FACTORIAL VALIDITY AND MEASUREMENT INVARIANCE OF THE TEST OF PERFORMANCE STRATEGIES, SPORT ANXIETY SCALE, AND THE GOLF PERFORMANCE SURVEY ACROSS AGE GROUPS

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The purpose of this study was to examine the factorial validity and measurement equivalence of the Test of Performance Strategies (TOPS; Thomas, Murphy, & Hardy, 1999); the Sport Anxiety Scale (SAS; Smith, Smoll, & Schultz, 1990); and the Golf Performance Survey (GPS; Thomas & Over, 1994) across age groups in a representative sample of amateur golfers. Based on archival data, participants comprising this study were 649 younger adult \( n = 237 \) and older adult \( n = 412 \) amateur golfers who played in the Dupont World Amateur Golf Championship in Myrtle Beach, South Carolina. The participants completed a set of questionnaires including psychological skills and strategies (e.g., self-talk, goal setting, imagery, etc.) used during competition, sport-specific competitive trait anxiety, and psychomotor skills and involvement in golf. Results demonstrated that the original factor structure of the TOPS competition subscale, the SAS, and the GPS, did not adequately fit the data among this sample of younger and older adult amateur golfers. Further exploratory and confirmatory factor analyses established evidence of factorial validity with the TOPS competition subscale, SAS, and the GPS with both younger and older adult amateur golfers. Configural, metric, scalar, and strict measurement invariance were identified in relation to the TOPS competition subscale, SAS, and the GPS across age cross-group comparisons. In general, the analyses demonstrated support that the TOPS competition subscale, SAS, and the GPS can be utilized with confidence with older adult amateur golfers, as well as conducting group comparisons with younger adult amateur golfers. The findings from this study have several future research directions and practical implications for structuring effective interventions with older adult amateur athletes.
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CHAPTER 1

INTRODUCTION

Research has demonstrated that exercise and physical activity is vital for improving or maintaining quality of life and psychological well-being in older adults (Rejeski & Mihalko, 2001). The older adult population of age 65 and older is living much longer than in previous years as this population has been steadily increasing over the past thirty years (Kinsella & Velkoff, 2001). According to Kinsella and Velkoff, worldwide in 1950, there were approximately 131 million people over the age of 65. The number of older adults had ascended to approximately 420 million in 2000 and the older adult population was projected to increase to nearly 1 billion by the year 2030 (Kinsella & Velkoff). However, incorporating a life span developmental perspective has yet to be a central focus of research and applied work in sport and exercise psychology. To date, there has been a dearth of empirical data that has addressed age-related differences and age-related changes in sport and exercise psychology.

Developmental research to date has primarily focused on developmental changes in youth sport participants’ cognitive, affective, and behavioral reactions, particularly relating to self-perceptions, anxiety, and motivation in sport (Smith, Weiss & Raedeke, 2004). Far less research has examined developmental change across other pertinent sport and exercise-related contexts, and even less in adult competitive sport contexts.

Age-Related Differences and Sport Performance

An area that has received limited attention in the sport and exercise psychology literature is age-related differences and performance in a sport context. Age-related changes related to performance include physical, such as increases or decreases in strength, flexibility, balance, and coordination; cognitive, such as self-efficacy, processing speed, memory, or using different
sources to assess one’s abilities; affective, such as increases or decreases in one’s emotional intelligence and positive and negative affect; and behavioral, such as motivation, adherence, coping, and the type of activity one chooses to participate in (Smith, Smoll, & Barnett, 1995; Weiss & Raedeke, 2004). These aspects of age-related changes have implications for participation, continued involvement, and performance in sport, exercise, and physical activity (Weiss & Raedeke). Most studies have focused on factors related to sport performance as it relates to high school, collegiate, and elite (e.g., professional, Olympic, and international) athletes (Gould, Dieffenbach, & Moffett, 2002; Miller & Donohue, 2003; Post, Muncie, & Simpson, 2012; Williams & Kranc, 2001). Studies that have focused on both physical and psychological factors that can potentially interfere with or facilitate performance in a sport context with older, amateur athletes are virtually non-existent in the sport and exercise psychology literature.

Petrie, Hayslip, and Jones (2000) addressed this gap in the research by examining differences of amateur golfers who varied in age, gender, and skill level as it related to the influence of general psychological skills, competitive trait anxiety, and golf specific skills on the competitive performances of the amateur golfers. Participants were 1,324 male and female amateur golfers who participated in the final three rounds (the first round was cancelled due to poor weather) of the 2000 Dupont World Amateur Golf Championship in Myrtle Beach, South Carolina (Petrie et al.). Results of the study indicated that there were no significant differences between male and female golfers among the variables, and, as a result, the authors combined their scores and completed further analyses with the entire population of interest (Petrie et al.). Findings of the study demonstrated that younger golfers (age 49 and under) reported greater use of goal setting, imagery, and activation than the older golfers (age 50 and above) (Petrie et al.).
Also, younger golfers reported that their golf game was more automatic and that they experienced higher levels of somatic anxiety than did the older golfers (Petrie et al.).

In relation to predictors of tournament performance by age, better performances across all three rounds were associated with higher levels of automaticity and commitment for both younger and older golfers (Petrie et al., 2000). For younger golfers, poorer scores across all three rounds of the tournament were associated with higher levels of worry about competition (Petrie et al.). In addition, better performance was associated with higher use of goal setting for Rounds 2 and 3 and better performance was associated with higher use of somatic anxiety and concentration disruption in Rounds 1 and 3 for younger golfers (Petrie et al.). For older golfers, better performance was associated with greater concentration disruption and greater use of self-talk was associated with poorer scores in Rounds 1 and 2 (Petrie et al.). Also, poorer scores were associated with higher levels of emotional control and negative thinking for older golfers in Round 3 (Petrie et al.).

In relation to predicting tournament performance by the combination of age and skill level, older golfers at a medium skill level (handicap between 12-19 inclusive) performed worse with lower levels of emotional control and performed better with greater use of relaxation skills during Round 1 (Petrie et al., 2000). Also, older golfers performed worse with higher levels of emotional control and negative thinking during Round 3 (Petrie et al.). Younger golfers at a low skill level (handicap of 20 or higher) performed better with higher levels of imagery use and higher levels of positive self-talk predicted poorer scores during Round 3 (Petrie et al.). One of the authors' implications of this study was that older golfer's skills, self-efficacy, enjoyment, commitment, and satisfaction with one's golf experience and one's overall quality of life can be enhanced through mental skills education and psychological skills training (Petrie et al.). The
results of this study, in relation with the analyses reported by Hayslip, Petrie, MacIntire, and Jones, (2010), emphasize the need for comparisons among different level of skills for amateur athletes. The findings from this study also clearly highlight the fact that examining age differences between older adults and younger adults on factors that interfere with or facilitate performance in a sport context is a worthy topic of interest in current sport and exercise psychology research.

Measurement Invariance

Prior to examining the meaning of age-group differences on a given construct, it is important that the measures used are invariant and the underlying construct has the same meaning across groups (Vandenberg & Lance, 2000). The notion of measurement invariance is a critical issue in developmental assessment (Hertzog & Nesselroade, 2005). Measurement invariance refers to the assumption that a measure has the same meaning across different age groups (Vandenberg & Lance, 2000). Horn and McArdle (1992) describe measurement invariance as “whether or not, under different conditions of observing and studying phenomena, measurement operations yield measure of the same attribute (p. 117).” If measurement invariance is not attained, then using the mean scores from the measure to make legitimate conclusions about age-group differences on a given construct are invalid (Vandenberg & Lance, 2000). Without measurement invariance, observed mean differences on a given construct are unclear whether the differences are attributable to actual differences or if they are due to differential item functioning across age groups (Thompson & Daniel, 1996; Vandenberg & Lance, 2000).

It is important to assess the factor structure of a measure to verify if a stable factor structure exists across age groups (Vandenberg & Lance, 2000). Significant changes in the
factor structure across age groups may indicate that the items are construed differently or that the given construct produces different meaning in each age group (Vandenberg & Lance, 2000).

Differences in how a construct is conceptualized and defined could also extend to generational/cohort differences (Baltes, 1968). Factors that interfere with or facilitate performance in a sport context for an older adult could be different than factors that interfere with or facilitate performance in a sport context for a younger adult. It is important to be cautious regarding the generalizability of certain measures on a given construct across age groups (Hertzog & Nesselroade, 2005).

The utility of measures for assessing factors that may interfere with or facilitate performance depends upon the demonstration of appropriate factorial validity and measurement invariance characteristics. Thus, it is essential to test the generalizability of these measures for different age groups of interest.

Objective of the Present Study

As such, the objective of this study was to examine the factorial validity and measurement equivalence of the three measures from the research of Petrie et al. (2000) and Hayslip et al. (2010): the Test of Performance Strategies (TOPS; Thomas, Murphy, & Hardy, 1999); the Sport Anxiety Scale (SAS; Smith, Smoll, & Schultz, 1990); and the Golf Performance Survey (GPS; Thomas & Over, 1994) across two different age groups.

Test of Performance Strategies

The Test of Performance Strategies (TOPS) was developed by Thomas et al. (1999) and was intended to measure a broad range of psychological skills and strategies used by athletes both in practice and competition. In addition, Thomas et al. developed subscales that focused on eight of the most salient psychological skills and strategies that were pertinent to success in
athletic performance. Thomas et al. developed an initial pool of 112 items to measure athletes’ psychological skills and strategies in each of the eight areas in practice and competition. The names and descriptions of the eight constructs and the representative items were then given to ten applied sport psychology consultants (Thomas et al.) to confirm the importance of each item and then assign each item to one of the eight subscales. As a result, 111 items were utilized for the initial study (Thomas et al.).

Participants included both male and female athletes at numerous skill levels and abilities (i.e., intercollegiate, national, and international) who were training and competing in a wide variety of sports (Thomas et al., 1999). The participants consisted of 472 athletes ($M_{age} = 19.25$ $SD = 6.87$ years) from three different locations in Australia. Information were obtained from 110 males and 89 females training at the Australian Institute of Sport, from 117 boys active in sport who attended a private high school in Sydney, Australia, and from 100 male athletes and 56 female athletes in the Brisbane region (Thomas et al.). Athletes in the study had been participating in 28 different sports for an average of nine years (Thomas et al.). 461 of the 472 total participants were competing internationally (14.1%), nationally (13.7%), intercollegiate or regional standard (8.7%), junior national standard (24.9%), and at club or recreational standard (11.5%) (Thomas et al.). The remaining participants included athletes who competed in interschool sport and a sample of 117 high school boys (Thomas et al.).

According to Thomas et al. (1999), all 101 items were included in subsequent analyses. The absolute values of skewness and kurtosis for 107 of the 111 items were within 1.0 and none of the remaining four items had an absolute value of skewness greater than 1.3 (Thomas et al.). Items were then divided into two subscales; 56 items represented the competition subscales, and the other 55 items represented the practice subscales (Thomas et al.). Exploratory factor analysis
was then utilized to assess the specific dimensions of each of these subscales (Thomas et al.). Based upon the correlations among the variables of interest, principal axis factoring was utilized to extract factors along with oblique rotations to allow for correlations among the factors (Thomas et al.). The factor interpretability and the alternative rotated solutions were assessed on the basis of the eigenvalues discontinuity principle (Thomas et al.).

For the competition subscales, the factor analysis yielded 12 factors with eigenvalues greater than 1.0, but three of the factors consisted of two items with loadings of 0.30 or higher (Thomas et al.). According to Thomas et al., the scree plot suggested the number of factors to be between 8 and 12. Four items were chosen with the highest rotated loadings on each of seven factors (Thomas et al.). Two other factors, defined as energizing and psyching-up components of activation, had four total items that loaded the highest on both factors (Thomas et al.). The 32 competition subscale items that loaded the highest in relation to the original 56 items were further utilized for successive analyses (Thomas et al.).

For the practice subscales, a similar analytic process was utilized for further data analysis (Thomas et al., 1999). A factor analysis yielded 12 factors with eigenvalues greater than 1.0 (Thomas et al.). However, numerous factors were not interpretable and one of these factors contained only two items with loadings of 0.30 or more (Thomas et al.). From this, Thomas et al. selected the highest loading four items for each of eight factors, which resulted in 32 practice subscale items for subsequent analyses.

The factor analysis of the 32 competition subscale items produced eight factors which accounted for 62.5% of the variance (Thomas et al., 1999). The item-total correlations for the four items for each factor were 0.30 or more (Thomas et al.). The eight factors for competition are self-talk, emotional control, automaticity, goal setting, imagery, activation, negative thinking,
and relaxation (Thomas et al.). Thomas et al. had originally conceptualized attentional control and emotional control as distinct constructs, but found that items related to these factors formed a single factor for competition, but not for practice (Thomas et al.).

The factor analysis of the 32 practice subscale items also produced eight factors which accounted for 60.4% of the variance (Thomas et al., 1999). The item-total correlations for the four items for each factor were 0.30 or more (Thomas et al.). The eight factors for practice are self-talk, emotional control, automaticity, goal setting, imagery, activation, relaxation, and attentional control (Thomas et al.). In addition, the authors noted that there were similarities in the use of these psychological skills and strategies across the competition and practice contexts as well as moderate correlations among many of the psychological skills and strategies (Thomas et al.).

Thomas et al. (1999) demonstrated that than younger athletes (athletes aged 17 and younger) reported more automaticity in the execution of skills and older athletes (athletes aged 20 years and older) used imagery and activation strategies less in competition. Female athletes scored lower on automaticity and higher on imagery use than male athletes (Thomas et al.). Less skilled male athletes reported higher levels of automaticity in competition than male athletes performing at international and national competitions (Thomas et al.). According to Thomas et al., no evident differences among psychological skills and strategies use were found for female athletes in competition. Finally, recreational/club athletes reported less use of most psychological skills and strategies and more negative thinking than athletes performing at international and national competitions (Thomas et al.).

The TOPS, through continued research, has been shown to be one of the more accepted instruments for assessing athletes’ use of psychological skills and strategies in athletic
performance (Williams & Krane, 2001). Fletcher and Hanton (2001) examined whether the use of psychological skills and strategies (i.e., use of TOPS) was related to athletes' responses of competitive anxiety. They found that athletes who had lower levels of relaxation self-talk, and imagery use significantly differed from those who had higher use of the psychological skills and strategies in their responses of competitive anxiety (Fletcher & Hanton). The results also demonstrated that athletes who reported lower levels of cognitive and somatic anxiety had higher use of relaxation (Fletcher & Hanton). Fletcher and Hanton also reported that the athletes who had a lower use of relaxation also had higher levels of self-confidence. Athletes making lower use of these psychological skills and strategies were less self-confident than those utilizing higher levels of self-talk and imagery use (Fletcher & Hanton). The use of goal setting strategies resulted in no differences in responses of competitive anxiety (Fletcher & Hanton).

Jackson, Thomas, Marsh, and Smethurst (2001) examined relationships among the use of psychological skills and strategies in competition, the flow experience, athlete self-concept, and performance. The results from this study demonstrated that the more athletes experienced a state of flow; they utilized psychological skills and strategies in their respective sport at a greater level (Jackson et al.). With the exception of automaticity, the results also showed that the remaining TOPS subscales significantly predicted a flow state for the athletes (Jackson et al.). In addition, there were no correlations between TOPS subscales and dissimilar constructs and strong correlations for the TOPS and measures of similar constructs (e.g., TOPS goal setting factor was correlated with the Flow State Scale clear goals dimension) (Jackson et al.).

Gould et al. (2002) included the TOPS in a study examining the development and psychological characteristics of Olympic champions. The athletes in the Gould et al. study scored lower on negative thinking and higher on automaticity, goal setting, activation, relaxation,
and emotional control in competition, and on goal setting and attentional control at practice. Subsequent interviews were held with the Olympic champions, coaches, parents, siblings, and significant others utilizing a mixed-methods approach for their study (Gould et al.). The qualitative themes that emerged from these interviews provided support for many of the quantitative findings in this study, along with previous research identifying psychological skills and strategies use as important factors of successful performance (Vealey, 2007).

Frey, Laguna, and Ravizza (2003) demonstrated that athletes’ perceived success at both practice and competition was related to their higher use of psychological skills and strategies. The findings from this study demonstrated that the more successful the athletes perceived themselves to be at both practice and competition, the more that they utilized psychological skills and strategies at practice (Frey et al.). An implication from this study was for coaches and athletes to understand the relationship between psychological skill use in a practice context and success in a competition context (Frey et al.). This was noted in relation to enhancing the quality of practice, such that athletes would incorporate psychological skill usage when in a practice context (Frey et al.).

The Thomas et al. (1999) original study on the TOPS was only utilized with exploratory factor analyses and it was not followed with confirmatory factor analysis to further test the proposed factor structure with different populations. Thomas et al. reiterated the importance of further research using confirmatory factor analysis to examine the factorial validity of the TOPS with other populations of interest.

Lane, Harwood, Terry, and Karageorghis (2004) examined the factorial validity of the TOPS with British adolescent (ages 15-18) athletes. Participants were 584 athletes (320 females and 264 males) from national level training camps in the United Kingdom, representing a variety
of sports. The results demonstrated significant differences regarding the factor structures for practice and competition contexts (Lane et al.). Based on the initial Thomas et al. (1999) model, fit indices showed empirical support for an adequate model fit for practice and found a good model fit for competition (Lane et al.). However, the results also demonstrated that both practice and competition models could be improved significantly (Lane et al.). Lane et al. stated that attempts were then made to identify the specific concerns of the models for both practice and competition and improve the fit of the initial models. Despite numerous attempts with the revised models for both practice and competition, the results demonstrated that the fit indices did not improve at a significant rate of acceptance (Lane et al., 2004).

According to Lane et al. (2004), the analyses of each factor for competition provided strong significant support for the self-talk, goal setting, automaticity, and relaxation factors, indicated need for improvement for the imagery, negative thinking, and emotional control factors, and provided no significant support for the activation factor. Alpha coefficients for the competition subscales ranged from .69 to .82.

Further analyses for the practice factors demonstrated strong significant support for the self-talk, goal setting, attentional control, emotional control, and imagery factors, indicated need for improvement in the relaxation and automaticity factors, and provided no significant support for the activation factor (Lane et al., 2004). Alpha coefficients for the practice subscales ranged from .57 to .79, whereas two of the factors (activation and automaticity) had low internal consistency, .57 and .62, respectively (Lane et al.). According to Lane et al., 84% of the specific items had good to excellent factor loadings and standard errors. Lane et al. reported that only 3 of the 64 items were considered poor items and both were in the practice subscales (two items in the activation factor and one item in the automaticity factor). Results also demonstrated that in
the competition context, the athletes had higher levels of use of emotional control, automaticity, activation, goal setting, relaxation, and imagery than those factors in the practice context (Lane et al.). One of the suggestions from the authors involved separating the factors of attentional control and emotional control for the competition context due to conceptual overlap with some of the items (Lane et al.). Lane et al. suggested that, with the specific population of adolescent athletes, these two combined factors should be viewed as separate constructs (Lane et al.).

Lane et al. (2004) questioned whether the specific language used in the some of the items of the TOPS might be considered “inappropriate” for adolescent athletes, as all of the participants were all younger than 18 years of age (p. 809). For example, Lane et al. questioned whether adolescent athletes understood the concept of performing ‘on automatic pilot’ (TOPS; Question 30), even though the confirmatory factor analysis provided strong support for the automaticity factor in the competition context. In addition, the authors questioned the validity of the measure due to cultural differences of the samples (e.g., Australian and British athletes) utilized in the previous TOPS studies (Lane et al.). With this, further research needs to continue to examine the factor structure of the TOPS with athletes varying in age and level of skill.

Hardy, Roberts, Thomas, & Murphy (2010) further examined the factorial validity of the TOPS. They reported the results of a pilot study which used confirmatory factor analysis to examine the factorial validity of the TOPS with North American athletes (Hardy et al.). The participants were 520 North American male (\( M_{age} = 16.97 \) years; \( SD = 1.99 \)) and female athletes (\( M_{age} = 17.54 \) years; \( SD = 2.77 \)) of various sports and levels of skill (Hardy et al.). For the competition subscales, the authors reported that there were concerns found for emotional control, negative thinking, and activation (Hardy et al.). For the practice subscales, the authors also reported that problems were also found for activation, automaticity, and attentional control.
(Hardy et al.). The authors did not specify the presenting concern related to the empirical issues with the subscales in the pilot study. However, due to these concerns, the authors decided not to further analyze the original eight-factor model for both competition and practice contexts (Hardy et al.). As a result, the authors developed additional items with the concerning subscales and then attempted to evaluate the fit of the modified TOPS in two additional studies (Hardy et al.).

The first study examined the factorial validity of a revised version of the TOPS (TOPS 2) which contained several new items and a new subscale (i.e., distractibility) developed to address measurement issues identified with the initial instrument (Hardy et al., 2010). The participants in the first study were a mixed sample of American, Australian, and British athletes representing various sports with various levels of skill (Hardy et al.). To confirm the factorial validity of the TOPS 2, the participants in the second study were Australian athletes (Hardy et al.). Since the findings of this research focused on the creation and confirmation of the TOPS 2, the specific results will not be reported due to a lack of relevance with the purpose of the current study. Based on the previous studies on the factor structure of the TOPS, it appears that the TOPS needs further examination and possible refinement with different age groups and varying levels of abilities before researchers and practitioners can feel confident about the instrument’s psychometric properties.

TOPS Factor Structure that was Evaluated in the Present Study

The TOPS factor structure that was evaluated in this study was the initial eight-factor model for psychological skills and strategies used during competition and was defined as self-talk, emotional control, automaticity, goal setting, imagery, activation, negative thinking, and relaxation (Thomas et al., 1999). For the purpose of this study, only the eight competition factors
were utilized for further analyses. Each factor has four items for a total of eight factors and 32 items.

**Sport Anxiety Scale**

Smith et al. (1990) developed the Sport Anxiety Scale (SAS), a multidimensional measure of competitive trait anxiety that differentiated between cognitive and somatic anxiety in a sport context. In the initial development of the measure, Smith et al. developed a preliminary set of 15 cognitive anxiety items and 15 somatic anxiety items for further study. Smith et al. administered a 30-item version of the scale to 451 male and female high school athletes (Sample 1). An exploratory principal components analysis was utilized and the results demonstrated five factors having eigenvalues greater than 1.00 and accounted for 59% of the variance (Smith et al., 1990). Only three factors were retained due to a scree plot indication that a natural break occurred after factor three, accounting for 48% of the variance (Smith et al., 1990). In addition, factors four and five each contained only two items with factor loadings above .30 (Smith et al., 1990). The first factor consisted of items related to manifestations of somatic anxiety (e.g., muscle tension), the second factor consisted of items related to worry and self-doubt, and the third factor included items related to concentration disruption and intrusive thoughts (Smith et al.). Additional analyses demonstrated identical factor structures and similar high item factor loadings for both male and female athletes (Smith et al., 1990).

A follow-up exploratory principal component analysis with a sample of 123 intercollegiate football players (Sample 2) resulted in three separate factors for somatic anxiety, worry, and concentration disruption (Smith et al., 1990). The pattern of item factor loadings was similar to the results with Sample 1 and these three factors accounted for 53% of the variance (Smith et al., 1990).
Smith et al. (1990) then administered the 30-item version four months after the initial administration to 384 athletes from the original high school sample. All 30 items were assigned to one of the three factors in the first confirmatory factor analysis (Model 1) (Smith et al., 1990). The items comprising the worry and concentration disruption factors were combined into a cognitive single factor which then resulted in a two factor structure (Model 2) (Smith et al., 1990). The results indicated that eight items were a poor fit and were not subsequently retained by any one of the three factors (Smith et al., 1990). As a result, these eight items were then deleted from the overall scale (Smith et al., 1990).

Smith et al. (1990) then administered a 22-item version of the scale to a different sample of 490 male and female high school athletes (Sample 3). Through several confirmatory factor analyses, the researchers found that the best fitting factor solution was a three-factor, 21-item version of the SAS (Smith et al., 1990). The final version of the SAS consisted of a somatic anxiety subscale (nine items), a worry subscale (seven items), and a concentration disruption subscale (five items) (Smith et al., 1990).

Dunn, Dunn, Wilson, & Syrotuik (2000) further examined the factor structure of the SAS. Participants included 202 male varsity level ice hockey players representing ten different Canadian university or college teams (\(M_{age} = 22.32, SD = 1.62\)); 174 male high school Canadian football players from five provincial representative teams (\(M_{age} = 18.24, SD = .66\)); and 128 male NCAA Division II intercollegiate athletes (\(M_{age} = 20.48, SD = 1.45\)) competing in a variety of individual (e.g., swimming) and team (e.g., basketball) sports (Dunn et al).

The data from each sample (on each variable) were combined into one data set of 504 athletes by transforming the scores to standardized z scores (Dunn et al.). The combined sample was split into two groups of approximate equal size, one group of 255 athletes was explored
through exploratory factor analysis and the second group of 249 athletes was explored through confirmatory factor analysis (Dunn et al., 1990). The researchers justified this approach by stating that by attaining an exploratory factor analysis solution for half of the participants, this would then provide the basis for identifying a confirmatory factor analysis model that can be applied to the other half of the overall sample (Dunn et al.).

Results of the exploratory factor analysis demonstrated a three factor solution which accounted for 55.78% of the variance (Dunn et al., 2000). One factor contained nine items representing cognitive anxiety, self doubt, or worry (Dunn et al.). The nine items included seven of the original items reported by Smith et al. (1990) and two items (items 14 and 20) that were originally reported by Smith et al. (1990) to measure the concentration disruption factor (Dunn et al., 1990). A second factor consisted of nine items representing somatic anxiety, which resulted in the exact set of items that were reported in Smith et al. (1990) (Dunn et al.). The third factor consisted of three items that defined the concentration disruption factor (Dunn et al.).

Dunn et al. (2000) reported that the first confirmatory factor analysis model that was tested was the model that was based on the original three factor structure and corresponding 21 items of the SAS reported by Smith et al. (1990) (Dunn et al.). The second confirmatory factor analysis model tested an alternative three factor structure based on the previously described exploratory factor analysis results (Dunn et al.). The second alternative model was created by moving items 14 and 20 from the concentration disruption factor to the worry factor (Dunn et al.). The overall results of the confirmatory factor analysis demonstrated that the factor structure of the second alternative model was a better model fit for the second group of 249 athletes than the original model defined by Smith et al. (1990) (Dunn et al.). The authors stated that the results demonstrated that the somatic anxiety factor and the corresponding nine items were “well
defined (Dunn et al., p. 190).” In addition, seven of the items representing the original Smith et al. (1990) worry factor loaded on both the exploratory factor analysis and confirmatory factor analysis solutions in the Dunn et al. study. The results also revealed that items that represented the concentration disruption factor in the Smith et al. (1990) study (items 14 and 20), loaded on the worry factor in the Dunn et al. study. The authors concluded that these two items may have loaded in the worry factor because they make reference to components of anxiety as a direct cause or source of concentration loss, whereas the other three items in the concentration disruption factor only make specific reference to concentration and attentional difficulties (Dunn et al.). Dunn et al. suggested that the difference between the factor structures of the Smith et al. (1990) study and their study could be attributed to differences with the participant’s age, gender (i.e., all participants were male in the Dunn et al. study), and level of skill and that continued research examining the factor structure of the SAS with different populations is warranted.

Prapavessis, Maddison, and Fletcher (2005) further studied the factor structure of the SAS with a sample of 570 male rugby union players from New Zealand (Mean age = 20.69, SD = 4.18) who represented numerous ethnic groups (NZ European; NZ Maori; Samoan; other Pacific Islanders). Utilizing confirmatory factor analysis, Prapavessis et al. assessed the three factor model of the SAS by evaluating three models: the original Smith et al. (1990) model; the Dunn et al. (2000) model where items 14 and 20 originate from the worry factor and not the concentration disruption factor (Model A); and a third alternative model that was developed by the researchers within the item-response theory (IRT) measurement model after examining the psychometric properties of all items in the SAS (Model B).

Results demonstrated that for the original Smith et al. (1990) model, each of the 21 item factor loadings ranged in size from .50 to .71 and were statistically significant at $p < .01$.
(Prapavessis et al., 2005). The results for Model A showed this model to be a better model fit than the original Smith et al. (1990) model, as each of the 21 item factor loadings ranged in size from .50 to .85 and were statistically significant at $p < .01$ (Prapavessis et al.). One of the major findings for Model B was that modification indices and standardized residuals of Item 1 were problematic and were subsequently removed from further analyses of the SAS (Prapavessis et al.). Similar to Model A, each of the 20 factor loadings for Model B ranged in size from .49 to .85 and were statistically significant at $p < .01$ (Prapavessis et al.).

The results from this study are similar to findings from the Dunn et al. (2000) study, whereas items 14 and 20 originate from the worry factor and not the concentration disruption factor, as defined by the original Smith et al. (1990) model (Prapavessis et al.). Also, Prapavessis et al. stated that item 1 lacks measurement precision and that the removal of item 1 from the SAS improves the theoretical component of the somatic anxiety factor.

Smith, Cumming, and Smoll (2006) addressed these concerns about items 1, 14, and 20 with the SAS and expressed their conceptual concerns about moving items 14 and 20 to the worry factor and relabeling the nine item worry factor as ‘cognitive anxiety’, as Prapavessis et al. (2005) had suggested. Smith et al. (2006) further analyzed data utilizing confirmatory factor analysis from a sample of 327 male and female high school athletes representing a variety of sports. Smith et al. (2006) compared the original three factor model (excluding items 1, 14 and 20) and the Prapavessis et al. three factor model without item 1 and where items 14 and 20 were added to the items representing the worry factor. Results demonstrated similar findings for both of the models and Smith et al. (2006) further conducted single-factor confirmatory factor analyses comparing Prapavessis et al. nine item ‘cognitive anxiety’ factor with the original seven item worry scale. Results showed that the original worry scale from Smith et al. (1990) was a
better fit than the ‘cognitive anxiety’ scale and, as a result, the authors suggest not combining items 14 and 20 with the original worry scale (Smith et al., 2006). However, Smith et al. (2006) took a step further and recommended researchers score the original three factor SAS without items 1, 14, and 20 due to inconsistent factor loadings from the different studies addressing the factorial structure of the SAS. Despite efforts to further refine the factorial structure of the SAS, researchers have yet to examine the factorial composition of the SAS with older adult athletes.

SAS Factor Structure that was Evaluated in the Present Study

The SAS factor structure that was evaluated in this study was the three-factor model for sport-specific competitive trait anxiety and were defined as somatic anxiety (eight items); worry (seven items); and concentration disruption (three items) for a total of 18 items. As suggested by Smith et al. (2006), items 1, 14, and 20 will not be included in further data analyses.

Golf Performance Survey

The Golf Performance Survey (GPS) was designed by Thomas and Over (1994) to assess psychological skills and psychomotor competencies associated with golf performance and commitment to golf. Participants in the study were 172 male golfers representing the Pacific Golf Club in Brisbane, Australia (Thomas & Over). Age of the participants ranged from 20 to 74 years ($M_{age} = 48.15$, $SD = 12.03$) (Thomas & Over). Golf handicaps ranged from 5 to 27 ($M = 15.67$, $SD = 5.30$). The GPS originally comprised 95 items assessing psychological skills, psychomotor skills, and one’s level of involvement in golf (Thomas & Over). A majority of the items were originally developed by the researchers, however, some items were adapted from measures such as the Psychological Performance Inventory (PPI) (Loehr, 1982) and the Psychological Skills Inventory for Sports (PSIS) (Mahoney, Gabriel, & Perkins, 1987) (Thomas & Over). Other items regarding component skills were developed from golf instructional
manuals (Thomas & Over). Ten university staff members, who were active members of regional
golf clubs, completed an initial version of the questionnaire (Thomas & Over). The results of a
pilot study led to revising some items as well as the overall instructions of the GPS (Thomas &
Over).

The 95 items included content such as a player's concentration, use of imagery, mental
preparation, strategies and tactics, self-control, emotions and cognitions, psychomotor skills,
commitment, and competitiveness with direct references to golf participation (Thomas & Over).
Thomas and Over stated that 40 of the 165 participants, who completed the GPS when it was
initially distributed, were randomly chosen to rate the 95 items assessing psychological skills and
psychomotor skills in golf three months after their initial ratings. To establish the test-retest
reliability of the golf performance subscales, data was obtained from 36 of these participants at
the two different time points (Thomas & Over). Five items were excluded from the data
analyses due to skewed distributions and therefore, the final version of the GPS resulted in 90
items (Thomas & Over).

In addition, other content with the GPS included demographic information such as age,
height, weight, years of playing golf, the number of competition and practice rounds one
currently played per month, and one's current handicap (Thomas & Over). Other questions
focused on the number of shots one would take on average on each hole, one’s average length of
drive, the percentage of times one would sink a putt from different distances, and further items
assessing motives for playing golf (Thomas & Over).

Principal axis factor analyses were conducted to explore the structure in each of the three
areas (psychological and tactical skills, psychomotor skills, and involvement in golf) and resulted
in three separate scales with several factors representing each scale (Thomas & Over, 1994).
Psychological skills and tactics in golf demonstrated five factors and accounted for 43% of the variance (Thomas & Over). Factor 1 was Negative Emotions and Cognitions (10 items); Factor 2 was Mental Preparation (9 items); Factor 3 was Conservative Approach (4 items); Factor 4 was Concentration (3 items); and Factor 5 was Striving for Maximum Distance (4 items) (Thomas & Over). Psychomotor skills in golf demonstrated four factors and accounted for 35% of the variance (Thomas & Over). The fourth factor was not included in further analyses due to poor internal consistency (alpha coefficient of .45) (Thomas & Over). Factor 1 was Automaticity (13 items); Factor 2 was Putting Skill (3 items); and Factor 3 was Seeking Improvement (8 items) (Thomas & Over). An interesting finding related to age was that automaticity and putting skill were not significantly associated with age (Thomas & Over). However, the results from this study demonstrated that significant decline with age occurred in relation to the extent to which players seek to improve their psychomotor skills (Thomas & Over). Involvement in golf demonstrated two factors and the second factor was not included for further analyses due to poor internal consistency (alpha coefficient of .58) (Thomas & Over). Therefore, there was one factor and it accounted for 16% of the variance (Thomas & Over). The factor was labeled as Commitment (5 items) (Thomas & Over).

The results also demonstrated that intercorrelations above .40 were between the factors of Negative Emotions and Concentration (−.49), Mental Preparation and Automaticity (.43), and Mental Preparation and Commitment to golf (.40) (Thomas & Over, 1994). Results also demonstrated that the less skilled golfers (higher handicap group) had significantly lower scores on the factors Mental Preparation, Concentration, Automaticity, and Commitment compared to the highly skilled golfers (lower handicap group) (Thomas & Over). Also, the less skilled golfers had higher scores on the factors of Negative Emotions and Cognitions than the highly
skilled golfers (Thomas & Over). Results also demonstrated that there was no difference between the more skilled and less skilled golfers on the factors of Conservative Approach, Striving for Maximum Distance, Seeking Improvement, and Putting Skill (Thomas & Over).

Even though this study addressed the GPS with varying ages and skill levels, further examination of the factorial structure of the GPS with older adult amateur athletes is considered necessary for empirical and applied purposes (Thomas & Over, 1994).

GPS Factor Structure that was Evaluated in the Present Study

The GPS factor structure that was evaluated in this study was a four-factor model for a) psychomotor skills in golf and b) involvement in golf. The three subscales of psychomotor skills in golf refer to automaticity (13 items), putting skill (3 items), and seeking improvement in psychomotor skills (8 items). The factor of commitment (5 items) comprises the area of involvement in golf. This model has a total of four factors and 29 items. Petrie et al. (2000) and Hayslip et al. (2010) decided not to include the five factors and subsequent 24 items of psychological skills and tactics in golf in their original data collection due to the conceptual common characteristics with the TOPS. Therefore, based on the information from this archival data and for the purpose of this study, only the areas of psychomotor skills in golf and involvement in golf will be addressed and discussed in further data analyses.

Statement of the Problem

Despite Petrie et al. (2000) being one of the first empirical attempts to investigate an older, amateur athlete sample as well as a study involving multigroup comparisons, for the study of older, amateur athletes and comparisons across groups to be appropriate, it is imperative to support the factorial validity of scores yielded from available psychological skills, competitive trait anxiety, and golf specific skills instruments for such a purpose. Verifying that different age
groups conceptualize the factors that interfere with or facilitate performance in a sport context in the same way and that the measures function equivalently across groups are crucial first steps in supporting the validity of the inferences made from multigroup comparison studies (Hertzog & Nesselroade, 2005).

Before multigroup comparisons can be conducted, however, we must be assured that the measures used to represent psychological skills, competitive trait anxiety, and golf specific skills functions well for persons of different ages (Hertzog & Nesselroade, 2005). Because the factorial validity for the TOPS, SAS, and the GPS scores has predominantly come from younger samples (i.e., high school and college-age participants), it is impossible to say whether conclusions are appropriately applied to older adult athletes and that the measures work equivalently for all age groups. Thus, there is a clear need to support the factorial validity of the TOPS, SAS, and the GPS scores for these purposes.

Although the TOPS, SAS, and the GPS have been assessed in numerous studies, they have not been appropriately validated for use with older adult populations. Instead, measurement equivalence is often assumed (Vandenberg & Lance, 2000). However, it is entirely possible that questionnaire items hold different meaning to different age groups (Hertzog & Nesselroade, 2005). To date, no research has evaluated the validity of the TOPS, SAS, and the GPS for use among older adult athletes and it is important that researchers should address this gap in the literature. Therefore, the purpose of the study was to examine the factorial validity and measurement invariance of the TOPS, SAS, and the GPS across age groups in a representative sample of amateur golfers.
CHAPTER 2

METHOD

Participants

Based on archival data, 649 golfers who played in the 2000 Dupont World Amateur Golf Championship in Myrtle Beach, South Carolina were chosen to represent the population of interest. The first subgroup consisted of 237 younger adults who were between the ages of 19 and 40 ($M_{age} = 33.60, SD = 5.24$). The second subgroup consisted of 412 older adults who were over the age of 60 ($M_{age} = 66.25, SD = 5.10$).

Measures

Psychological skills and strategies. Psychological skills and strategies were assessed using the Test of Performance Strategies (TOPS; Thomas et al., 1999). The TOPS is a 64-item self-report instrument designed to measure an athlete’s use of psychological skills and strategies during practice and competition. As mentioned previously, for the purpose of this study, only the competition subscales were utilized. The eight different subscales for psychological skills and strategies used during competition are self-talk (“I talk positively to myself to get the most out of competitions”), emotional control (“My emotions get out of control under the pressure of competition”), automaticity (“I perform at competitions without consciously thinking about it”), goal-setting (“I set personal performance goals for a competition”), imagery (“I rehersae my performance in my mind at competitions”), activation (“I can increase my energy to just the right level for competitions”), negative thinking (“During competition I have thoughts of failure”), and relaxation (“I am able to relax if I get too nervous at a competition”). Each subscale has four items. Items 7, 8, 9, 11, 13, 14, 17, 18, 21, 22, 24, 25, 26, 28, 30, 31, 32, 33, 34, 36, 40, 41, 43, 46, 52, 54, 55, 56, 57, 59, 62, and 63 comprise the items representing the competition subscales.
Participants responded to these items on a 5-point Likert scale ranging from 1 (never) to 5 (always) to indicate their use of the specific skill. A total score is obtained by summing all of the items and dividing by four, resulting in overall scores for each subscale that could range from 1 to 5. Higher scores indicate greater use of a specific skill. Results from several studies have shown support for the reliability and validity of the TOPS. Initial findings with Cronbach alpha coefficients for the eight competition subscales were .80, .79, .74, .78, .79, .76, .74, and .80, respectively (Thomas et al.). Lane et al. (2004) indicated adequate internal consistency for the TOPS with alpha coefficients of .77, .72, .74, .80, .82, .69, .75, and .80, respectively. In a more recent study, satisfactory scale reliabilities were obtained with alpha coefficients of .79, .77, .75, .83, .80, .76, .69, and .72, respectively (Hayslip et al., 2010; Petrie et al., 2000).

*Competitive trait anxiety.* Competitive trait anxiety levels were assessed using the Sport Anxiety Scale (SAS; Smith et al., 1990). The SAS is a 21-item self-report multidimensional measure of competitive trait anxiety that differentiates between cognitive and somatic anxiety in a sport context. The three subscales that comprise the SAS refer to somatic anxiety (9 items) and two subsets of cognitive anxiety, worry (7 items), and concentration disruption (5 items). Examples of items from the SAS are “I feel tense in my stomach” (somatic anxiety); “I am concerned about performing poorly” (worry); and “While performing, I often do not pay attention to what’s going on” (concentration disruption). Each item is rated on a 4-point Likert scale, ranging from 1 (not at all) to 4 (very much) where respondents indicate the degree to which they experience these anxiety symptoms prior to or during competition. Total scores for each factor from the SAS are the average from the specific scales’ items with higher scores indicating higher levels of anxiety. Data from an initial scale development study suggested that the SAS is a reliable and valid measure of somatic and cognitive anxiety (Smith et al., 1990).
Smith et al. reported Cronbach alpha coefficients of .88 (somatic anxiety), .82 (worry), and .74 (concentration disruption), and test-retest reliability coefficients exceeding over .85 for all three scales was reported across a 7-day period (Smith et al. 1990).

Additional research addressing the factor structure of the SAS demonstrated inconsistent factor loadings of three items (items 1, 14, and 20) (Dunn et al., 2000; Prapavessis et al., 2005; Smith et al., 2006). Based on these findings, Smith et al. (2006) recommended that researchers score the current SAS for the original three scales minus items 1, 14, and 20. With these changes, Cronbach alpha coefficients of .85 (somatic anxiety), .82 (worry), and .71 (concentration disruption) were achieved (Smith et al., 2006). Current research also has indicated adequate internal consistency for the 18-item SAS with Cronbach alpha coefficients of .89 (somatic anxiety), .86 (worry), and .73 (concentration disruption) (Hayslip et al., 2010; Petrie et al., 2000).

Golf specific skills. Golf specific skills were assessed using the Golf Performance Survey (GPS; Thomas & Over, 1994). The GPS is a 68-item self-report inventory which assesses the psychological and psychomotor skills associated with golf performance and level of involvement in golf in three separate areas: (a) psychological skills and tactics in golf, (b) psychomotor skills in golf, and (c) involvement in golf. Hayslip et al. (2010) and Petrie et al. (2000) decided not to include the area and subsequent subscales of psychological skills and tactics in golf in their original data collection due to the conceptual common characteristics with the TOPS. As a result, only the area and subsequent subscales of psychomotor skills in golf and the involvement in golf (i.e., 29 items) were utilized in further data analyses. The three subscales of psychomotor skills in golf refer to automaticity (13 items), putting skill (3 items), and seeking improvement in psychomotor skills (8 items). The subscale of commitment (5 items) comprises the area of involvement in golf. Examples of items from the GPS are “My actions seem automatic when
playing a shot" (automaticity); "I am good at reading greens" (putting skills); "I often make adjustments to my grip or swing" (seeking improvement); and "Playing golf well is an important part of my life" (commitment). Each item is rated on a 5-point Likert scale, ranging from 1 (strongly disagree) to 4 (strongly agree) where participants indicate the degree to which they experience these attributes defined in a golf context. A total score is obtained for each dimension and is represented by the average from the specific subscales' items with higher scores indicating greater levels of confidence in that area.

Thomas & Over (1994) reported Cronbach's alphas of .80 (automaticity), .79 (putting skills), .67 (seeking improvement), and .67 (commitment). In addition, they reported test-retest reliabilities of .92 (automaticity), .85 (putting skills), .78 (seeking improvement), and .85 (commitment) across a three month period. Current research obtained Cronbach alpha coefficients of .63 (automaticity), .66 (putting skills), .56 (seeking improvement), and .84 (commitment) (Hayslip et al., 2010; Petrie et al., 2000).

Procedure

Approval from the university's Institutional Review Board for Human Subjects Research was obtained prior to data collection. During the day prior to the start of the 2000 DuPont World Amateur Golf Championship, golfers were solicited to participate in a study examining the relationship among golf skills levels, anxiety, psychological coping skills, and golf performance (Petrie et al., 2000). At the registration sign-in, the researchers approached the golfers and the golfers were informed of the nature of the study. The researchers also explained to the golfers that they would be entered into a drawing for golf equipment if they chose to participate in the study. After verbal assent had been obtained, each participant completed the written consent form and was given a packet of questionnaires that contained the previously described measures,
along with a demographic questionnaire that contained age, sex, items regarding their golf activities, and techniques they had adopted to improve their games. Participants did not provide their names or any identifying information on the questionnaire packets. Instead, the participants’ responses were coded only by number that was linked to each participant’s name on the consent form in order to be matched with data from each individual’s tournament results and his or her questionnaire data.
CHAPTER 3

RESULTS

Based on this archival dataset, data analyses of the TOPS, SAS, and the GPS were conducted in four phases. In the first phase, a confirmatory factor analysis (CFA) was implemented to examine the original factor structure proposed by previous literature with the TOPS, SAS, and the GPS, respectively. To the extent that the overall fit of each of the three models was poor, an exploratory factor analysis (EFA) was then conducted to identify a viable factor structure for the three measures in phase two. In the third phase, the factor structure determined in the second phase for each of the three measures was examined through CFA. In the final phase, measurement invariance of several types was tested via multigroup comparisons using structural equation modeling within the framework of CFA. The statistical software package R and R package lavaan was utilized to conduct all of the predefined data analyses (R Development Core Team 2013; Rosseel, 2012).

TOPS: Exploratory and Confirmatory Factor Analyses

To assess the eight factor model based upon the original factor structure of the TOPS (i.e., all 32 items), a CFA was conducted using the entire sample of amateur golfers. Following Brown (2006) and Kline’s (2005) guidelines, the following goodness-of-fit indices were used to assess the degree of fit between the model and the sample: the comparative fit index (CFI: > .90 acceptable, > .95 good; Bentler, 1990), the root mean square error of approximation (RMSEA: < .08 acceptable, < .05 good; Steiger & Lind, 1980) with a 90% confidence interval, and the standardized root mean square residual (SRMR: < .10 acceptable, < .08 good; Bentler, 1995).

The CFA yielded a relatively poor fit to the data (CFI = .883, RMSEA = .059, [90% C.I. = .056 -.063]; SRMR .079). A parallel analysis, an alternative empirical technique used to decide
how many factors in a factor analysis, was initially conducted to utilize as a guideline to
determine the number of factors to extract (Horn, 1965). Due to the lack of precision and the
tendency to overestimate the number of factors to retain involved with the parallel analysis, this
analysis was only used as a beginning point to initiate the process of determining the number of
factors to extract (Floyd & Widaman, 2005). The parallel analysis for the TOPS suggested that
the number of factors to extract was six.

With this in mind, a preliminary EFA was then conducted to examine the factor structure
utilizing maximum likelihood estimation and oblique rotations were performed using oblimin
procedures. Criteria for item retention or deletion included: (a) deleting items with factor
loadings of less than .32; (b) deleting cross-loading items that load at .32 or higher on two or
more factors; (c) deleting items that had large negative loadings; and d) deleting items where
there were fewer than three items that loaded on any one factor (Tabachnick & Fidell, 2007).
The EFA yielded an eight factor solution (Tucker Lewis Index of factoring reliability (TLI),
Tucker & Lewis, 1973; $TLI = .949$, $RMSEA = .037$, [90% C.I. = .031-.041]). However, one of
the eight factors was not retained due to only two items loading on that specific factor (i.e.,
activation subscale of the TOPS). Items 13, 18, 24, 28, 32, 40, 43, and 52 were then removed
one at a time from the original 32 item measure. Each item was removed on the basis of these
predefined criteria. A subsequent EFA resulted in a seven factor solution and consisted of 24
items ($TLI = .971$, $RMSEA = .032$, [90% C.I. = .023-.038]). The items and standardized factor
loadings for the seven factor EFA model are presented in Table 1.

Utilizing the entire sample of amateur golfers, the above seven factor solution formed the
basis for a subsequent CFA of the TOPS factor structure. The resultant final model shows an
excellent fit to the data ($CFI = .955$, $RMSEA = .042$, [90% C.I. = .037-.047]; $SRMR .041$).
The items and standardized factor loadings for the CFA model are presented in Table 2. As the seven factors were previously named by Thomas et al. (1999), the original factor names were retained.

Factor 1 (Self-Talk) was defined by items 21 (“I have specific cue words or phrases that I say to myself to help my performance during competition”), 33 (“I say things to myself to help my competitive performance”), 36 (“I manage my self-talk effectively during competitions”), and 57 (“I talk positively to myself to get the most out of competitions”).

Factor 2 (Emotional Control) was defined by items 31 (“When something upsets me during a competition, my performance suffers”), 62 (“My emotions keep me from performing my best at competitions”), and 63 (“My emotions get out of control under the pressure of competition”).

Factor 3 (Automaticity) was defined by items 11 (“I perform at competitions without consciously thinking about it”), 30 (“During competition, I perform on ‘automatic pilot’”), 41 (“During competition, I don’t think about performance much - I just let it happen”), and 54 (“During competitions, I play/perform instinctively with little conscious effort”).

Factor 4 (Goal Setting) was defined by 7 (“During competition I set specific result goals for myself”), 22 (“I evaluate whether I achieve my competition goals”), 26 (“I set very specific goals for competition”), and 46 (“I set personal performance goals for a competition”).

Factor 5 (Imagery) was defined by 34 (“At competitions, I rehearse the feel of my performance in my imagination”), 55 (“I imagine my competitive routine before I do it at a competition”) and 59 (“I rehearse my performance in my mind at competitions”).

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Factor 6 (Negative Thinking) was defined by 9 ("My self-talk during competitions is negative"), 14 ("During competition I have thoughts of failure"), and 56 ("I imagine screwing up during a competition").

Factor 7 (Relaxation) was defined by 8 ("When the pressure is on at competitions, I know how to relax"), 17 ("I am able to relax if I get too nervous at a competition"), and 25 ("When I need to, I can relax myself at competitions to get ready to perform").

Tests of Measurement Invariance Across Age Groups

Testing of measurement invariance was conducted via multigroup comparisons (i.e., comparing younger adult golfers and older adult golfers) within the framework of the CFA model for the TOPS. According to Vandenbeng & Lance (2000), a set of sequential steps are followed when testing measurement invariance with multigroup comparisons. The steps start with the identification of the best-fitting baseline model to the data and continue with invariance constraints in the successive model parameters across groups (Vandenbeng & Lance).

The baseline model is termed the configural model, which is the first and least restrictive model specified (Vandenbeng & Lance, 2000). It has demonstrated its importance due to the fact that it represents the baseline model that is used to compare against all subsequent invariance models (Vandenbeng & Lance). The configural model is established by specifying, testing, and validating the CFA model in both groups (Vandenbeng & Lance). Configural invariance is then examined and this model requires that the same pattern of freely and fixed estimated model parameters is equivalent across groups (Vandenbeng & Lance). When configural invariance is met and the model fits the data, it suggests that at least the general factor structure is similar and that the same general concept is being measured in each group (Vandenbeng & Lance).
The second step is to constrain factor loadings to be equal across the groups to test metric or weak invariance (Vandenberg & Lance, 2000). If the model fit with the constrained factor loadings is significantly worse than the configural model, then metric invariance is not supported (Vandenberg & Lance). When metric invariance is achieved, it suggests that the participants from each of the groups interpret and respond to the measure in a similar manner and that the same unit of measurement is being used for the items across the groups (Horn & McArdle, 1992). According to Steenkamp and Baumgartner (1998), metric invariance allows the use of a measure to examine correlations with other measures across groups. However, achieving metric invariance does not include the comparison or interpretation of mean differences across groups (Vandenberg & Lance).

The third step is to impose constraints on the item intercepts and factor loadings equal across groups to test scalar or strong invariance (Vandenberg & Lance, 2000). Under scalar measurement invariance, assessing mean difference of the latent variable across groups is permitted (Vandenberg & Lance).

The final step is to constrain item residual variances, item intercepts, and item factor loadings to be equal across groups to test strict invariance (Vandenberg & Lance, 2000). When measurement strict invariance has been established, item uniqueness across groups demonstrates that the items measured in each group were measured with the same accuracy (Vandenberg & Lance). When strict measurement invariance is established, any group differences on any item are due only to group differences on the means of the latent factors (Vandenberg & Lance). The analyzed models are nested sequentially, meaning that the imposed constraints of the model are progressively added when each successive level (i.e., configural, metric, scalar, and strict) has been achieved (Vandenberg & Lance). The degree of measurement invariance across nested
models tends to be assessed using chi-square difference tests ($\Delta \chi^2$) (Vandenberg & Lance). When comparing the respective chi-square fit statistic or goodness-of-fit indices between the configural model to the model with additional constraints, the fit of the nested model may be assessed (Cheung & Rensvold, 2002). Previous literature has identified both criteria as important when assessing model fit (Cheung & Rensvold; Vandenberg & Lance), primarily due to the faulty conclusions that are made when only using the chi-square difference test as the sole decision point. Due to the limitations of the chi-square difference test, particularly its tendency to yield significant results with large sample sizes, therefore increasing the likelihood of making a Type II error, Cheung and Rensvold suggested that the $\Delta$CFI, or change in the CFI score, be used as a criterion to determine if nested models are equivalent across groups. Change in CFI values $\leq$ .02 indicate model invariance (Cheung & Rensvold). In addition, an alternative fit index, the $\Delta$BIC (Bayesian Information Criterion; Schwartz, 1978), or change in the BIC score, has also been addressed in the literature as an important criteria for assessing model fit (Raftery, 1993; 1995). Raftery (1993) suggests a difference score of $> 10$ as a cutoff point when testing for significant differences between groups, resulting in “conclusive evidence” that there are significant differences (p.168). According to Raftery (1993; 1995), models with a lower BIC value are chosen as a better fit over the model with a higher BIC value. In the present study, the $\Delta$CFI and $\Delta$BIC tests were given more consideration whenever there was incongruity between the conclusions of the $\Delta \chi^2$ test and the $\Delta$CFI and $\Delta$BIC tests.

TOPS: Tests of Measurement Invariance Across Age Groups

For the TOPS, a multigroup CFA model based upon the seven factor solution was tested for measurement invariance between younger adult golfers and older adult golfers. Table 3 shows the results of the measurement invariance tests for the TOPS. Based on the above CFA
results confirming a seven factor model for the TOPS, the configural model (Model 1) in which no equality constraints were imposed represented an excellent fit to the data ($CFI = .945$, $RMSEA = .047$, $BIC = 39765.53$), incorporating all golfers, irrespective of age. Based on these results, we can conclude that there is configural invariance of the CFA model across age groups for the TOPS.

After configural invariance across age was established, testing for multigroup invariance was conducted, using the sequential procedures described earlier. The CFI values for Model 1 were identical to the metric invariant model (Model 2) ($CFI = .945$, $RMSEA = .046$, $BIC = 39669.69$), indicating metric invariance across age. The nonsignificant difference $\chi^2 (\Delta \chi^2)$ and the change in BIC between models 1 and 2 give additional support to the idea that the invariance constraints imposed by Model 2 did not significantly worsen the model fit as compared to Model 1, thus supporting the viability of these constraints. In addition, both the scalar (Model 3) ($CFI = .945$, $RMSEA = .045$, $BIC = 39576.46$) and the strict invariance (Model 4) $\Delta \chi^2$ and $\Delta$CFI tests ($CFI = .944$, $RMSEA = .045$, $BIC = 39453.23$) indicated no significant differences across younger and older adult golfers. Model fit as measured by BIC improved while fit measured by CFI remained consistently high as more constraints were imposed to the models. Therefore, the results support not only configural, but also metric, scalar, and strict invariance in psychological skill usage measured by the TOPS across age.

SAS: Exploratory and Confirmatory Factor Analyses

To assess the three factor model based upon the original factor structure of the SAS (i.e., all 18 items), a CFA was conducted using the entire sample of amateur golfers. The CFA yielded a relatively poor fit to the data ($CFI = .872$, $RMSEA = .088$, [90% C.I. = .082 – .094]; $SRMR = .064$). The parallel analysis for the SAS suggested that the number of factors to extract
was five. With this in mind, a preliminary EFA was then conducted to examine the factor structure utilizing maximum likelihood estimation and oblique rotations were performed using oblimin procedures. Initially, the EFA yielded a five factor solution \((TLI = .928, RMSEA = .061, [90\% \text{ C.I.} = .052-.069])\). Two of the five factors were not retained due to only two items loading on each factor, respectively. Items 3, 4, and 11 were removed from the original 18 item measure. Each item was removed on the basis of the previously defined criteria. A subsequent EFA resulted in a three factor solution and consisted of 15 items \((TLI = .926, RMSEA = .065, [90\% \text{ C.I.} = .055-.073])\). The items and standardized factor loadings for the three factor EFA model are presented in Table 4.

Utilizing the entire sample, the above three factor solution formed the basis for a subsequent CFA of the SAS factor structure. The initial model was then run and showed an acceptable fit to the data \((CFI = .932, RMSEA = .068, [90\% \text{ C.I.} = .060-.075]; SRMR .048)\). In an attempt to improve the fit of the model to the data, the residual item covariance matrix was examined. Additional items with large residuals were identified with a range from .10 to .14 (McDonald, 1999) and removed one at a time. Thus, a sequential iterative approach was utilized in a sequential refitting of the model based on removing items based on residual misfits (McDonald, 1999). Overall, items 9, 16, 17, and 21 were removed from the data. The resultant final model shows an excellent fit to the data \((CFI = .963, RMSEA = .056, [90\% \text{ C.I.} = .045-.067]; SRMR .038)\). The items and standardized factor loadings for the three factor, 11 item CFA model are presented in Table 5. As the three factors were previously named by Smith et al. (1990), the original factor names were retained.
Factor 1 (Somatic Anxiety) was defined by items 8 (“I feel tense in my stomach”), 12 (“I feel my stomach stinking”), 15 (“I sometimes find myself trembling before or during a competitive event”), and 19 (“My stomach gets upset before or during a competitive event”).

Factor 2 (Worry) was defined by items 5 (“I am concerned that I may not do as well in competition as I could”), 10 (“I’m concerned about choking under pressure”), 13 (“I am concerned about performing poorly”) and 18 (“I am concerned that others will be disappointed in my performance”).

Factor 3 (Concentration Disruption) was defined by items 2 (“During competition, I find myself thinking about unrelated things”), 6 (“My mind wanders during sport competitions”), and 7 (“While performing, I often do not pay attention to what’s going on”).

SAS: Tests of Measurement Invariance Across Age Groups

For the SAS, a multigroup CFA model based upon the three factor solution was tested for measurement invariance between younger adult golfers and older adult golfers. Table 6 shows the results of the measurement invariance tests for the SAS. Based on the above CFA results confirming a three factor model for the SAS, the configural model (Model 1) in which no equality constraints were imposed represented a good fit to the data (\(CFI = .954\), \(RMSEA = .062\), \(BIC = 16122.30\)), incorporating all golfers, irrespective of age. Based on these results, we can conclude that there is configural invariance of the CFA model across age groups for the SAS. After configural invariance across age was established, testing for multigroup invariance was conducted, using the sequential procedures described earlier. The change in CFI values between Model 1 and the metric invariant model (Model 2) (\(CFI = .948\), \(RMSEA = .063\), \(BIC = 16090.28\)) were nonsignificant, indicating metric invariance across age. The significant change in BIC scores between models 1 and 2 gives additional support to the idea that the invariance constraints
imposed by Model 2 did not significantly worsen the model fit as compared to Model 1, thus supporting the viability of these constraints. In addition, both the scalar (Model 3) (\( CFI = .946, RMSEA = .062, BIC = 16051.69 \)) and the strict invariance (Model 4) \( \Delta CFI \) tests (\( CFI = .942, RMSEA = .061, BIC = 16001.16 \)) indicated no significant differences across younger and older adult golfers. Model fit as measured by BIC improved while fit measured by CFI remained consistently high as more constraints were imposed to the models. Therefore, the results support not only configural, but also metric, scalar, and strict invariance in sport-specific competitive trait anxiety usage measured by the SAS across age.

GPS: Exploratory and Confirmatory Factor Analyses

To assess the four factor model based upon the original factor structure of the GPS (i.e., all 29 items), a CFA was conducted using the entire sample of amateur golfers. The CFA yielded a relatively poor fit to the data (\( CFI = .717, RMSEA = .067, [90\% \text{ C.I.} = .064-.071]; SRMR .077 \)). The parallel analysis for the GPS suggested that the number of factors to extract was eight. With this in mind, a preliminary EFA was then conducted to examine the factor structure utilizing maximum likelihood estimation and oblique rotations were performed using oblimin procedures. Regarding the next step for further data analysis, the following has been written by Dr. Richard Herrington, a consultant who provided research and statistical support on this study. Dr. Herrington is a research and statistical consultant working at Research and Statistical Support at the University of North Texas:

Numerous attempts were made to find a good subset of items on the GPS subscale that met the sequence of measurement invariance constraints imposed on the GPS items: configural measurement invariance (factor structure equivalence), metric measurement invariance (item slope equivalence), strong scalar measurement invariance (item intercept equivalence), and strict measurement invariance (item residual equivalence). A typical model respecification approach consists of a sequential ‘fit-refit’ strategy, whereby poor fitting items are identified by residual analysis and/or low item loadings. Items are removed and the model is refit leading to a new round of model assessment. Problems
can occur with this strategy in that this approach can lead to sub-optimal item selection. All items are related in a multivariate way; that is, the performance of a single item, in the item set, is conditioned on all other included items. The effect of including or removing a single item can have dramatic changes on the fit of the measurement model.

With the GPS subscale, this sequential fit-refit strategy did not lead to an acceptable measurement invariance set of items. Therefore, a different strategy was used. A discrete optimization procedure was used to perform a model specification search on the GPS subscale items using the measurement invariance constraints to constrain the set possible candidate solutions. Specifically, an “Ant Colony Optimization” (ACO) discrete optimization procedure was used to systematically explore all possible arrangement of items subjected to the measurement invariance constraints mentioned earlier (Leite, Huang, & Marcoulides 2008). The R programming language was used to implement this procedure (R Development Core Team, 2013). Additional supporting packages that were used were package ‘lavaan’ (Rosseel, 2012) and package ‘semTools’ (Pornprasertmanit, Miller, Schoemann & Rosseel, 2013). Additional customized programming to implement the ACO algorithm was provided by the Research and Statistical Support (RSS) support team at the University of North Texas. The website URL for the R script used to implement the ACO in this dissertation can be found at http://www.unt.edu/rss/rich/SEM_MI_ACO.html (Herrington, 2013).

The ACO discrete optimization program ultimately resulted in a four factor solution.

Utilizing the entire sample, the four factor solution formed the basis for a subsequent CFA of the GPS factor structure. The resultant final model shows a good fit to the data (CFI = .936, RMSEA = .046, [90% C.I. = .038-.054]; SRMR .048). The items and standardized factor loadings for the four factor, 16 item CFA model are presented in Table 7. As the four factors were previously named by Thomas and Over (1994), the original factor names were retained.

Factor 1 (Automaticity) was defined by items 1 (“My golf swing is well grooved”), 3 (“My actions seem automatic when playing a shot”), 4 (“I lose no more than one ball a round”), 5 (“My swing is so automatic, I can drive blindfolded”), 10 (“I have an orthodox golf swing”), and 12 (“I swing instinctively, with little conscious effort”).

Factor 2 (Putting Skill) was defined by items 14 (“My putting is a strength”), 15 (“I am good at reading greens”), and 16 (“I am inconsistent in putting”).
Factor 3 (Seeking Improvement in Psychomotor Skills) was defined by items 20 ("I practice putting before a round"), 21 ("I play a practice round before major competition"), 23 ("I hit practice balls before a round"), and 24 ("I have changed clubs to improve my performance").

Factor 4 (Commitment) was defined by 26 ("I am competitive when playing golf"), 27 ("I think about golf even when I am not playing"), and 28 ("I am always trying to reduce my handicap").

GPS: Tests of Measurement Invariance Across Age Groups

For the GPS, a multigroup CFA model based upon the three factor solution was tested for measurement invariance between younger adult golfers and older adult golfers. Table 8 shows the results of the measurement invariance tests for the GPS. Based on the above CFA results confirming a four factor model for the GPS, the configural model (Model 1) in which no equality constraints were imposed represented a good fit to the data ($CFI = .928$, $RMSEA = .049$, $BIC = 30602.13$), incorporating all golfers, irrespective of age. Based on these results, we can conclude that there is configural invariance of the CFA model across age groups for the GPS.

After configural invariance across age was established, testing for multigroup invariance was conducted, using the sequential procedures described earlier. The change in CFI values between Model 1 and the metric invariant model (Model 2) ($CFI = .919$, $RMSEA = .051$, $BIC = 30555.89$) were nonsignificant, indicating metric invariance across age. The significant change in BIC scores between models 1 and 2 gives additional support to the idea that the invariance constraints imposed by Model 2 did not significantly worsen the model fit as compared to Model 1, thus supporting the viability of these constraints. In addition, both the scalar (Model 3) ($CFI = .909$, $RMSEA = .052$, $BIC = 30512.06$) and the strict invariance (Model 4) $\Delta$CFI tests ($CFI = .900$, $RMSEA = .053$, $BIC = 30443.91$) indicated no significant differences across younger and older
adult golfers. Model fit as measured by BIC improved while fit measured by CFI remained consistent as more constraints were imposed to the models. Therefore, the results support not only configural, but also metric, scalar, and strict invariance in golf specific skills usage measured by the GPS across age.

Overall, the results demonstrated support for configural, metric, scalar, and strict multigroup invariance for the CFA model of the TOPS, SAS, and the GPS across the two groups of amateur golfers (younger adult and older adult). These results indicated that the total scores appeared to have the same meaning across groups and could be used to make comparisons of observed mean scores across age groups.
CHAPTER 4

DISCUSSION

The purpose of the current study was to examine the factorial validity and measurement invariance of the TOPS, SAS, and the GPS across age groups in a representative sample of amateur golfers. Research in the sport psychology literature has primarily focused on group differences related to sport performance, particularly among adolescent and young adult elite athletes (Gould et al., 2002; Miller & Donohue, 2003; Post et al., 2012; Williams & Krane, 2001). Few empirical studies have examined group differences on factors that can potentially interfere with or facilitate performance in a sport context among younger and older adult amateur athletes (Hayslip et al., 2010; Petrie et al., 2000). However, before such comparisons can be conducted, it is important to determine whether measurement invariance has been achieved across groups (Hertzog & Nesselroade, 2005; Vandenberg & Lance, 2000). Measures are utilized in research with the assumption that they are measuring the same construct(s) across groups (Hertzog & Nesselroade; Vandenberg & Lance). Invalid conclusions and implications can be made from the results of studies that focus on group similarities or differences with a lack of measurement invariance (Vandenberg & Lance).

TOPS

For the purpose of this study, the TOPS competition subscale assesses the use of psychological skills and strategies in competition settings (Thomas et al., 1999). Results demonstrated that the original factor structure proposed by Thomas et al. of the TOPS (i.e., 8 factors, 32 items), did not adequately fit the data among this sample of amateur golfers. Further results showed that an exploratory factor analysis yielded an eight-factor solution, similar to Thomas et al.’s original factor structure. However, the activation subscale and its related items
were removed entirely from further analyses due to only two items loading on that respective factor. The other two items on the activation subscale did not load on any factor and were subsequently removed from further analyses. This finding is consistent with results from previous research which provided no support for the fit of the activation subscale in an adolescent athlete population (Lane et al., 2004). The self-talk, automaticity, and goal setting scales showed good fit, whereas one item was removed from each of the emotional control, imagery, negative thinking, and relaxation scales in order to fit the model to the data. This finding suggests that the seven-factor structure of the TOPS competition subscale is relatively similar to Thomas et al.'s original eight-factor structure, whereas revision of one of the subscales is needed. In particular, the activation subscale appears to require revision before the original TOPS competition subscale can be applied with confidence among young adult and older adult amateur golfers.

The confirmatory factor analysis yielded the seven-factor structure, suggesting that each factor may be considered independently when scoring the TOPS competition subscale. In addition, the version of the TOPS that yielded the best fit represented a more efficient measure, as it was comprised of fewer items (i.e., 24 items) than the original version. Moreover, each of the items corresponding to the self-talk, emotional control, automaticity, goal setting, imagery, negative thinking, and relaxation factors in the retained confirmatory factor analysis solution had statistically significant loadings ranging in size from .49 to .90. These findings suggest that the TOPS competition subscales were relevant to the amateur golfers who participated in this study and are conceptually sound. This finding is not surprising considering that previous research suggests that athletes will use several different types of psychological skills and strategies to enhance athletic performance, including both general psychological skills as well as sport-
specific psychological strategies to cope with the demands of their sport (Gould et al., 2000; Williams & Krane, 2001).

Measurement invariance indicates that across the relevant comparison groups, the same underlying construct is measured in a similar fashion (Vandenb shares & Lance, 2000). Measurement invariance ensures that multigroup comparisons can be interpreted in a valid fashion in terms of group differences in the underlying construct (Vandenb shares & Lance). Multigroup comparisons may not be correct and the conclusions and resultant implications may be invalid if measurement equivalence is not met (Vandenb shares & Lance).

For the seven-factor model of the TOPS competition subscale, the requirements for configural, metric, scalar, and strict invariance were met, supporting the use of the seven subscale scores and the comparison across all age groups. No age differences were observed at the level of factor loadings, indicating metric invariance across age in the total sample of amateur athletes. This attests to the fact that the latent variable is related to the items in the same way for younger adult and older adult amateur golfers. In the current study, additional fit indices were either improved (BIC and RMSEA) or only slightly decreased (CFI) when adding further constraints equating the intercepts (scalar invariance) and the residuals (strict invariance) to the baseline model. In the present analyses, it was found that there were no significant age differences with the TOPS competition subscales at the strong and strict invariant levels, indicating that psychological skills and strategies as measured by the TOPS competition subscales do retain the same meaning across age groups.

SAS

The SAS measure assesses individual differences in competitive trait anxiety, namely in somatic anxiety and in two aspects of cognitive anxiety (i.e., worry and concentration disruption)
(Smith et al., 1990). Results demonstrated that the original factor structure proposed by Smith et al. (1990) of the SAS (i.e., 3 factors, 18 items), did not adequately fit the data among this sample of amateur golfers. Further results showed that an exploratory factor analysis initially yielded a five-factor solution, similar to Smith et al.’s (1990) initial development of the measure. However, factors four and five each were removed entirely from further analyses due to only two items that loaded on those respective factors. An additional three items, two from the somatic anxiety subscale and one item from the worry subscale, did not load on any factor and were subsequently removed from further analyses. This finding is consistent with results from previous research which provided support for five factors, whereas only three factors were retained after factors four and five each contained only two items with factor loadings above .30 (Smith, Smoll, and Barnett, 1995; Smith et al., 1990). This finding also suggests that the three-factor structure of the SAS is relatively similar to Smith et al.’s (1990) original three-factor structure, whereas revision of two of the subscales are needed. In particular, the somatic anxiety and worry subscale appears to require revision before the original SAS measure can be applied with confidence among young adult and older adult amateur golfers.

The confirmatory factor analysis yielded an acceptable fit with the three-factor structure. However, attempts were made to improve the confirmatory factor analysis model to best fit the data. The concentration disruption scale showed good fit, whereas two items were each removed from the somatic anxiety and worry subscales, respectively, in order to better fit the model to the data. After these modifications, the confirmatory factor analysis yielded a better fit with the three-factor structure, suggesting that each factor may be considered independently when scoring the SAS. In addition, the version of the SAS that yielded the best fit represented a more efficient measure, as it was comprised of fewer items (i.e., 11 items) than the original version. Moreover,
each of the items corresponding to the somatic anxiety, worry, and concentration disruption factors in the retained confirmatory factor analysis solution had statistically significant loadings ranging in size from .51 to .80. The SAS results from this study yielded a three-factor, eleven item measure, indicating a lack of replicable findings so consistently found in previous research (Dunn et al., 2000; Prapavessis et al., 2005; Smith et al., 2000; Smith et al., 2006). One explanation with this difference between the final model reported in this study and the final model reported in previous research might result, in part, from differences among age and competition level with the representative participants of previous research. Previous research has addressed the factor structure of the SAS with only adolescent and young adult elite athletes (Dunn et al.; Prapavessis et al.; Smith et al., 2000; Smith et al., 2006).

The findings from this study suggest that the SAS final model was relevant to the amateur golfers who participated in this study and is conceptually sound. In addition, the results of the SAS indicated that the participants in this study were able to differentiate between the three aspects of anxiety, areas which have been known to be highly correlated with one another when assessing an individual’s level of competitive trait anxiety (Smith et al., 2000; Smith et al., 2006).

For the three-factor model of the SAS, the requirements for configural, metric, scalar, and scalar invariance were met, supporting the use of the three subscale scores and the comparison across all age groups.

No age differences were observed at the level of factor loadings, indicating metric invariance across age in the total sample of amateur athletes. This attests to the fact that the latent variable is related to the items in the same way for younger adult and older adult amateur golfers. In the current study, additional fit indices were either improved (BIC and RMSEA) or
only slightly decreased (CFI) when adding further constraints equating the intercepts (scalar invariance) and the residuals (strict invariance) to the baseline model. In the present analyses, it was found that there were no significant age differences with the SAS at the strong and strict invariant levels, indicating that competitive trait anxiety as measured by the SAS does have the same meaning across age groups.

GPS

For the purposes of this study, the GPS measure assesses the use of psychomotor skills associated with golf performance and level of involvement in golf across two areas: a) psychomotor skills in golf and b) involvement in golf (Thomas & Over, 1994). Results demonstrated that the original factor structure proposed by Thomas and Over of the GPS (i.e., 4 factors, 29 items), did not adequately fit the data among this sample of amateur golfers. Numerous attempts were made to find a workable factor solution with acceptable items on the GPS subscale with limited success and acceptability. Therefore, a discrete optimization procedure was performed to identify the best possible “candidate solutions” regarding factor structure and item loadings on the GPS subscale (Herrington, 2013). The discrete optimization program ultimately produced a four factor solution.

The confirmatory factor analysis yielded an acceptable fit with the four-factor structure, suggesting that each factor may be considered independently when scoring the GPS. The putting skill scale showed good fit, whereas seven items were removed from the automaticity scale, four items were removed from the seeking improvement in psychomotor skills scale, and two items were removed from the commitment scale, in order to better fit the model to the data. In addition, the version of the GPS that yielded the best fit represented a more efficient measure, as it was comprised of fewer items (i.e., 16 items) than the original version. Moreover, each of the
items corresponding to the automaticity, putting skill, seeking improvement in psychomotor skills, and commitment factors in the retained confirmatory factor analysis solution had statistically significant loadings ranging in size from .33 to .95.

These findings suggest that the GPS subscales were relevant to the amateur golfers who participated in this study and are conceptually sound. This finding also suggests that the four-factor structure of the GPS is relatively similar to Thomas and Over’s (1994) original four-factor structure. On the other hand, some revision of three of the subscales was needed at the item level in this study, wherein 13 of the original 29 items were deleted in order to achieve a workable factor solution across groups. Thus, the automaticity, seeking improvement in psychomotor skills, and commitment subscales did require some major revisions. Further research focusing on the factor structure of the GPS appears to require further revision before the total GPS psychomotor skills and involvement in golf measure can be applied with confidence among young adult and older adult amateur golfers.

Although no other studies have examined the factorial validity of the GPS since the original development of the GPS (Thomas & Over, 1994), researchers have found that sport-specific measures assessing psychological and psychomotor skills utilized in a given sport context plays a significant role in understanding athletes responses toward a certain sport (Hayslip et al., 2010; Petrie et al., 2000; Smith et al., 1990; Thomas & Over, 1994; Weinberg & Williams, 2001). These studies and the findings from the present study, support the idea that the influence of golf-specific psychological and psychomotor skills may be an important component with regard to the sport-specific (i.e., golf) performance relationship and deserves additional study, both as an antecedent of performance outcomes and a variable that may influence how athletes cope with the stresses and demands of performance.
For the four-factor model of the GPS competition subscale, configural, metric, scalar, and scalar invariance were met supporting the use of the four subscale scores and the comparison across all age groups.

No age differences were observed at the level of factor loadings, indicating metric invariance across age in the total sample of amateur athletes. This attests to the fact that the latent variable is related to the items in the same way for younger adult and older adult amateur golfers. In the current study, additional fit indices were either improved (BIC) or only slightly decreased (CFI) when adding further constraints equating the intercepts (scalar invariance) and the residuals (strict invariance) to the baseline model. In the present analyses, it was found that there were no significant age differences with the GPS at the strong and strict invariant levels, indicating that psychomotor skills and involvement in golf as measured by the GPS does have the same meaning across age groups.

Implications

Several practical implications can be derived from the findings of this study. First, the TOPS competition subscale, SAS, and the GPS can be utilized with confidence with older adult amateur golfers, as well as conducting substantive group comparisons with younger adult amateur athletes.

Second, scores from the TOPS competition subscale, SAS, and the GPS can provide valuable information for instructors and coaches about the existing psychological skills, competitive trait anxiety, and psychomotor skills and involvement in golf and future needs of older adult athletes (Singer & Anshel, 2006). The TOPS competition subscale, SAS, and the GPS can be utilized as a research tool regarding the effectiveness of interventions to improve psychological skills, competitive trait anxiety, and psychomotor skills and involvement in golf
among older adult amateur athletes (Weinberg & Williams, 2001). It is important for coaches, instructors, and sport psychologists to tailor their interventions toward the specific needs of the older adult athlete (Singer & Anshel). Specific interventions that target the strengths and areas of improvement of the older adult athlete in terms of psychological skills, competitive trait anxiety, and psychomotor skills and involvement in golf need to be taken into consideration when addressing what is best for the older adult athlete (Vealey, 2007).

Third, the TOPS competition subscale, the SAS, and the GPS may be appropriate measures for establishing the extent to which psychological skills, competitive trait anxiety, and psychomotor skills and involvement in golf usage changes over time with older adult amateur athletes (Weinberg & Williams, 2001). Scores from the TOPS competition subscale, SAS, and the GPS can be utilized to assess ongoing changes in psychological skills, competitive trait anxiety, and psychomotor skills and involvement in golf related to psychological skills training with coaches, instructors, and sport psychologists (Bunker, 2006). Increased attention to older, adult, amateur athletes is clearly warranted. It is important to continue to understand the older athlete’s perception of the situation and realize that coping with performance is a continuous and dynamic process that can have just as many positive outcomes as it can have setbacks or negative outcomes.

Finally, coaches and instructors need to continue to be aware of these athletes by helping to structure a support system with specific interventions based on the TOPS competition subscale, SAS, and the GPS that target this group to facilitate the process of physical and psychological enjoyment, satisfaction, and overall quality of life (Rejeski & Mihalko, 2001). The role of social support and the environment that the instructors and coaches create could potentially act as a buffer against the stress and demands of performance (Baumeister & Leary,
1995; Singer & Anshel, 2006). This is an area that future researchers and practitioners can focus their attention to by helping to understand and facilitate the proper environment.

Limitations of the Present Study

Several limitations of this study warrant mention. First, all data were based on self-report, which is subject to reporting biases. Second, only amateur golfers were used, and thus, the study’s generalizability is limited to athletes of a similar level and in a similar sport. Additional research is needed to extend our findings, particularly with respect to other sports with a high amateur participation rate, such as running and swimming, and to older adult athletes at both the amateur and professional levels. Another limitation of this study is that concurrent validity was not established as comparisons with other similar measures were nonexistent as findings relevant to this study were limited to the measures and specific items used in this study.

Finally, only the TOPS competition subscale was assessed and not the practice subscale. Even though previous research has provided support for the use of separate subscale profiles for competition and practice (Thomas et al., 1999; Lane et al., 2010), results may vary depending upon if the entire measure is assessed and scored to assess similarities and differences between the use of psychological skills and strategies in competition and the use of those skills and strategies in practice settings. Similarly, only the psychomotor skills and involvement in golf areas of the GPS were utilized in this study. Due to the conceptual overlap between the subscales of the TOPS and the GPS, the psychological skills and tactics in golf area were not included in the data analyses of this study. Even though they are considered distinct areas of the GPS, there may be moderate to strong correlations across psychological and psychomotor skills in golf contexts, which may affect the overall results of the factorial validity and measurement invariance of the GPS. The presence of this variable would have provided much needed

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information on psychological skills associated with golf performance. When assessing golfers’ psychological skills and strategies in the future, a measure that accurately represents the psychological skills and strategies associated with golf performance characteristic of amateur golfers is needed.

Future Research Directions

As with many studies, replication of results in future research is needed. Future research needs to continue to address older athletes to determine if the same factor structure and measurement equivalence involved with the TOPS competition subscale, SAS, and the GPS applies at different sports and different levels of athletic participation (e.g., elite, amateur, and recreational participants). Even though differences between male and female athletes was not a focus of this study, it is important to address factorial validity and measurement invariance tests to determine if there are differences between male and female older amateur athletes with respect to the stated measures of interest. Another area of research needs to focus on longitudinal studies with the TOPS competition subscale, SAS, and the GPS to investigate changes over time and whether levels of psychological skills, competitive trait anxiety, and psychomotor skills and involvement in golf changes or remain stable. Future research needs to compare the TOPS competition subscale, SAS, and the GPS with other pertinent performance measures, such as the Test of Attentional and Interpersonal Style (Nideffer, 1976), Athletic Coping Skills Inventory-28 (Smith, Schutz, Smoll, & Ptacek, 1995), Trait-State Sport Confidence Inventory (Vealey, 1986), and the Psychological Skills Inventory for Sport (Mahoney et al., 1987). Related, continuous measurement equivalence research on the previously mentioned performance measures across age, gender, different levels of sports, and different levels of sport participation (i.e., elite, amateur, and recreational) is a much needed area of focus. Research also is needed to determine
whether specific intervention efforts can effectively alleviate the stress and demands of performance associated with older amateur athletes. Additional work in this area is needed to determine what types of interventions can be most effectively employed.

Summary

In summary, three major findings emerged from this study. First, results demonstrated that the original factor structure proposed by Thomas et al. (1999) of the TOPS competition subscale (i.e., 8 factors, 32 items), by Smith et al. (1999) of the SAS (i.e., 3 factors, 18 items), and by Thomas and Over (1994) of the GPS (i.e., 4 factors, 29 items), did not adequately fit the data among this sample of younger adult and older adult amateur golfers. Second, there is evidence of factorial validity with the TOPS competition subscale, SAS, and the GPS with both younger adult and older adult amateur golfers. Third, configural, metric, scalar, and strict measurement invariance were identified in relation to the TOPS competition subscale, SAS, and the GPS between younger and older adult amateur golfers. These three significant findings demonstrated support that comparing younger and older adult amateur golfers is feasible in relation to the TOPS competition subscale, SAS, and the GPS. The results from this study provide a unique perspective on psychological skills and strategies, competitive trait anxiety, and psychomotor skills and involvement in golf among younger and older adult amateur golfers. To the author’s knowledge, this study was the first to examine the factorial validity of the TOPS competition subscale, SAS, and the GPS of younger adult and older adult amateur athletes, as well as address measurement invariance with the TOPS competition subscale, SAS, and the GPS across age groups. As continued efforts to acquire knowledge with older amateur athletes is necessary given the aging of the population (Kinsella & Velkoff, 2001), utilizing measures such as the GPS, SAS, and TOPS, we can develop, structure, and evaluate specific interventions that
can encourage and facilitate healthy and adaptive physical and psychological outcomes for older adults.

Thus, the use of these measures for research and practical purposes has the potential for greater application in a wide range of settings with both elite and amateur athletes ranging in age from young to old.
Table 1

Factor Loadings for the Seven-Factor Solution of the Test of Performance Strategies (TOPS) by Exploratory Factor Analysis using the Maximum Likelihood Estimation with Oblimin Rotation ($N = 649$)

<table>
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Note: Self Talk (ST); Emotional Control (EC); Automaticity (AUT); Goal Setting (GS); Imagery (IMA); Negative Thinking (NT); Relaxation (REL)

Tucker-Lewis index of factoring reliability (TLI) = .971
root mean square error of approximation (RMSEA) = .032
Table 2

Standardized Factor Loadings and Standard Errors by Confirmatory Factor Analysis for the
Seven-Factor Model of the Test of Performance Strategies (TOPS) (N = 649)

<table>
<thead>
<tr>
<th>Item</th>
<th>ST</th>
<th>EC</th>
<th>AUT</th>
<th>GS</th>
<th>IMA</th>
<th>NT</th>
<th>REL</th>
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<tr>
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<td>.749 (.038)</td>
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</table>

Note: Self Talk (ST); Emotional Control (EC); Automaticity (AUT); Goal Setting (GS); Imagery (IMA); Negative Thinking (NT); Relaxation (REL)

Note: All factor loadings are statistically significant (p < .001). Standard errors are in parentheses.

comparative fit index (CFI) = .955
root mean square error of approximation (RMSEA) = .032
standardized root mean square residual (SRMR) = .041
Table 3

Tests of Multigroup Measurement Invariance for the Test of Performance Strategies (TOPS) (N = 649)

<table>
<thead>
<tr>
<th>Model</th>
<th>$\chi^2$</th>
<th>df</th>
<th>CFI</th>
<th>RMSEA</th>
<th>BIC</th>
<th>$\Delta\chi^2$</th>
<th>$\Delta$df</th>
<th>$\Delta$CFI</th>
<th>$\Delta$BIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Configural invariance</td>
<td>791.20</td>
<td>462</td>
<td>.945</td>
<td>.047</td>
<td>39765.53</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>1 versus 2</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>14.25</td>
<td>17</td>
<td>.000</td>
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<td>.046</td>
<td>39669.69</td>
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<tr>
<td>2 versus 3</td>
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<td></td>
<td></td>
<td>16.85</td>
<td>17</td>
<td>.000</td>
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<td>.945</td>
<td>.045</td>
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<td>3 versus 4</td>
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<td>.045</td>
<td>39453.23</td>
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Note. chi-square ($\chi^2$); degrees of freedom (df); comparative fit index (CFI); root mean square error of approximation (RMSEA); Bayesian information criterion (BIC)
Table 4

*Factor Loadings for the Three-Factor Solution of the Sport Anxiety Scale (SAS) by Exploratory Factor Analysis using the Maximum Likelihood Estimation with Oblimin Rotation (N =649)*

<table>
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<th>Item</th>
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<th>CD</th>
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<tbody>
<tr>
<td>8</td>
<td>.65</td>
<td>-</td>
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<tr>
<td>12</td>
<td>.74</td>
<td>-</td>
<td>-</td>
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<tr>
<td>15</td>
<td>.65</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>17</td>
<td>.49</td>
<td>-</td>
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<tr>
<td>19</td>
<td>.76</td>
<td>-</td>
<td>-</td>
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<tr>
<td>21</td>
<td>.73</td>
<td>-</td>
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<td>5</td>
<td>-</td>
<td>.73</td>
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<td>9</td>
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<td>.67</td>
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<td>.77</td>
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<tr>
<td>7</td>
<td>-</td>
<td>-</td>
<td>.58</td>
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</table>

*Note: Somatic Anxiety (SA); Worry (WOR); Concentration Disruption (CD)*

Tucker-Lewis index of factoring reliability (TLI) = .926, RMSEA = .065
Table 5

*Standardized Factor Loadings and Standard Errors by Confirmatory Factor Analysis for the Three-Factor Model of the Sport Anxiety Scale (SAS) (N = 649)*

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<td>.798 (.036)</td>
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<td>-</td>
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<tr>
<td>15</td>
<td>.630 (.038)</td>
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<tr>
<td>19</td>
<td>.717 (.037)</td>
<td>-</td>
<td>-</td>
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<tr>
<td>5</td>
<td>-</td>
<td>.639 (.039)</td>
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<tr>
<td>10</td>
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<td>.773 (.037)</td>
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<td>.691 (.038)</td>
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<td>.510 (.041)</td>
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<td>.593 (.042)</td>
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<td>.781 (.042)</td>
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<td>-</td>
<td>-</td>
<td>.636 (.042)</td>
</tr>
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</table>

*Note:* Somatic Anxiety (SA); Worry (WOR); Concentration Disruption (CD)

*Note:* All factor loadings are statistically significant (p < .001). Standard errors are in parentheses.

comparative fit index (CFI) = .963
root mean square error of approximation (RMSEA) = .056
standardized root mean square residual (SRMR) = .038
Table 6

Tests of Multigroup Measurement Invariance for the Sport Anxiety Scale (SAS) (N = 649)

<table>
<thead>
<tr>
<th>Model</th>
<th>$\chi^2$</th>
<th>df</th>
<th>CFI</th>
<th>RMSEA</th>
<th>BIC</th>
<th>$\Delta\chi^2$</th>
<th>$\Delta$df</th>
<th>$\Delta$CFI</th>
<th>$\Delta$BIC</th>
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<td>1. Configural invariance</td>
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<td>19.78*</td>
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<td>-.006</td>
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<tr>
<td>2 versus 3</td>
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Note. chi-square ($\chi^2$); degrees of freedom (df); comparative fit index (CFI); root mean square error of approximation (RMSEA); Bayesian information criterion (BIC)

*p < .05
Table 7

Standardized Factor Loadings and Standard Errors by Confirmatory Factor Analysis for the Four-Factor Model of the Golf Performance Survey (GPS) (N = 649)

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<td>4</td>
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<td>5</td>
<td>.435 (.045)</td>
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<tr>
<td>10</td>
<td>.199 (.046)</td>
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<td>.471 (.045)</td>
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<td>.726 (.038)</td>
</tr>
<tr>
<td>28</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.724 (.038)</td>
</tr>
</tbody>
</table>

Note: Automaticity (AUT); Putting Skill (PS); Seeking Improvement (SI); Commitment (COM)

Note: All factor loadings are statistically significant (p < .001). Standard errors are in parentheses.

comparative fit index (CFI) = .936  
root mean square error of approximation (RMSEA) = .046  
standardized root mean square residual (SRMR) = .048
Table 8

Tests of Multigroup Measurement Invariance for the Golf Performance Survey (GPS) (N = 649)

<table>
<thead>
<tr>
<th>Model</th>
<th>$\chi^2$</th>
<th>df</th>
<th>CFI</th>
<th>RMSEA</th>
<th>BIC</th>
<th>$\Delta\chi^2$</th>
<th>$\Delta$df</th>
<th>$\Delta$CFI</th>
<th>$\Delta$BIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Configural invariance</td>
<td>349.35</td>
<td>196</td>
<td>.928</td>
<td>.049</td>
<td>30602.13</td>
<td>31.46**</td>
<td>12</td>
<td>-.009</td>
<td>46.24</td>
</tr>
<tr>
<td>1 versus 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Metric invariance</td>
<td>380.81</td>
<td>208</td>
<td>.919</td>
<td>.051</td>
<td>30555.89</td>
<td>33.87**</td>
<td>12</td>
<td>-.010</td>
<td>43.83</td>
</tr>
<tr>
<td>2 versus 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Scalar invariance</td>
<td>414.68</td>
<td>220</td>
<td>.909</td>
<td>.052</td>
<td>30512.06</td>
<td>35.64**</td>
<td>16</td>
<td>-.009</td>
<td>68.15</td>
</tr>
<tr>
<td>3 versus 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Strict invariance</td>
<td>450.15</td>
<td>236</td>
<td>.900</td>
<td>.053</td>
<td>30443.91</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. chi-square ($\chi^2$); degrees of freedom (df); comparative fit index (CFI); root mean square error of approximation (RMSEA); Bayesian information criterion (BIC)

**$p < .01$
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