% CIs*

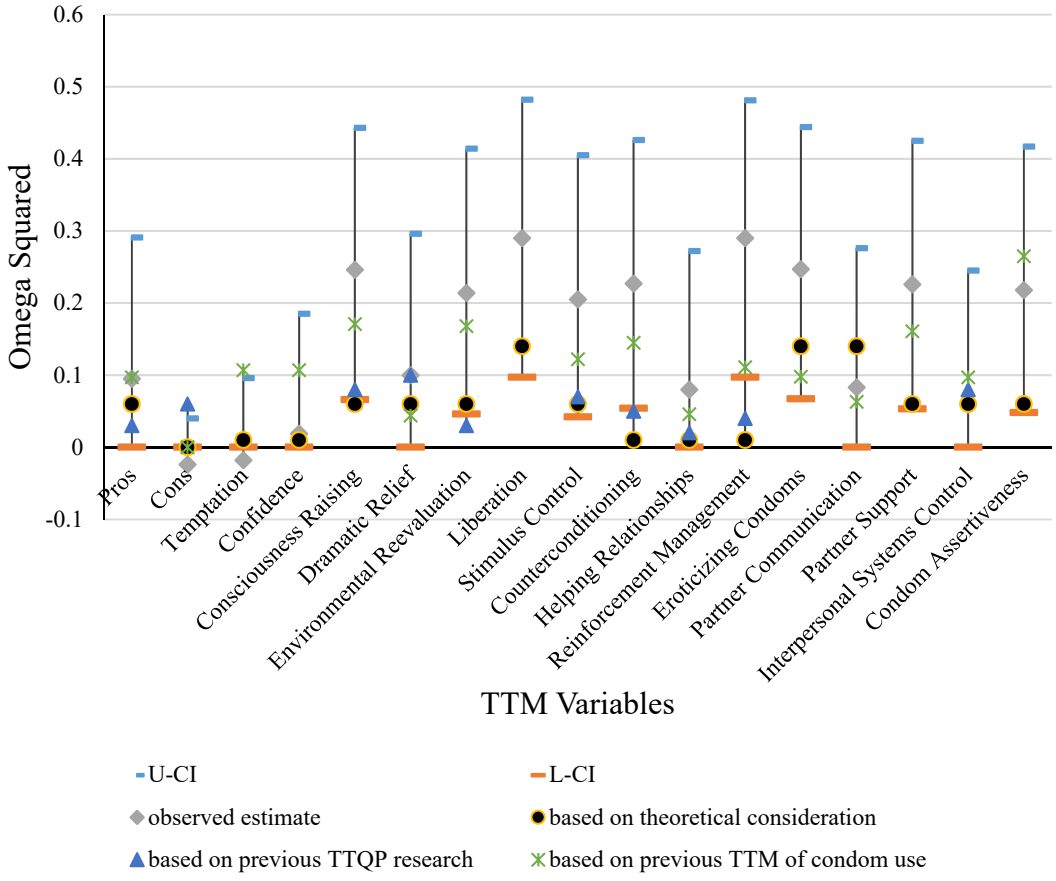

Table 4

Observed ω^2 for Condom Use with 90% CIs across Five Stages of Change and Cohen's d

TTM Measures	Observed Data			Cohen's d			
	ω^2_{obs}	L-CI	U-CI	PC-C	C-PR	PR-A	A-M
Decisional Balance							
Pros	.224	.142	.313	.638	.462	-.127	.366
Cons	.033	.001	.099	-.026	-.030	.065	.453
Temptation	.181	.105	.269	.201	-.083	-1.172	.168
Confidence	.252	.168	.341	.429	.114	.783	.046
Processes of Change (Experiential)							
Consciousness Raising	.523	.444	.591	1.215	.467	.775	.041
Dramatic Relief	.287	.201	.375	.761	.230	.513	.038
Environmental Reevaluation	.451	.367	.527	.852	.441	.716	.144
Liberation	.655	.593	.706	1.142	.992	.957	.123
Processes of Change (Behavioral)							
Stimulus Control	.550	.475	.615	.757	.733	1.006	.059
Counterconditioning	.555	.480	.620	.984	.767	.848	.019
Helping Relationships	.311	.224	.398	.688	.183	.954	-.250
Reinforcement Management	.368	.280	.451	.792	.127	.500	.428
Eroticizing Condoms	.440	.355	.517	.670	.452	.854	.094
Processes of Change (Interpersonal)							
Partner Communication	.354	.267	.438	.677	-.052	1.307	-.227
Partner Support	.508	.429	.578	1.000	.679	.954	-.264
Interpersonal Systems Control	.425	.340	.503	.707	.019	.808	.498
Condom Assertiveness	.605	.536	.663	1.077	.342	1.045	.458

CHAPTER 4

DISCUSSION

Examination of Failed Predictions

If the CI of the observed ω^2 contains the predicted ω^2, then the prediction is confirmed. If the predicted ω^2 falls outside of the CI, then the prediction is not confirmed and examination of failed predictions is needed. Missed predictions suggest a need for theory refinement through replication and empirical study rather than indicating a failure of the theory (Velicer et al., 2013). Examination of failed predictions is a method to promote replication and improve theory based on empirical findings. The examination of the potential reasons that caused missed predictions could make researchers move away from the dichotomous accept/reject thinking to the consideration of how to revise and improve the theory (Brick et al., 2015).

There are four potential explanations for non-confirmation of predictions: 1. Sample fluctuation. The use of CI permits a small number of near misses due to chance fluctuations. These misses are very close to falling within the CI, which may require very slight adjustment of expected effect size values. Moreover, some of these near misses may be confirmed in another independent sample or with a different CI. As the number of predictions increase, the chance of a miss due to sample fluctuation increases. 2. A need for theory/prediction revision. This may happen when an observed effect size value falls far away from the predicted effect size value (e.g. a small or medium effect was predicted but a large effect was observed), then the

prediction needs to be revised. 3. Theory is incorrect. When an observed effect size is so clearly discordant with the predicted effect size that all alternative explanations are infeasible (e.g., the predicted effect and the observed effect are too far apart or in the opposite direction), then the theory itself needs major reconsideration rather than a slight revision or a near miss. The incorrect theory could lead to overwhelmingly incorrect predictions. 4. A need for further calibration of effect size categories. Cohen's (1988) guidelines for omega-squared (i.e., a small effect is about 0.01, a medium effect is about 0.06, and a large effect is about 0.14) are broadly defined and were intended only as a guide to initial estimates. When observations and their CIs do not align with any of the predicted values, then further calibration of predicted effect size is needed. For example, a medium effect may be represented by a prediction of .08 instead of .06; a large effect may be represented by a prediction of .18 instead of .14. The creation of new categories may also be needed if the observed values fall too far outside of Cohen's guidelines (e.g., a new category "extra-large" may be created if observed effects are well beyond .14).

We can see from the results that the number of non-confirmation of predictions were different when different CI's were used. When 90% CI was used, 6 of 10 predictions were not confirmed for predictions based on previous TTQP studies of other health behavior changes; 9 of 17 predictions were not confirmed for predictions based on theoretical considerations; and 3 of 16 predictions were not confirmed for predictions based on previous TTM condom use studies. Missed predictions were examined.

For the predictions based on theoretical considerations, one of the nine misses, Helping Relationships, was due to a near miss, as it fell just outside of the CI. This near miss may be confirmed with a higher confidence level or with a different sample (e.g., in this study this prediction was confirmed when 95% or 99% CI was used). Seven of these misses, Consciousness Raising, Environmental Reevaluation, Stimulus Control, Counterconditioning, Reinforcement Management, Partner Support, and Condom Assertiveness, suggested a need for prediction/theory revision. Predicted effect sizes for these variables tended to be low (e.g., medium effects were predicted but large effects were observed). One of these misses, Liberation, may require a recalibration of the effect size categories. The prediction of a large effect size was represented as .14. However, the lower bound of the CI for Liberation was .165. A recalibration of the large effect from .14 to .18 can solve the problem. In addition, since the observed effect was .29, and the CI was (.165, .419), the creation of a new category, "extra-large", may also solve this problem. The created value for this new category, extra-large effect, could be around .25 or .30.

For the predictions based on previous TTQP studies of other health behavior changes, all six misses, Cons, Consciousness Raising, Environmental Reevaluation, Stimulus Control, Counterconditioning, and Reinforcement Management, suggested a need for prediction/theory revision. Predicted effect size for Cons was medium while the observed effect size was zero; predicted effect sizes for other five variables tended to be low, compared to the observed effect sizes (e.g., medium effects were predicted but large effects were observed).

For the predictions based on previous TTM condom use studies, all of the three misses, Temptation, Eroticizing Condoms, and Reinforcement Management, suggested a need for prediction/theory revision. The predicted effect size values were either higher or lower than the observed effect size values.

When 95% CI was used, 6 of 10 predictions were not confirmed for predictions based on previous TTQP studies of other health behavior changes; 8 of 17 predictions were not confirmed for predictions based on theoretical considerations; and 3 of 16 predictions were not confirmed for predictions based on previous TTM condom use studies. Missed predictions were examined.

For the predictions based on theoretical considerations, one of the eight misses, Liberation, was due to a near miss, as it fell just outside of the CI. This near miss may be confirmed with a higher confidence level or with a different sample (e.g., in this study this prediction was confirmed when 99% CI was used). Seven of these misses, Consciousness Raising, Environmental Reevaluation, Stimulus Control, Counterconditioning, Reinforcement Management, Partner Support, and Condom Assertiveness, suggested a need for prediction/theory revision. Predicted effect sizes for these variables tended to be low (e.g., medium effects were predicted but large effects were observed). The number of non-confirmation of predictions when 95% CI was used was one less than when 90% CI was used. Moreover, the near miss associated with 90% CI, Helping Relationships, was confirmed when 95% CI was used.

For the predictions based on previous TTQP studies of other health behavior changes, five of the six misses, Cons, Consciousness Raising, Environmental

Reevaluation, Counterconditioning, and Reinforcement Management, indicted a need for prediction/theory revision. Predicted effect size for Cons was medium while the observed effect size was zero; predicted effect sizes for other four variables tended to be low (e.g., medium effects were predicted but large effects were observed). One of the six misses, Stimulus Control, was due to sample fluctuation (near misses), as it fell just outside of the CI. This near miss may be confirmed with a higher confidence level or with a different sample (e.g., in this study this prediction was confirmed when 99% CI was used).

For the predictions based on previous TTM condom use studies, two of the three misses, Temptation and Reinforcement Management, suggested a need for prediction/theory revision. The predicted effect size values were either higher or lower than the observed effect size values. One of the three misses, Eroticizing Condoms, was due to sample fluctuation (near miss), as it fell just outside of the CI. This near miss may be confirmed with a higher confidence level or with a different sample (e.g., in this study this prediction was confirmed when 99% CI was used).

When 99% CI was used, 4 of 10 predictions were not confirmed for predictions based on previous TTQP studies of other health behavior changes; 3 of 17 predictions were not confirmed for predictions based on theoretical considerations; and 1 of 16 predictions were not confirmed for predictions based on previous TTM condom use studies. Missed predictions were examined.

For the predictions based on theoretical considerations, one of the three misses, Consciousness Raising, was due to a near miss, as it fell just outside of the CI. This near miss may be confirmed with a higher confidence level or with a different sample.

Two of the three misses, Counterconditioning and Reinforcement Management, suggested a need for prediction/theory revision. Predicted effect sizes for these variables tended to be low (e.g., small effects were predicted but medium or large effects were observed). For the predictions based on theoretical considerations, the number of non-confirmation of predictions when 99% CI was used was five less than when 95% CI was used. Moreover, the near miss associated with 95% CI, Liberation, was confirmed when 99% CI was used.

For the predictions based on previous TTQP studies of other health behavior changes, three of the four misses, Cons, Environmental Reevaluation, and Reinforcement Management, indicated a need for prediction/theory revision. Predicted effect size for Cons was medium while the observed effect size was zero; predicted effect sizes for other two variables tended to be low (e.g., small effects were predicted but medium or large effects were observed). One of the four misses, Counterconditioning, was due to sample fluctuation (near miss), as it fell just outside of the CI. This near miss may be confirmed with a higher confidence level or with a different sample. For the predictions based on previous TTQP studies of other health behavior changes, the number of non-confirmation of predictions when 99% CI was used was two less than when 95% CI was used. Moreover, the near miss associated with 95% CI, Stimulus Control, was confirmed when 99% CI was used.

For the predictions based on previous TTM condom use studies, the only miss, Temptation, suggested a need for prediction/theory revision. The predicted effect size value was higher than the observed effect size value (medium-to-large effect was predicted while zero effect was observed).

The findings associated with the three different CIs (90%, 95%, and 99%) demonstrated that as CI increased, the number of confirmation of predictions increased and the number of non-confirmation of predictions decreased; the near misses associated with a lower confidence level were confirmed when a higher confidence level was used. The 90% CI is narrower than the 95% CI, which is narrower than the 99% CI. A narrower interval may lead to more missed predictions as it allows for more error, and a narrower interval can provide a test more prone to misses due to sampling fluctuation (Velicer et al., 2013). The higher the confidence level, the less likely we are to get a missed prediction, especially when sampling variability is the only cause. The different findings across different CI's indicated the importance of carefully selecting CI level in doing this type of research.

Another thing to be noticed is that the effect size prediction for the TTM construct that belongs to the behavioral processes of change, Reinforcement Management, was consistently not confirmed in this study and in previous TTQP studies which used cross-sectional samples (Brick et al., 2015; Velicer et al., 2008). The examination of missed prediction for this variable mainly suggested a need for theory/prediction revision, indicating that the theory underlying the predicted effects of the TTM variable, Reinforcement Management, may need to be revised. Such theory revision may lead to future confirmation of prediction for this TTM variable.

Another finding worthy of discussion was that the observed ω^2 for two TTM measures, Cons and Temptation, was a little bit less than 0 (e.g., -.024). Obtaining omega-squared values of less than 0 is due to the sample size bias adjustment that is inherent in omega-squared. Omega-squared was developed because the more

commonly used eta-squared statistic has been shown to be biased "high" (overestimate the population proportion of variance accounted for), and the bias can become worse when sample sizes are small. Omega-squared was developed so as to correct for this sample size bias. A mathematical consequence of the adjustment is that when the effect size is small, the adjusted value of omega-squared can be less than 0. When this happens, we interpret the meaning of the negative omega-squared as indicating an effect size of 0.

The overall findings for this study indicated that the first two prediction methods (i.e., predictions based on theoretical considerations and predictions based on previous TTQP studies of other health behavior changes) did not do well at predicting effect size estimates for condom use behavior when 90% CI or 95% CI was used. However, the third prediction method (i.e., the predicted effect size values were calculated from the data reported in previous TTM condom use studies) did very well at predicting effect size estimates for condom use behavior, no matter which CI was used. The inadequate fit of predictions based on previous studies of other health behavior changes and the good fit of predictions derived from previous TTM condom use studies indicated that TTM constructs for condom use have different effects across the first three stages of change compared to other health behavior changes (e.g., smoking, sun protection, or diet), and that future studies should use previous empirical data based on the same health behavior change to generate effect size predictions whenever possible. The present study provides empirical data for future research making TTM-based cross-sectional and longitudinal quantitative predictions to condom use behavior. Moreover, the present study supports the need to further calibrate the effect

size categories and the need to revise theory using empirical data. Replication of this study using independent samples would be very helpful to refine theoretical predictions.

Strengths and Limitations

The current study has some obvious advantages. The first advantage is that the current study used a quantitative approach (TTQP) as an alternative to NHST. TTQP is more direct, informative and stronger than NHST. It can make researchers clarify what the theory estimates and specify what was previously vague about the theory, and then improve the theory. Moreover, the quantitative approach emphasizes the magnitude of a difference and allows for straightforward comparisons by using a common effect size metric. Furthermore, TTQP can be used to guide decision making for more effective behavioral interventions, because it can determine which psychological constructs lead to greater effects at certain points during the behavior change process (Rossi, 2001). In addition, effect size estimation also provides the basis for the development of power analysis and meta-analysis. Another advantage is that the present study is the first study applying the TTQP approach to TTM measures of condom use, especially in a MSM sample, which will contribute to the literature and provide empirical support for future research making TTM-based effect size predictions to condom use behavior. In addition, compared to the previous TTQP studies, this study added another prediction method which generated effect size predictions from the data reported in previous TTM condom use studies. This prediction method was more accurate in predicting effect size estimates for MSM condom use behavior, compared with the other two prediction methods, indicating the

importance of using previous empirical data based on the same health behavior change to generate effect size predictions. Besides, the present study supports the need to further calibrate the effect size categories and the need to revise theory using empirical data. Replication of this study using independent samples would be very helpful to refine theoretical predictions.

However, there are also some limitations of this study. First, this study used cross-sectional data and not longitudinal data. Cross-sectional study is less time-consuming and more feasible, but it is difficult to determine the temporal relationships between variables. Second, the sample size was not large, and the majority of participants were White, aged 18 to 25, employed full time, and self-identified as gay, which may limit the generalizability of these results. Moreover, there was limited previous empirical data to help develop TTM-based quantitative predictions for this study. Thus, some predicted effect sizes may not be accurate which may lead to missed predictions. Additionally, the TTQP approach has only been applied to the TTM so far. Application of this quantitative approach to other theories may also be needed.

Future studies should try to use longitudinal data and use larger, more diverse, and more representative samples. Future studies should also try to use previous empirical data based on the same health behavior change to generate effect size predictions whenever possible. Besides, future studies can try to develop quantitative predictions from additional theories beyond TTM.

APPENDICES

Appendix A

The Stages of Change Algorithm

1) When you had anal sex in the last 2 months, how often did you use condoms?

1. Never.

2. Almost never.

3. Sometimes.

4. Almost every time.

5. Every time.

2) Are you thinking about or planning to start using condoms every time you have anal sex?

1. No, I am not thinking about starting to use condoms every time.

2. Yes, I am planning to start using condoms every time in the next 30 days.

3. Yes, I am planning to start using condoms every time in the next 6 months.

4. I already do use condoms every time.

3) For how long have you been using condoms every time you have anal sex?

1. I have not been using condoms every time.

2. 1 to 3 months.

3. 4 to 6 months.

4. 7 to 11 months.

5. 1 year or more.

Readiness to use condoms in general during anal sex with men was measured as follows:

If Q1 < 5 and Q2 = 1 stage of change is Precontemplation.

If Q1 < 5 and Q2 = 3 stage of change is Contemplation.

If Q1 < 4 and Q2 = 2 stage of change is Contemplation.

If Q1 = 4 and Q2 = 2 stage of change is Preparation.

If Q1 = 5 and Q2 = 4 and Q3 = 2 stage of change is Action.

If Q1 = 5 and Q2 = 4 and Q3 = 3 stage of change is Action.

If Q1 = 5 and Q2 = 4 and Q3 = 4 stage of change is Maintenance.

If Q1 = 5 and Q2 = 4 and Q3 = 5 stage of change is Maintenance.

Appendix B

SAS Codes for Analyses

```
libname SASDATA V9 "C:\Users\bchen\Desktop\SASDATA";
PROC IMPORT OUT= SASDATA.MSM1
DATAFILE= 'C:\Users\bchen\Desktop\MSM1.sav'
DBMS=SAV REPLACE;
run;
data SASDATA.MSMnew(drop=x);
set SASDATA.msm1(rename=(STGCNDG=x));
STGCNDG=input(x,best12.);
run;
proc print data=SASDATA.MSMnew;
run;
data SASDATA.subset;
set SASDATA.MSMnew;
if STGCNDG=0 then delete;
if STGCNDG=4 then delete;
if STGCNDG=5 then delete;
run;
proc print data=SASDATA.subset;
title 'delete cannot stage, Action, Maintenance';
run;
proc glm data=SASDATA.subset;
```

```
class stgcndg;
model prosfm consfm tmptfm conffm crpocfm drpocfm erpocfm clpocfm scpocfm
ccpocfm hrpocfm rmpocfm ecpocfm copocfm pspocfm ispocfm aspocfm= stgcndg /
ss1 effectsize alpha=0.1;
means stgcndg;
run;
proc glm data=SASDATA.subset;
class stgcndg;
model prosfm consfm tmptfm conffm crpocfm drpocfm erpocfm clpocfm scpocfm
ccpocfm hrpocfm rmpocfm ecpocfm copocfm pspocfm ispocfm aspocfm= stgcndg /
ss1 effectsize alpha=0.05;
means stgcndg;
run;
proc glm data=SASDATA.subset;
class stgcndg;
model prosfm consfm tmptfm conffm crpocfm drpocfm erpocfm clpocfm scpocfm
ccpocfm hrpocfm rmpocfm ecpocfm copocfm pspocfm ispocfm aspocfm= stgcndg /
ss1 effectsize alpha=0.01;
means stgcndg;
run;
```

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