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# Assessing Readiness for Advancing Women Scientists Using the Transtheoretical Model

*Sex Roles, June 2006*

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**Abstract**

The under-representation of women in the science, technology, engineering, and math disciplines is of broad national concern. This paper reports on the development of new Transtheoretical Model-based measures to assess readiness to take action to advance women scientists. Reliable, valid measures of stage of change, decisional balance, and self-efficacy were developed with a sample of science faculty from a northeastern university. Theoretical relationships among the constructs were validated with the current data, offering support for the application of the Transtheoretical Model to this area. These measures are being used as part of a campus wide initiative to examine the advancement of women scientists before and after a series of interventions.

## Introduction

There is broad national concern about the under-representation of women in the science, technology, engineering, and math (STEM) academic disciplines. Although nearly half of science undergraduates are women, college educated women are less than half as likely as men to be employed in science and engineering. Further, women who do work in those fields tend to earn about 20% less than their male peers (Graham & Smith, 2005). Within academia, tenure and promotion rates are slower and attrition rates are higher for women scientists than men. Even after controlling for time-since-doctorate, men are still more likely to be tenured (60% of men vs. 35% of women), and to be full professors (51% of men vs. 24% of women) (NSF, 2000). Indeed, fewer than 15% of women scientists are awarded full professor positions in the top science and engineering institutions and in some disciplines it is as low as 3% (MIT, 1999, CAWMSET, 2000; Etzkowitz, Kemelyor, & Ussi, 2000; NSF, 2001). Those trends lead to a significant difference in median salaries between women and men faculty in many STEM departments at universities and four-year colleges (NSF, 2001). Workplace inequity is an obvious concern, however, the under-

representation of women in academic sciences is alarming for several other reasons.

Women faculty provide critically needed role models for female students. Currently women are less likely than men to choose a STEM discipline as their major in college, and women who do choose a science major are more likely than men to change their major before graduation. It is not the case that women stray from science majors because they struggle with the topics or studies. In fact, women who leave engineering to pursue other college majors often have a higher grade point average than the male students who continue their engineer track. These fields lose some of their most able candidates before the end of college. (Nauta, Epperson & Waggoner, 1999). Women science majors may be dissuaded from completing the major not only because the majority of their peers are males, but also because women mentors in their fields are scarce. More women science faculty could attract and retain women students in those fields and further, may encourage recent female graduates to seek employment in academia (Tilghman, 2004).

Including the large, untapped pool of qualified women in STEM fields would also diversify the study of science. Although women do not practice science differently than men, it has been argued that women's interests in science may be different than the kinds of things that interest men. Diversifying the STEM departments will simultaneously expand faculty areas of expertise and research focuses, which in turn will increase the department's internal diversity as well as range of research opportunities. In this time of global competition, diversifying leadership in the STEM disciplines will bring different perspectives, skills, and values to the fore and will more responsibly integrate scientific practice with societal needs (Fox Keller, 1991; Rosser, 1997).

Finally, greater representation of women faculty in STEM departments could help improve the working climate for these women. Nationally women in the academic sciences report more isolation, fewer interactions with faculty, fewer resources, less mentoring, and feelings of being overburdened (AAC&U, 2000; Peterson, 1997). One study which has been replicated at a number of different institutions has consistently shown that women faculty in the STEM disciplines are more likely to report feeling marginalized and isolated, having less job satisfaction, having unequal lab space, unequal salary, unequal recognition through awards, unequal access to resources, and unequal opportunities to take on administrative responsibilities dealing with the future of the department or the research unit. (Tilghman, 2004). These are not working conditions that lend to the productivity and retainment of women faculty, nor to the recruitment of new female scientists.

The process by which scientists are produced and supported, particularly in academia, warrants re-evaluation. To date the advancement of scientists, whether in industry or academia, has been largely limited to white males (NSF, 2000). Changes are needed to enable departmental diversity growth, expanded offerings and perspectives, and the view that STEM is an attractive choice for female students and prospective faculty. To achieve this, a northeast state university received a 5-year AD-

VANCE Institutional Transformation Award from the National Science Foundation to increase the number and facilitate the career advancement of women STEM faculty and to improve the institutional climate for women scientists. The National Science Foundation created ADVANCE to increase the participation of women in the scientific and engineering workforce through the increased representation and advancement of women in academic science and engineering careers. This university is taking a multi-level approach to achieve the goals of this project, including increasing the number of ranked women faculty in STEM departments, providing existing women STEM faculty with career development and training opportunities, and improving social support services for women faculty. Changing the climate of the STEM departments is also one of the many steps this university is taking to help advance women scientists at their institution. The theoretical underpinning of the organizational or climate change approach is the Transtheoretical Model of change (TTM). Its fundamental premise is that organizational and individual behavior change occurs in stages over time. In this initiative the TTM is being used to assess readiness of faculty to adopt four specific behaviors that will help advance women scientists. These behaviors include creating opportunities for collaboration, enhancing competency through mentoring, providing resources for doing research, and generating support through community. The TTM can be applied to assess faculty on their stage of readiness to do these behaviors and to provide processes or strategies to help them move from one stage to the next.

*The Transtheoretical Model of Change*

The Transtheoretical Model (also known as the "stage model"), one of the leading models of behavior change (Prochaska, DiClemente, & Norcross, 1992; Prochaska, Norcross, & DiClemente, 1994), offers a systematic and empirically based approach to conceptualizing and assessing readiness to advance women scientists. The TTM understands change as progress, over time, through a series of stages: Precontemplation, Contemplation, Preparation, Action, and Maintenance. The TTM systematically integrates four theoretical constructs central to change:

1) Stage of Change — Intention to take action
2) Decisional Balance — Pros and Cons associated with a behavior's consequences
3) Self-Efficacy — Confidence to make and sustain changes in difficult situations
4) Processes of Change — Ten cognitive, affective, and behavioral activities that facilitate change.

*Stage of Change*

The TTM was chosen for this initiative in part because it utilizes stages of change or readiness as the central organizing construct. Studies of change have found that people move through a series of five stages when modifying behavior on their own or with the help of formal intervention (Prochaska & DiClemente, 1983; Prochaska et al., 1992; Prochaska, Velicer, Fava, Rossi, & Tsoh, 2001). In the first stage, Precontemplation, individuals either deny they need to do things differently and thus,

are resistant to making changes, are unaware of the negative consequences of their behavior, believe the consequences are insignificant, or have given up the thought of changing because they are demoralized. Individuals in Precontemplation are often uninformed or underinformed about the importance of specific actions, such as the importance of advancing women scientists. They often become defensive if they feel pressured to take action when they are not ready. Precontemplators are assessed as not intending to take action in the next six months. Individuals in the Contemplation stage are more likely to recognize the benefits of changing. However, Contemplators continue to overestimate the costs of changing and, therefore, are ambivalent and are still not ready to take action. Contemplators are seriously considering taking action in the next six months. Individuals in the Preparation stage have decided to make a change in the next 30 days and have already begun to take steps toward that goal. Individuals in the Action stage are overtly engaged in modifying their behaviors or acquiring new behaviors. After about six months, individuals do not have to work as hard as they progress into the Maintenance stage and become more confident that they can continue to do the Action criteria, in this case, mentoring, collaborating, sharing resources, and generating support. For most people, the change process is not linear. Movement across the stages is fluid and individuals can regress to an earlier stage, if their ambivalence increases or their self-efficacy decreases (Prochaska et al., 1994).

*Decisional Balance*

Change requires consideration of the potential gains (pros) and losses (cons) associated with a behavior's consequences. The Decisional Balance Inventory (Velicer, DiClemente, Prochaska, & Brandenburg, 1985) consists of two scales, the pros of change and the cons. Longitudinal studies have found those measures to be among the best available predictors of future change (e.g., Velicer et al., 1985). In an integrative report of 12 studies, Prochaska, Velicer, et al. (1994) found that the balance of pros and cons was systematically related to stage of change in all 12 behaviors examined. The cons of changing to the new behavior outweighed the pros in the Precontemplation stage, the pros surpassed the cons in the middle stages, and the pros outweighed the cons in the Action stage. From those 12 studies, Prochaska (1994) discovered the degree of change in pros and cons needed to progress across the stages of change: progression from Precontemplation to Action involved approximately a one standard deviation increase in the pros of making the behavior change, and progression from Contemplation to Action involved a one-half standard deviation decrease in the cons. A meta-analysis across 55 studies using the TTM offers impressive replication for Prochaska's 1994 findings (Hall, 2004). Among individuals not ready to advance women scientists, increasing the salience and enhancing the decisional weight of the pros and decreasing the cons, can help increase intentions to take the steps of mentoring, collaborating, sharing resources, and generating support. For example, individuals would be asked to list their current benefits for advancing women scientists and would be encouraged to double the list.

*Self-Efficacy*

Self-efficacy, or the degree to which an individual believes he or she has the capacity to make and sustain changes in difficult situations, can influence motivation and persistence (Bandura, 1977). Self-efficacy in the TTM has two components that are distinct but related: confidence to make and sustain changes, and temptation to relapse to an earlier stage. Like decisional balance, levels of self-efficacy differ systematically across the stages of change, with individuals further along in the stages of change generally experiencing greater confidence and less temptation. Hall and Rossi (2004) found that across 24 behaviors self-efficacy increased about 1.5 standard deviations from Precontemplation to Maintenance. Self-efficacy for advancing women scientists means having the confidence to take the steps of mentoring, collaborating, sharing, and supporting in a variety of difficult situations (e.g., when you don't think you have time or when you receive negative reactions from colleagues). To increase self-efficacy individuals would be encouraged to set realistic goals of moving one stage at a time. Small steps to increase confidence would be suggested.

*Processes of Change*

In a comparative analysis of 24 major systems of psychotherapy, Prochaska (1978) distilled a set of 10 fundamental processes by which people change. The set was refined following further theoretical analyses (Prochaska & DiClemente, 1984) and empirical studies (Prochaska & DiClemente, 1983). These 10 processes describe the basic patterns of activity counselors have used to help others change their behaviors, affects, cognitions or interpersonal relationships. The 10 processes applied to advancing women scientists are defined below:

| | |
|---|---|
| **Consciousness Raising** | Increasing awareness and information about the importance of taking the steps to advance women scientists. |
| **Dramatic Relief** | Experiencing strong positive emotions that go along with advancing women scientists. |
| **Environmental Reevaluation** | Realizing the impact that one's taking the steps to advance women scientists has on other people |
| **Self-Reevaluation** | Emotional and cognitive reappraisal of values and self-image related to advancing women scientists. |
| **Self-Liberation** | Making and demonstrating a firm commitment to take the steps to advance women scientists. |
| **Reinforcement Management** | Increasing intrinsic and extrinsic rewards for taking the steps for mentoring, collaborating, sharing, and supporting. |
| **Helping Relationships** | Seeking and using social support to encourage or help with taking the steps. |
| **Counter-Conditioning** | Identifying alternatives to support staying on track. |
| **Stimulus Control** | Adding cues or reminders to take the steps to advance women scientists. |
| **Social Liberation** | Realizing that universities are changing to support taking the steps to advance women scientists |

Data from previous research on a variety of behaviors, such as smoking (Prochaska, et al., 1988), condom use (Prochaska, Redding, et al., 1994) and psychological distress ( Prochaska & DiClemente, 198--3) show that self-changers in different stages rely on different processes of change. Individuals in the early stages rely more on cognitive, affective, and evaluative processes of change; individuals in the later stages rely more on social support, commitments, and behavior management techniques. Table 1 summarizes the current understanding of self-changers' patterns of emphasizing particular processes as they progress through the stages .

**Table 1.**

**Integration of the Stages, Processes, and Principles of Change**

| Precontemplation | Contemplation | Preparation | Action | Maintenance |
|---|---|---|---|---|
| Consciousness Raising | | | | |
| Dramatic Relief | | | | |
| Environmental Reevaluation | | | | |
| | Self-Reevaluation | | | |
| | | Self-Liberation | | |
| | | | | Reinforcement Management |
| | | | | Helping Relationships |
| | | | | Counter-Conditioning |
| | | | | Stimulus Control |
| Pros of Changing Increasing | | | | |
| | Cons of Changing Decreasing | | | |
| | | Self-Efficacy Increasing | | |

Social Liberation has been found to not have differentiated emphasis across all five stages.

*TTM-Based Interventions*

Multiple clinical trials have documented the ability of TTM interventions to recruit, retain, and effect change in large populations of individuals for several behaviors including smoking cessation (Prochaska et al., 1993; Prochaska et al., 2001; Velicer et al., 1999), stress management (Evers et al., in press), exercise adoption (Marcus et al., 1998), dietary change (Greene et al., 1999), limiting sun exposure (Weinstock et al.,2002), and multiple behaviors (Prochaska et al., 2004; Riebe et al., 2003; Prochaska et al., 2005). The TTM also has received empirical support across studies of behavior change in a range of organizational change areas, including collaborative service delivery (Levesque, Prochaska, & Prochaska,1999), time limited therapy (Prochaska, 2000), and continuous quality improvement (Levesque et al., 2001). Stage-matched interventions can have a greater impact than one-size-fits-all programs that are most often action-oriented. Programs that are suitable for individuals in all stages of change – those ready to change and those not ready – lead to higher participation rates. Research comparing stage distributions across behaviors and at-risk populations finds that the majority of individuals are not prepared to take action (Laforge, Velicer, Richmond, & Owen, 1999; Velicer et al., 1995). Because impact equals participation rate multiplied by

behavior change rates, stage-tailored programs delivered to an entire population can make a sizeable impact on the targeted behavior or problem such as the advancement of women scientists. Offering stage-matched interventions also increases the likelihood that individuals will take action. For example, stage-matched interventions for smokers more than double the smoking cessation rates of one of the best traditional home-based interventions available (Prochaska, DiClemente, Velicer, & Rossi, 1993). TTM-based measures can provide sensitive assessments of readiness to advance women scientists and guide the development of tailored interventions that can reduce resistance among more senior faculty and increase the likelihood of successful advancement of women scientists.

*Application of the TTM to Advancing Women Scientists*

Development of measures of the core constructs is the first step in the application of TTM to a new area. One of the initial challenges is identifying criteria that define action for the target behavior. For advancing women scientists, the process of defining these criteria included reviewing literature on the topic, conducting focus groups with women and men faculty, and individual interviews with professors experienced in advancing women and researchers highly experienced in developing TTM measures for new applications. Information and data collected from this process helped extract the four key behaviors (collaborating, mentoring, sharing resources, and generating support). This process was also used to generate items that would best express the pros and cons of changing and self-efficacy to advance women scientists. Measures of the processes of change were not included in this study. The present study focuses on the development and initial validation of TTM measures that assess stage, pros and cons, and self-efficacy for taking the steps to advance women scientists.

**Method**

*Participants*

Faculty members from across a northeastern university were invited to complete a campus climate survey. TTM assessments were included in the climate survey to assess readiness of science faculty to advance women scientists. Only data from that section of the survey, completed by science department faculty, are presented in this paper. One hundred and thirty eight professors from science departments completed the baseline climate survey. STEM departments as well as other science fields (including nursing, psychology, and sociology), are included in this ADVANCE initiative and therefore are included in this sample. Most participants were tenured associate or full professors (53.3%) and 15.6% were tenure track assistant professors. Because of the nature of certain science departments, 23.7% of participants were research professors without a tenure-track position. Other appointments noted by participants include administrative (4.4%) and other (3.0%). The majority of participants were male (73.7%). The age of participants ranged from 28 to 70 years with a mean age of 51.3 years.

*Procedure*

Faculty members were sent the climate survey and a letter inviting their participation in the mail. They were asked to complete the survey and return it in a postage paid envelope. Participants were notified that colleges would receive a $100 gift certificate for each department that had at least 75% of their faculty complete the survey. Participants were ensured that all information included in the survey would be strictly confidential. The university Institutional Review Board approved all of the study procedures. Upon receipt of the completed survey, research assistants entered the data into SPSS (version 9.0).

*Measures*

*Stage of Change Algorithm*

Participants read a four part definition including examples of what it means to advance women in science. An example of each of the four behaviors would be: (1) Creating opportunities for collaboration, e.g. inviting women faculty to collaborate on projects; (2) Enhancing competency through mentoring, e.g. teaching about funding mechanisms; (3) Providing resources for doing research, e.g. sharing equipment facilities; (4) Generating support through community, e.g. encouraging social activities for the department. They then rated how much they have participated in each of the four behaviors on a 5-point scale from "Not at all" to "Completely".

Next, participants were asked to keep the entire definition of what it means to advance women scientists in mind and to report on their readiness to take the four steps to advance women scientists. Participants were directed to select one of five alternatives that best represented their intentions to do all four steps, including the Precontemplation stage (PC) – not intending to take the four steps to advance women scientists in the next 6 months; the Contemplation stage (C) – intending to take the four steps in the next 6 months; the Preparation stage (PR) – intending to take the four steps in the next 30 days; the Action stage (A) – have taken the four steps but less than 6 months ago; the Maintenance stage (M) – have taken the four steps for more than 6 months.

*Decisional Balance*

This measure was designed to assess the relative importance of eight pros and eight cons of taking the steps to advance women scientists. Participants reported on a 5-point scale, ranging from 1 (Not at all important) to 5 (Extremely important) how important each item was in their decision whether or not to take the four steps. A sample pro item is "It could help keep competent women colleagues at URI." A sample con item is "It could take too much effort."

*Self-Efficacy*

This measure was designed to assess an individual's degree of confidence to take the four steps to advance women scientists. Participants reported on a 5-point scale, ranging from 1 (Not at all confident) to 5 (Extremely confident) how confi-

dent they were in 14 specific difficult situations that they could carry out the four steps. A sample situation is "It is unclear who would get principle credit for the work."

**Results**

*Behavior and Stage of Change*

Creating opportunities for collaboration was the most strongly endorsed behavior (M=3.51 SD=1.06) towards advancing women scientists. On average participants rated that they did the other behaviors 'sometimes' with the means all being close to 3.0 on a 5-point scale, enhanced competency through mentoring (M=3.06 SD=1.24), provided resources for doing research (M=3.22 SD=1.29), and generated support through community (M=3.07 SD=1.20). Those four behaviors were summed to get a total score with a range of 4 to 20. The sample mean was 12.85 (SD=3.91).

Based on their response to the stage of change question participants were classified into one of the five stages of change. Due to extremely low numbers in Preparation and in Action, the stages were collapsed into three categories representing Precontemplation (8.5%), Contemplation/Preparation (10.8%), and Action/Maintenance (80.8%). Most participants categorized in the Action/Maintenance stage reported being in Maintenance with only 3.8% of the sample classifying in Action.

As a validation of the stage of change algorithm, the four behaviors and their sum were investigated by stage classification. The sum of the behaviors increased across the stages, $F(2, 125) = 30.97$, $p < .01$, $\eta 2 = .33$. Follow-up Tukey tests revealed that individuals in Precontemplation scored (M=8.0 SD=2.86) much lower than those in Action/Maintenance (M=14.05 SD3.20). Those in Contemplation/Preparation scored closer to those in Precontemplation (M=9 SD=2.86), but there were no significant differences with those in Action/Maintenance. The individual behaviors were examined by stage using a MANOVA, Wilks' Lambda = .64, approximate $F(8, 244) = 7.70$, $p < .001$, $\eta^2 = .20$. Follow-up ANOVA's for each of the four behaviors were significant. Results can be found in Table 2.

*Overview of Measurement Development: Decisional Balance and Self-Efficacy*

The sample size limited using a split-half cross-validation procedure. Solely exploratory analyses were conducted using Principal Components Analyses (PCA) for both decisional balance and self-efficacy. After initial examination of the inter-item correlations, item means, item standard deviations, and component interpretability, a PCA was conducted for the decisional balance and self-efficacy measure. This analysis was conducted on the matrix of inter-item correlations, utilizing orthogonal (VARIMAX) rotation. Decisions regarding how many factors to retain were based on the Scree Plot (Cattell, 1966), the Minimum Average Partial (MAP) procedure (Velicer, 1976; Zwick & Velicer, 1982), Parallel Analysis (PA) (Horn, 1965), factor loadings and the theoretical interpretability of the factors. Elimination of items was based on factor loadings, inter-item correlations, item means, item standard deviations, complexity of items, Cronbach's coefficient alpha with and without individual

items, and component interpretability.

*Decisional Balance*

PCA reduced the number of decisional balance items from 16 to 10, five representing the pros of advancing women scientists and five representing the cons of advancing women scientists. After one poorly loading item was deleted, MAP and PA agreed on a two-factor solution. The final factor loadings ranged from .669 to .885 and both the pros and cons had good coefficient alphas, .842 and .804 respectively. The final two-component 10-item solution accounted for 60.3% of the total variance. Scale scores were derived from the sum of the item scores for each construct.

*Self-Efficacy*

The 14 self-efficacy items were reduced to a single 8-item factor representing confidence to engage in the four key behaviors to advance women scientists. Factor loadings ranged from .643 to .886 and the coefficient alpha was high (alpha=.902). The one-factor solution accounted for 60% of the total variance. A scale score was derived from the sum of the item scores.

*External Validity for Decisional Balance and Self-Efficacy*

Once the final measures and subscales were obtained, the relationships among the constructs of the TTM were examined to provide an index of external validity. Specifically, the relationship of stage to the other constructs (i.e., decisional balance and self-efficacy) was examined. Several cross-sectional analyses of the data (i.e. MANOVA, follow-up ANOVA, and post-hoc tests) were conducted to determine if the patterns predicted by the TTM emerged in this sample. To aid with ease of comparison of the constructs across the stages, scores for each scale were converted to T- scores (M=50, SD=10) for these analyses.

*Decisional Balance*

An overall MANOVA on decisional balance by stage revealed significant differences, Wilks' Lambda = .83, approximate $F(4, 240) = 5.85$, $p < .001$, $\eta^2 = .09$. As expected, a follow-up ANVOA on the pros was found to be significant, $F(2, 121) = 8.73$, $p < .01$, $\eta^2 = .13$. Those in Precontemplation reported significantly lower pros of advancing women scientists than those in Contemplation/Preparation and those in Action/Maintenance. The follow-up ANVOA for the cons did not show significant differences. However, the cons of advancing women scientists were lower in Action/Maintenance than either of the two earlier stages of change. Overall, the pattern of the pros and cons across the stages is consistent with past research using the TTM. Figure 1 indicates that the cons of changing are greater than the pros in Precontemplation, while the opposite is the case in Action/Maintenance. Figure 1 also indicates that the pros of changing increased about 1.5 standard deviations from Precontemplation to Action/Maintenance, while the cons decreased about .5 standard deviations from Contemplation/Preparation to

Action/Maintenance.

*Self-Efficacy*

An overall ANVOA on self-efficacy by stage revealed significant differences, $F(2, 117) = 8.26$, $p < .01$, $\eta^2 = .12$. Individuals in Precontempation reported significantly less confidence to advance women scientists than those in Contemplation/ Preparation and those in Action/Maintenance. As expected, confidence increased more than 1.5 standard deviations across the stages of change (see Figure 2).

*Gender Differences*

Differences were examined between how men and women reported on the variables included in this study. A Chi Square analysis revealed no gender differences across the stages with similar percentages of men and women participants classifying in each of the three stages. Means for the continuous variables by gender are presented in Table 3. Although there were no gender differences by the sum of the four key behaviors, examining the four behaviors individually revealed significant differences between men and women for generating support through community, $F(1, 130) = 6.97$, $p < .01$, $\eta^2 = .05$. Women endorsed that behavior more than men. There were no gender differences by the pros of advancing women scientists, or by confidence to advance women scientists. However, women rated the cons of advancing women scientists higher than men, $F(1, 128) = 6.07$, $p < .05$, $\eta^2 = .05$.

## Discussion

The results of this study offer preliminary support for the application of the TTM to the advancement of women scientists. One of the first challenges of applying the TTM to a new area is to develop criteria for what it means to take effective action. Through formative research, four behavioral markers were used to define action for advancing women scientists: 1) collaborating; 2) mentoring; 3) sharing resources; and 4) generating support. Using those behaviors as a framework, reliable and valid measures for assessing stage of change, decisional balance, and self-efficacy were developed. Increased practice of the four key behaviors by individuals in later stages of change (Action/Maintenance) offers validation for the stage of change assessment. The factor structure of the decisional balance and self-efficacy measures are consistent with measures developed across several other behaviors (Hall, 2004). In addition, predictable patterns of relationships were found between the stages of change and decisional balance and self-efficacy. These assessments can be used to understand the beliefs and practices of faculty members and academic departments towards the advancement of women scientists. These measurement tools also can aid in developing and structuring interventions aimed at advancing women scientists.

In this study, the theoretical relationships between stages of change and both the decisional balance and self-efficacy measures replicate past research and offer validation for the application of the TTM to this new area. The pattern of the pros

and cons was remarkably similar to what was found by meta analyses by Prochaska et al. (1994) and Hall (2004) across numerous behaviors. Replicating past research, the cons outweighed the pros in Precontemplation and the pros outweighed the cons in Action/Maintenance. In addition, the pros increased from Precontemplation to Action/Maintenance and the cons decreased from Contemplation to Action/Maintenance. Perhaps most striking was the predicted magnitude of the differences. Consistent with Prochaska and Hall's findings, the pros increased about 1 S.D. from Precontemplation to Action/Maintenance and the cons decreased about .5 S.D. A predictable pattern of results was also found with self-efficacy. Consistent with findings across 24 behaviors (Hall & Rossi, 2005), self-efficacy increased more than 1 S.D. from Precontemplation to Action/Maintenance. Validation of the theoretical relationships with the decisional balance and self-efficacy constructs bolsters the application of the TTM to the challenge of advancing women scientists.

Some results of this study were unexpected. It is surprising that almost 81% of participants were classified in the Action or Maintenance stages and that there were no differences in stage classification between men and women faculty. Further, men did not rate the pros or confidence to advance women scientists lower than women, nor did they rate the cons of advancing women scientists higher than women faculty. The university at which this study occurred has experienced unfavorable conditions for women faulty in certain science departments. The NSF grant was sought to assist with changing the climate of those departments and the university as a whole towards the advancement of women scientists. Qualitative data from formative focus groups for this study exemplify the continued displeasing and unfavorable climate for many women faculty in STEM departments (citation from Lisa Bowleg?). Yet, when reporting their readiness to do the four key behaviors, the great majority of science faculty participating in this research reported actively working towards the advancement of women colleagues. It should be noted that approximately 20% of faculty from the participating departments completed the baseline assessment. Faculty who are not committed or actively engaged in advancing women scientists were probably the most resistant to completing the survey. Participants who are in Precontemplation and Contemplation are often the most difficult to reach and at the same time the individuals most in need of assessment and intervention efforts (Prochaska et al., 1993). The relatively small percentages of participants in Precontemplation and Contemplation in this sample likely underestimates the actual percentage of faculty who currently are not ready to advance women scientists. The faculty who declined to participate may represent a significant portion of faculty who have yet to commit to advancing women scientists.

Despite the high percentages of participants in Action/Maintenance, there is much room for improvement in the frequency that they reported practicing the key behaviors and in their levels of pros, cons, and self-efficacy. On average, participants reported that they "sometimes" do the four key behaviors. Intervention efforts should focus on increasing the level of engagement in the behaviors and faculty members' commitment to always practicing the behaviors necessary to help the ad-

vancement of women scientists. The results indicated that creating opportunities to collaborate was the most frequently practiced behavior and that men are less likely to generate support through community than are women. Intervention efforts should emphasize the importance of doing all four of these behaviors while being cognizant of the current practices and shortcomings of faculty and administration in regards to the key behaviors. Further, on average participants rated moderate levels of pros, cons, and confidence towards advancing women scientists. A TTM-based intervention could help faculty members recognize more benefits and place less importance on the cons of advancing women. Interventions could be designed to provide consciousness raising to continue to raise the pros of advancing women scientists, while also paying attention to reducing barriers. In addition, self-efficacy could be increased by offering strategies to increase confidence in difficult situations. In this sample, with such a high percentage in Action or Maintenance, there is little room to monitor progress across the stages of change. However, there is considerable room to assess improvement with the key behaviors and other TTM constructs at follow-up time points.

There are limitations to this study that should be acknowledged. The sample size limits this study in two important ways. Due to the sample size, measurement development analyses were limited to exploratory data analysis. Future research will need to confirm the factor structure, reliability, and validity of the newly developed measures. In addition, a larger sample would likely have enabled a fuller stage distribution. In two cases adjacent stages (Contemplation/Preparation and Action/Maintenance) were collapsed because of limited sample sizes in the groups. Therefore, analyses were limited to investigating differences and patterns across three groupings of stages of change. Stages have been collapsed in other research, particularly with exploratory or pilot studies (Mauriello, 2003; Hall, 2004). Given the similarity of the results of the current study with previous TTM-based research, having stages collapsed does not appear to have compromised the data analysis or the assessment of the application of the TTM to this new area. Future work with a larger and more representative sample will allow for further validation of TTM-based theoretical relationships and will clarify distributions and patterns across all five stages of change.

The length of the campus climate survey, in which these TTM assessments were included, hindered the addition of a measure of the processes of change. The development of a process of change measure and examining the pattern of the processes across the stages for advancing women scientists should be conducted to further the application of the TTM to this area. An understanding of the processes of change for this application of the TTM also will help to inform intervention efforts and materials. Knowing the most important processes for each stage transition and the norms associated with each process subscale offers valuable information towards tailoring appropriate TTM-based interventions. In addition, longitudinal data would help elucidate the effectiveness of TTM-based interventions for the advancement of women scientists.

This new application of the TTM offers insights into how the model can be used to help with the advancement of women scientists. The TTM interventions that have produced the greatest impact have been tailored communications that tailor feedback to the needs of each individual. The measures developed in this study can be valuable assets to aid in the development of empirically based TTM interventions for departments and universities across the country. With the current measures communications could be tailored to each individual's stage of change, pros and cons of changing, and self-efficacy. In the current ADVANCE initiative, workshops with science departments are being conducted to help faculty members understand the processes that hinder versus promote the advancement of women colleagues. In addition, department chairs and administrators will receive TTM-based strategies to help facilitate faculty progress towards engaging in the advancement of women scientists. Follow-up assessments in year five will evaluate the effectiveness of using TTM-based interventions to prepare faculty to participate more actively and fully in the advancement of women scientists.

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Table 2.

Means and Standard Deviations of Key Behaviors by Stage of Change.

| | PC | C/PR | A/M |
|---|---|---|---|
| **Key Behaviors** | | | |
| **Collaboration*** | 2.36 (.809) | 2.64 (1.01) | 3.80 (.881) |
| **Mentoring*** | 1.91 (.944) | 2.07 (1.14) | 3.09 (1.23) |
| **Resources*** | 2.09 (1.22) | 1.86 (.864) | 3.25 (1.28) |
| **Support*** | 1.64 (.924) | 2.43 (.852) | 3.10 (1.19) |

* $p < .01$

Figure 1.

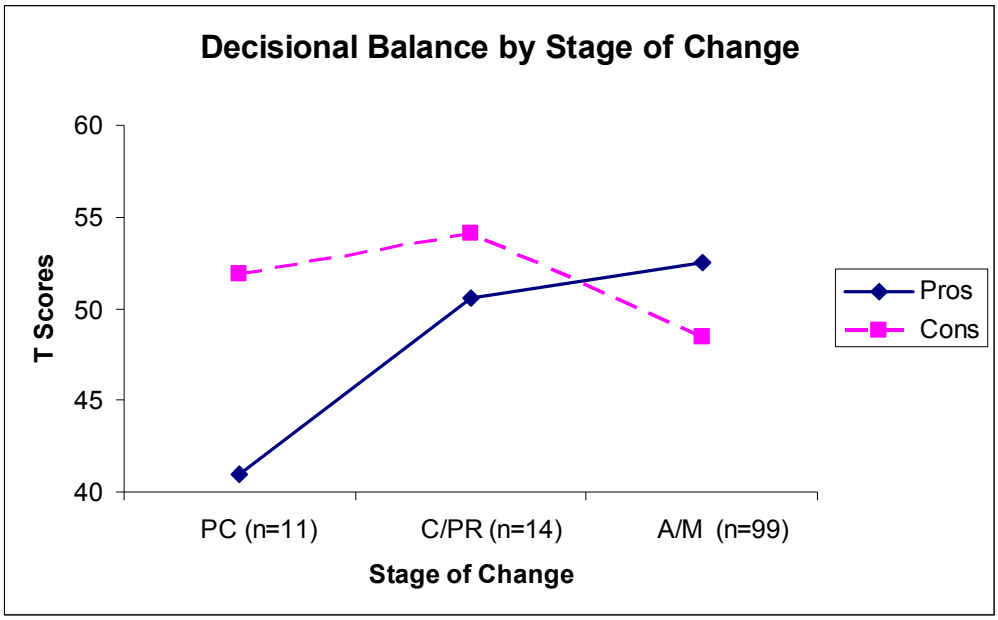

Figure 2.

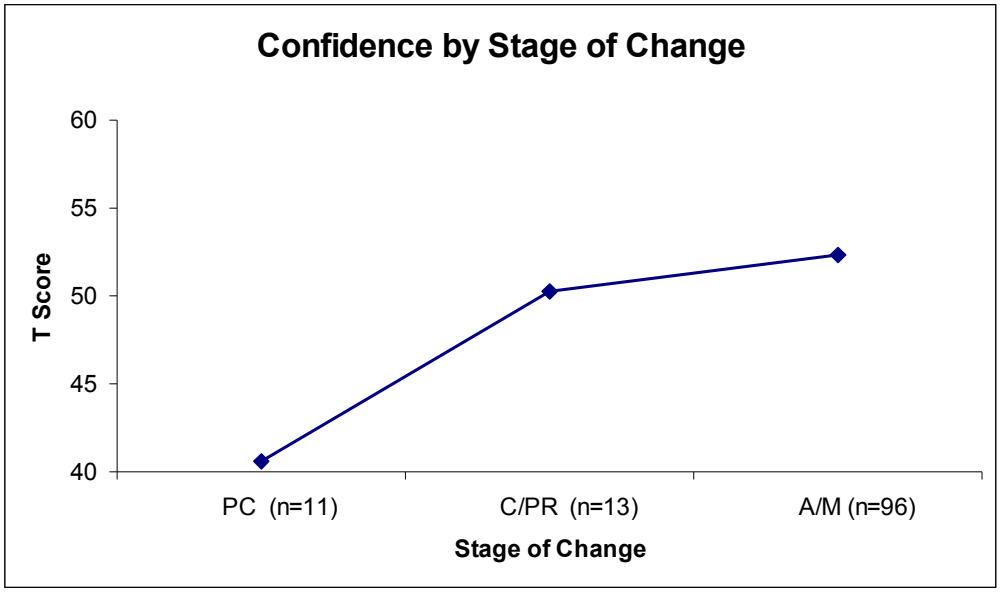


Table 3.

Means and Standard Deviations of Continuous Variables by Gender.

| | Women | Men |
|---|---|---|
| **Key Behaviors** | | |
| **Sum** | 13.38 (4.47) | 12.64 (3.72) |
| **Collaboration** | 3.61 (1.13) | 3.46 (1.04) |
| **Mentoring** | 3.20 (1.39) | 2.99 (1.17) |
| **Resources** | 2.94 (1.41) | 3.30 (1.24) |
| **Support**** | 3.50 (1.23) | 2.94 (1.14) |
| **TTM Constructs** | | |
| **Pros** | 19.69 (4.78) | 19.19 (4.19) |
| **Cons*** | 12.17 (4.27) | 10.15 (3.97) |
| **Confidence** | 25.63 (5.60) | 25.83 (7.13) |

* $p < .05$
** $p < .01$