A PROSPECTIVE INVESTIGATION OF SOCIAL-COGNITIVE PREDICTORS OF PHYSICAL ACTIVITY: DEVELOPMENT OF A CAUSAL MODEL

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Thesis submitted to the faculty of

Virginia Polytechnic Institute and State University

in partial fulfillment of the requirements for the degree of

Master of Science

in

Psychology

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December 1, 1999
Blacksburg, Virginia

Keywords: exercise, physical activity, social-cognitive, self-regulation, self-efficacy

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ABSTRACT

This study tested a model of the relationship between social-cognitive variables and physical activity in a sample of 277 university students using a prospective design. Results of structural equation modeling indicated a good fit of the social-cognitive model to the data. Self-efficacy had the greatest significant total effect on physical activity, largely through its significant association with self-regulation, which directly predicted physical activity. Social support indirectly predicted physical activity through its significant association with self-efficacy. Outcome expectations had the smallest total effect on physical activity. Overall, the social-cognitive model explained 51 percent of the variance observed in physical activity.

ACKNOWLEDGEMENTS

The design and conceptualization of this project benefited from the expert advice, support and encouragement I received from numerous individuals. First, I would like to thank my advisor, Dr. Richard Winett, for his constant encouragement and support, and for sharing his vast knowledge of exercise and fitness. Second, I want to extend a special thank you to Dr. Eileen Anderson for the many hours she devoted toward helping me understand structural equation modeling, and for making this technique fun and interesting to learn. Finally, I would like to thank Dr. Robert Stephens for encouraging me to do a prospective study and for his advice on methodological and theoretical issues. The advice and support of my fellow students was also invaluable. I would like to thank Kevin Bradley for sharing his knowledge of SPSS and LISREL, Jessica Whiteley for demonstrating the fundamentals of SPSS, and Kristi Graves for providing emotional support during our walks together. Most of all, I would like to thank my family for being there for me throughout this endeavor. Even though we were many miles apart, knowing that we were close in heart and mind gave me strength in the face of ongoing challenges.

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INTRODUCTION

As obesity climbs to epidemic proportions around the globe (Taubes, 1998), physical activity is likely to be increasingly targeted in health promotion and disease prevention interventions. In 1995, fewer than 25 percent of U.S. adults engaged in regular, light to moderate activity and only 16 percent engaged in regular vigorous activity (USDHHS, 1998). Furthermore, the mean dropout rate from supervised exercise programs reported around the world is around 50 percent and has remained at that level for the past 20 years (Dishman & Buckworth, 1997). The high prevalence of physical inactivity is unfortunate, because a sedentary lifestyle is associated with increased risk for numerous diseases and disabilities, including lung cancer (Lee, Sesso, & Paffenbarger, 1999), breast and colon cancer (McTiernan, Ulrich, Slate & Potter, 1998), coronary heart disease (Manson, Hu, Rich-Edwards, et al., 1999), non-insulin dependent diabetes mellitus (Kriska, Blair, & Pereira, 1994), and osteoporosis (Marcus, Drinkwater, Dalsky, et al., 1992). Most research suggests that regular moderate to vigorous activity can significantly reduce risk for these diseases, but that lower intensity activities such as gardening and housework are not associated with significant disease-risk reduction (McMurray, Ainsworth, Harrell, Griggs, & Williams, 1998; Winett, 1998).

To develop cost-effective interventions to reach the large numbers of people who are inactive, it is important to know which intervention components are likely to produce change in physical activity. Baranowski et al. (1997) suggest that the development of effective intervention components would be facilitated by an increased understanding of the mediating variables underlying behavior and that the selection and study of such mediating variables should be guided by theory. Because exercise is multiply determined by biological, psychological, and environmental factors (McAuley & Courneya, 1993), in selecting a theory to understand exercise behavior, comprehensiveness is an important criterion (Sallis, Hovell, Hofstetter, & Barrington, 1992). Social-cognitive theory, a multivariate theory which posits that exercise behavior is influenced by personal, cognitive, and environmental factors fits well with the complex nature of exercise behavior and has been the primary theory guiding major health promotion interventions (Bandura, 1997).

The key social-cognitive predictors of health behavior advocated by Bandura (1997) are social and environmental supports, self-efficacy, self-regulation, outcome expectations, and outcome values. *Self-efficacy*, people's belief in their capability to execute a given type of

performance in a given situation, has consistently predicted the adoption and maintenance of physical activity in both structured and unstructured exercise settings, and in cross-sectional and longitudinal research (Armstrong, Sallis, Hovell et al., 1993; Calfas, Sallis, Oldenburg, & French, 1997; DuCharme & Brawley, 1995; McAuley, 1992a, McAuley, 1992b, McAuley, 1993; McAuley & Courneya, 1993). Beta weights for the relationship between self-efficacy and physical activity have ranged from approximately .10 to .42. The effects of social support, environmental conditions, perceived benefits of exercise (positive outcome expectations), and perceived barriers have also been studied with beta weights ranging from approximately .06 to .12 for social support (Hovell, Sallis, Hofstetter, & Spry, 1989; Sallis, Hovell, Hofstetter, et al., 1989; Sallis, Hovell, Hofstetter, & Barrington, 1992), .05 to .09 for environmental conditions (Hovell et al., 1989; Sallis, Hovell, Hofstetter, & Barrington, 1992; Sallis, Hovell, & Hofstetter, 1992), .08 to .24 for perceived benefits (Sallis, Hovell, Hofstetter et al., 1989; Schneider, 1997), and .13 to .35 for perceived barriers (Sallis, Hovell, Hofstetter, Faucher et al. 1989; Sallis, Hovell, Hofstetter, & Barrington, 1992; Steinhardt & Dishman, 1989) suggesting that compared to self-efficacy, these variables have more modest effects on physical activity. The magnitude of these relationships substantiates Bandura's (1997) prediction that self-efficacy should be the strongest social-cognitive predictor of physical activity. However, the paths by which self-efficacy influence physical activity have not been well explored.

At least two variables may mediate the relationship between self-efficacy and physical activity: self-regulation and outcome expectations. *Self-regulation*, the capacity to plan, monitor, self-correct, and maintain goal directed behavior, should be predicted by self-efficacy since people base their personal goals on their perceived capabilities (Bandura, 1997). Outcome expectations, the belief that performing a behavior will have certain beneficial or detrimental effects, should also be predicted by self-efficacy since the outcomes people expect depend largely on how well they expect to perform (Bandura, 1997; Maddux, 1995). Furthermore, it is likely that self-regulation and outcome expectations predict exercise behavior (Bandura, 1997; Maddux, 1995; Winett, Whiteley, Rovniak, Galper, & Graves, 1999). In empirical studies in which self-regulatory strategies for exercise were explored, (Ebbeck, 1990; Gallucci, 1995; Poag & McAuley, 1992; Weber & Wertheim, 1988) self-regulatory strategies such as goal-setting, planning, and self-monitoring increased exercise persistence and performance. However, the lack of scale-development for self-regulatory behaviors has limited the ability to study self-regulation

as a predictor of physical activity, and as an outcome measure in interventions. No published scale could be located to measure self-regulatory skills such as goal-setting and planning that was suitable for use among large groups of individuals engaged in a variety of exercise activities.

Although outcome expectations should predict physical activity (Dzewaltowski, 1994; Rogers & Brawley, 1996) scale development for outcome expectations has also been limited. In the literature on predictors of physical activity, outcome expectations are most frequently operationalized as the "benefits" of physical activity. However, Bandura (1997) suggests that it is equally important to consider the detrimental outcomes that may arise from doing physical activity. Exercise barriers have often been studied with exercise benefits, but a barrier impedes exercise behavior, whereas a negative expected outcome results from participating in exercise behavior (Bandura, 1997). As with self-regulation, no published scale could be located to measure negative outcome expectations. Furthermore, it has been suggested that it is unlikely that outcome expectations will be predictive of physical activity if people do not value the expected outcomes (Rodgers & Brawley, 1996). Therefore, assessing the value placed on positive and negative outcome expectations may enhance the predictive power of this construct (Bandura, 1997).

Most studies exploring the relationships between social cognitive variables and physical activity have used multiple regression analysis (MR). However, the most frequently used MR technique in the exercise literature, hierarchical MR, limits the amount of information that can be extracted about the relationships between social cognitive variables and physical activity. In hierarchical MR, variables are entered into the regression equation in an order that seems consistent with theory. However, because the purpose of hierarchical MR is to assess the contribution of each independent variable to the dependent variable, that other variables entered first do not explain, hierarchical MR does not give complete information about the unique (direct) and indirect effects contributed by each social-cognitive variable (Keith, 1996). While linear regression can give information about the unique effect of social-cognitive variables, it does not give information about indirect effects, and the order of entry of variables into a linear regression is not theoretically driven (Keith, 1996).

Structural equation modeling (SEM), a multivariate method for determining the magnitude of influence of one or several presumed causes on one or several presumed effects (Keith, 1996) combines the strengths of MR techniques. With SEM, the direct, indirect, and total

effects of variables in a theoretically-based model can be evaluated (Kline, 1998). This capacity of SEM may increase our understanding of which variables should be targeted to maximize the effectiveness of interventions. Direct effects assess the unique contribution of each social cognitive variable and give information about whether targeting a specific social-cognitive variable is likely to influence physical activity. Indirect effects provide information on the process by which direct effects exert their effects, thereby identifying potential mediating variables which should be targeted in interventions. Total effects, the sum of all direct and indirect effects for each variable, give the total impact that targeting a variable will have on physical activity.

In addition to giving a more complete picture of the processes by which variables influence each other, SEM can play an important role in testing theory. Social-cognitive theory (Bandura, 1997) suggests that social support is a source of self-efficacy and that self-efficacy, in turn, predicts self-regulation and outcome expectations (as described above), but this pattern of relationships has not been empirically tested in the exercise domain. Through analysis of a model's direct and indirect effects, SEM can be used to test these theoretical predictions. Finally, Bandura (1995) suggests that research aimed at maximizing the amount of variance explained in human behavior should include the full set of social-cognitive determinants in a causal structure. Since previous studies which have not included a full set of predictors explained approximately 11 to 38 percent of the variance in physical activity in adults (Armstrong, Sallis, Hovell, & Hofstetter, 1993; McAuley, 1992; Sallis, Hovell, Hofstetter, & Barrington, 1992; Sallis, Hovell, Hofstetter, et al., 1989), and 18 to 59 percent of the variance in children (Sallis, Prochaska, Taylor, Hill, & Geraci, 1999), it is important to determine whether including additional components such as self-regulation and valued outcome expectations increases the amount of variance that can be explained.

Many studies investigating the relationship between social-cognitive variables and physical activity have been cross-sectional (e.g. Calfas, Sallis, Lovato et al., 1994; Hofstetter, Hovell, & Sallis, 1990), which limits the extent to which inferences can be made about the causal direction of these variables. While higher levels of social support, self-regulation, and outcome expectations may all cause increased levels of physical activity, more frequent physical activity may also result in higher levels of these social cognitive variables. To infer causality, prospective research is needed, but only two prospective studies could be located that included a range of

social-cognitive variables (Sallis, Haskell, Fortmann, Vranizan, Taylor, & Solomon; Sallis, Hovell, & Hofstetter, 1992; Sallis, Hovell, Hofstetter, & Barrington, 1992). These studies suggested that higher scores on social cognitive variables lead to increased adoption and maintenance of physical activity. More research is needed to examine the causal direction of these variables, because cognitive expectancies, self-regulation, and social influences have been shown to be modifiable factors (McAuley & Courneya, 1993; McAuley, Talbot, & Martinez, 1999; Weber & Wertheim, 1988). If these factors play a causal role in exercise participation, it may be possible to help largely inactive people become more active by changing aspects of their expectancies, self-regulatory skills, and social environment.

In sum, this study aimed to clarify the relationships between social-cognitive variables and physical activity by (a) developing a reliable and valid self-regulation scale and valued outcome expectations scale (b) exploring whether self-regulation and outcome expectations mediate the effect of self-efficacy on physical activity, (c) using SEM to examine the direct, indirect, and total effects of social support, self-efficacy, self-regulation, and outcome expectations in relation to physical activity, and (d) prospectively examining the amount of variance in physical activity explained by social-cognitive variables in a theoretical model.

Because the study was exploratory, the hypotheses were general in nature. We hypothesized that higher levels of social support, self-efficacy, self-regulation, and outcome expectations would predict higher levels of physical activity at follow-up. It was also hypothesized that higher levels of social support would predict higher levels of self-efficacy, self-regulation, and outcome expectations and that higher levels of self-efficacy would predict higher levels of self-regulation and outcome expectations.

METHOD

Participants

The participants were undergraduate students enrolled in introductory psychology courses at Virginia Polytechnic Institute and State University. To increase the probability of recruiting participants at all fitness levels, there were no exclusionary criteria for participation in the study. Participants were recruited through a folder displayed in the university's psychology department.

Procedure

Three hundred and fifty-three undergraduate students (109 males, 244 females) attended a 30 minute session and completed the initial questionnaire (Time 1) which contained measures of demographic variables, social support, self-efficacy, self-regulation, outcome expectations, and physical activity. One week later (Time 2), 229 of these students returned to a second 20 minute session and completed a second questionnaire to obtain estimates of test-retest reliability for measures which were developed for this study or substantially modified. Eight weeks after completing the initial questionnaire (Time 3), 283 of these students (87 males, 196 females) returned to a final 10 minute session and completed the follow-up questionnaire, which included only measures of demographic variables and physical activity. The participants obtained course credits for participating in each of the three sessions. In addition, for attending the 8-week follow-up session (Time 3), participants were offered coupons from local vendors and were entered in a raffle for small prizes (e.g. ice cream, pizza). Participants were contacted both by phone and by e-mail as a reminder to attend the Time 1 and Time 3 sessions, and by e-mail as a reminder to attend the Time 2 session. All three sessions took place in the same classroom at Virginia Tech and involved completing the questionnaires. To ensure confidentiality, each participant's questionnaire was assigned a unique identification number. Prior to completing all questionnaires, participants were also given a consent form and informed that they could withdraw from the study at any time, without loss of course credit.

Measures

The latent variables included in the initial model were gender, social support, self-efficacy, self-regulation, outcome expectations, and physical activity at the 8-week follow-up. Multiple measures were used to assess all latent social-cognitive and physical activity variables in this study, with the exception of social support, for which only one appropriate measure was found.

Demographic Variables. Information on gender, age, race, and body-mass index (calculated as weight in kilograms divided by height in meters, squared) were obtained from the questionnaires to provide background data on the sample. Since previous studies have suggested that gender may influence participation in physical activity (Craig, Goldberg, & Dietz, 1996; Troped & Saunders, 1998), gender was included in the model as a single-item indicator.

Social Support. Social support was measured with the 5-item Friend Support for Exercise Habits Scale (Sallis, Grossman, Pinski, Patterson, & Nader, 1987). This scale was modified to assess social support during the past month, whereas the original scale assessed social support during the past 3 months. Items assessed the extent to which participants received social support from their friends (e.g. "Exercised with me"; "Offered to exercise with me"). Participants rated each item on a scale ranging from 1 (*never*) to 5 (*16 or more times*). The internal consistency of the modified social support scale was high (alpha = .91) and the scores were stable over time ($r_{test-retest}$ = .88).

Self-Efficacy. The latent variable self-efficacy was measured with two subscales from the 12-item Self-Efficacy for Exercise Behaviors Scales (Sallis, Pinski, Grossman, Patterson, & Nader, 1988). The 7-item "making time for exercise" subscale assessed self-efficacy for scheduling and maintaining a regular exercise routine (e.g. "Get up early, even on weekends, to exercise"). The 5-item "resisting relapse" subscale assessed self-efficacy for continuing a regular exercise program in the face of other competing demands (e.g. "Stick to your exercise program when you have excessive demands at work"). Participants rated items for both subscales on a 5-point Likert scale ranging from 1 (*I know I cannot*) to 5 (*I know I can*). The internal consistency was adequate for the "making time for exercise" subscale (alpha = .78), and good for the "resisting relapse" subscale (alpha = . 84).

Self-Regulation. The latent variable self-regulation was measured by the Exercise Goal-Setting Scale (EGS) and the Exercise Scheduling and Planning Scale (EPS), which were developed by the authors for this study. Items for the EGS were generated from a pilot study questionnaire in which participants were asked questions about their current exercise goals, through consultation with an exercise-science expert, and from a chapter on goal-setting strategies (Weinberg, 1996). Items for the EPS were generated from the pilot study questionnaire in which participants self-reported how they typically schedule their exercise. Participants rated the initial 14 EGS items and the initial 12 EPS items on a 5-point scale ranging from 1 (*does not describe*) to 5 (*describes*

completely). Exploratory factor analyses with oblique rotation were conducted to investigate the factor structure of the items in each scale. Examination of the scree plot and the eigenvalues for the EGS scale and the EPS scale suggested that each scale represented a single factor—one EGS factor and one EPS factor. These single factor scales were confirmed in subsequent confirmatory analyses. All items with factor loadings of .40 and above were retained (Table 1), resulting in an 11-item EGS scale and a 10-item EPS scale. Each scale exhibited good internal consistency (alpha $_{(EGS)}$ = .89; alpha $_{(EPS)}$ =.87) and the scores on the scales were stable over time ($r_{test\text{-}retest}$ = .87 and .89 respectively).

Place Table 1 About Here

Outcome Expectations. The latent variable outcome expectations was measured with an expanded set of items based on the Benefits of Physical Activity (BPA) Scale (Sallis, Hovell, Hofstetter et al., 1989) and with the Physical Activity Enjoyment Scale (Kendzierski & DeCarlo, 1991). The 14-item BPA Scale which assessed positive outcome expectations from physical activity (e.g. “I will improve my health or reduce my risk of disease”) was supplemented with 15 items created by the authors to assess negative outcome expectations from physical activity (e.g. “My muscles will feel sore”). Participants rated each of the positive and negative outcome expectations on a scale ranging from 1 (*Not at all likely*) to 5 (*Extremely likely*). In addition, participants provided a measure of outcome value by rating the personal importance of each of these positive and negative outcome expectations on a 5-point scale ranging from 1 (*Not at all important*) to 5 (*Extremely important*). Participants’ ratings of the positive and the negative outcome expectation items were multiplied by their corresponding ratings of the outcome’s value to obtain a rating of valued outcome expectations for each item. Factor analysis of the valued outcome expectations items indicated that there were two reliable factors: valued positive outcome expectations and valued negative outcome expectations. All items with factor loadings of .40 and above were retained. The resulting 12-item valued positive outcome expectations subscale and the 13-item valued negative outcome expectations subcale exhibited good internal consistency (alpha = .89 and .81 respectively) and the scores were stable over time ($r_{test\text{-}retest}$ = .86 and .81 respectively).

The Physical Activity Enjoyment Scale (PACES), used as a third measure of outcome expectations, assessed the extent to which participants expected to enjoy engaging in physical activity. Participants rated each of the 18 items on a 7-point scale ranging from 1 (*I enjoy it*) to 7 (*I hate it*). The internal consistency of the PACES measure was high (alpha = .93).

Physical Activity. The latent variable physical activity was measured with a stage of change instrument, by the number of times per week participants reported engaging in vigorous physical activity, and by the total energy expended in kilocalories over a seven-day period. The stage-of-change instrument (Marcus, Niaura, Selby, & Rossi, 1992) assessed participants' general level of exercise participation. Participants indicated which of five exercise stages—precontemplation, contemplation, preparation, action, and maintenance, best described their level of physical activity. The items ranged from Precontemplation ("I currently do not exercise and I do not intend to start exercising in the next 6 months") to Maintenance ("I currently exercise regularly and have done so for longer than 6 months"). The kappa index of reliability for the stage of change instrument over a 2-week period was .78 (Marcus, Rakowski, & Rossi, 1992), suggesting that this scale exhibits adequate stability over time.

Participants also completed the Aerobics Center Longitudinal Study Physical Activity Questionnaire (Kohl, Blair, Paffenbarger, Macera, & Kronfield, 1998) which measured the average duration and frequency of participants' participation in a variety of activities. Originally designed to measure physical activity over the past three months, this questionnaire was modified to assess physical activity over the past seven days. The two scores derived from this measure, the number of times per week participants typically engaged in vigorous activity (one item), and the total energy expended in kilocalories over a seven day period (assessed using the activity categories of walking, running, treadmill, bicycling, swimming, aerobic dance, moderate sports, vigorous racquet sports, other vigorous sports, other activities, and weight training) , exhibited adequate stability over time ($r_{test\text{-}retest}$ = .72 and .78 respectively).

RESULTS

We conducted the analysis in three steps. First, estimation procedures in structural equation modeling typically assume normal distributions for continuous variables (Kline, 1998). Therefore, analyses were conducted to examine the presence of outliers, skewness, and kurtosis for the two open-ended, frequency measures in the model, namely, times per week engaged in vigorous exercise, and number of kilocalories expended over a seven-day period. Because each of these measures had a significant number of outliers that met the criteria of being more than three standard deviations away from the mean (Kline, 1998), a logarithmic transformation (Log-10) was performed on each of these measured variables. Scale means were computed for all multi-item scales and all measured variables were standardized (z-scores). The correlation matrix (Table 2) and standard deviations of the standardized measured variables (listwise deletion of missing data) were then entered into Lisrel 8.3 to do structural equation analysis of the proposed model.

Place Table 2 About Here

In the second step of the analysis, the measurement portion of the model, which examines how adequately the measures represent each latent variable, was tested (Joreskog & Sorbom, 1993). In the third step of the analysis, the structural model representing the hypothesized relationships between the latent variables was examined. Maximum likelihood estimation was used to evaluate the fit of the measurement and the structural models to the empirical data. Acceptable model fit is generally indicated by a χ^2/df ratio of less than 3 (Kline, 1998), a GFI and AGFI greater than .90, and a RMSEA not significantly greater than .05 (Schumacher & Lomax, 1996). The fit indices of model AIC and model CAIC are also useful as they indicate the extent to which the model is parsimonious, with lower values indicating greater parsimony (Joreskog & Sorbom, 1993). The initial fit of the model was tested and then trimmed through standard procedures including examination of the modification indices for reducing restrictions on the model.

Descriptive Statistics. The initial sample of 353 participants had a mean age of 19.6 (SD = 1.39); 69% was female. Participants were largely Caucasian (84%); 7% were Asian, 3% were African

American, 1% were Native American, 2% were Latina, and 4% categorized themselves as being from “other” racial/ethnic background.

The initial sample had a fairly lean mean body-mass index of 22.7 (SD = 3.27) and was fairly active. Two percent were in the precontemplation stage of exercise, 9% were in the contemplation stage, 34% were in the preparation stage, 20% were in the action stage, and 35% were in the maintenance stage. Participants engaged in vigorous exercise a mean of four times per week and expended a mean of 2394 kilocalories from physical activity during the seven-day period preceding assessment. The Time 3 sample at the 8-week follow-up (n = 283) did not differ significantly from the initial sample (ANOVA or Chi-Square, alpha = .05) on any variable except stage of exercise change, for which the follow-up sample was slightly more active. The largest differences from the initial to the follow-up sample occurred in the contemplation and preparation stages. Of the initial sample, 9.4% were in the contemplation stage compared to 7.5% percent in the follow-up sample. In addition, 33.5% of the initial sample was in the preparation stage, compared to 36% of the follow-up sample. Although statistically significant, these differences do not appear to be meaningful. The means and standard deviations for all measured variables are shown in Table 2.

Testing the model. First the measurement component of the model was evaluated. For the two single-item indicators in the model, estimates of error associated with the measure were set according to accepted procedures. For gender, we assumed zero percent error variance since there was a perfect correspondence between gender assessed at Time 1 and Time 3. For social support, the error variance was set at 9 % (1 minus alpha).

The initial test of the measurement model indicated a questionable fit to the data (χ^2 (41, N=277) = 143.23, p = 0.00, GFI = .92, AGFI = .85, RMSEA = .095). Modification indices for parameters consistent with theory indicated fit could be improved by freeing the correlation between the measurement errors of the valued positive outcome expectations scale and the valued negative expectations scale, and between the measurement errors of the times/week and kilocalories/week physical activity measures. Making these modifications did improve the fit so that all fit statistics indicated a good fit to the data. Standardized factor loadings in the measurement model were all statistically significant and were of adequate size, ranging from .50 to .95. The moderate to large factor loadings indicated that the constructs were measured with adequate internal consistency. All of the factor loadings were above the minimum factor loading

sizes recommended prior to interpretation in factor analysis (Gorsuch, 1983). Fit statistics indicated that the fit of the measurement model was acceptable (χ^2 (39, N=277) = 97.24 ($p < .001$), χ^2/df = 2.49, GFI = .95, AGFI = .89, RMSEA = .071).

Since the fit statistics from the measurement model indicated that the measures adequately represented each latent variable, we then proceeded to test the structural model.

Initial Model. In the initial structural model tested, gender predicted social support, self-efficacy, self-regulation, outcome expectations, and physical activity. In turn, social support predicted self-efficacy, self-regulation, outcome expectations, and physical activity. Self-efficacy predicted self-regulation, outcome expectations, and physical activity; self-regulation predicted outcome expectations and physical activity; and outcome expectations predicted physical activity. The causal ordering of the latent variables was based on social-cognitive theory (Bandura, 1997). The fit statistics for the initial structural model were similar to those of the final measurement model.

Intermediate Model. Examination of the beta weights in the initial model revealed that the model could be made more parsimonious by eliminating gender, since gender did not significantly predict any other variable in the model ($\beta < .10$ and $p > .05$). We re-tested the model without the gender variable and obtained improved indicators of parsimony, (Model AIC = 133.55, Model CAIC = 286.15) compared to the initial model (Model AIC = 172.02, Model CAIC =352.36). In addition to a more parsimonious model, this modification resulted in improved model fit (χ^2 (33, N = 277) = 70.96 ($p < .0001$), χ^2/df = 2.2, GFI = .96, AGFI = .91, RMSEA = .062).

Final Model. One last theoretically consistent adjustment was made to the model to narrow the influence of social support. Social support did not significantly predict any variable in the model except self-efficacy. In that social support is viewed in social-cognitive theory as a source of self-efficacy, (Bandura, 1997) it was theoretically consistent to further increase the parsimony of the model by eliminating all non-significant paths less than .10 from social support to the other social-cognitive and physical activity variables. The fit statistics for the final model indicated acceptable fit of the model to the empirical data with enhanced parsimony (χ^2 (36, N = 277) = 76.12, $p < .0001$, χ^2/df = 2.1, GFI = .95, AGFI = .92, RMSEA = .061 [CI = .040 to .081], Model AIC =132.60, Model CAIC = 271.32). The final model explained 51% of the variance in physical activity at 8-week follow-up (r^2, $p < .001$).

Place Figure 1 About Here

Figure 1 illustrates the final model. Higher levels of social support for exercise were directly associated with higher levels of self-efficacy for making time for exercise and for resisting relapse from exercise ($\beta_{direct} = .38$, $p < .001$). In turn, higher levels of self-efficacy directly resulted in higher levels of self-regulation ($\beta_{direct} = .92$, $p < .001$) and higher levels of outcome expectations ($\beta_{direct} = .62$, $p < .05$). However, self-efficacy did not directly predict physical activity ($\beta_{direct} = .11$). Self-efficacy was indirectly associated with physical activity through self-regulation and outcome expectations. The indirect effect of self-efficacy on physical activity (mediated by self-regulation and outcome expectations) was significant ($\beta_{indirect} = .57$, $p < .05$). Self-regulation was the only variable in the model that directly predicted physical activity ($\beta_{direct} = .49$, $p < .05$).

Self-efficacy had the greatest significant total effect on physical activity ($\beta_{total} = .68$, $p < .001$) largely through its significant association with self-regulation. Social support also exhibited a significant total effect on physical activity ($\beta_{(total\ and\ indirect)} = .26$, $p < .001$) mediated entirely by self-efficacy. The total effect of self-regulation ($\beta_{total} = .52.$, $p < .05$) was not significantly mediated by outcome expectations, which had the smallest total effect on physical activity ($\beta_{total} = .15$, non-significant).

DISCUSSION

The purpose of this study was to test a theoretical model of the relationship between social-cognitive variables and physical activity. The most prominent social-cognitive variables—social support, self-efficacy, self-regulation, and outcome expectations, were examined in relation to three measures of physical activity: stage of exercise change, times per week engaged in vigorous activity, and energy expended in kilocalories. The overall model provided a good fit to the data and explained 51 percent of the variance in physical activity at 8-week follow-up. This compares favorably to previous studies investigating predictors of physical activity in adult populations in which the variance explained in physical activity ranged from approximately 11 to 38 percent (Armstrong, Sallis, Hovell, & Hofstetter, 1993; McAuley, 1992; Sallis, Hovell, Hofstetter, & Barrington, 1992; Sallis, Hovell, Hofstetter, et al., 1989). This result is also comparable to a more recent cross-sectional study which investigated the effects of 22 variables on physical activity in children (Sallis, Prochaska, Taylor, Hill, & Geraci, 1999). The percentage of variance explained in physical activity ranged from 18 percent for boys in Grades 4 to 6 to 59 percent for girls in Grades 10 to 12.

Our study expanded on previous research by investigating the role of self-regulation in predicting physical activity. Previous studies investigating predictors of physical activity have had difficulty assessing self-regulatory skills such as goal-setting and planning because of the lack of scale-development in this area. We developed two scales to measure self-regulation, one scale for goal-setting strategies, and one scale for exercise planning and scheduling. Each scale showed good internal consistency and stability over time, and each exhibited strong predictive validity. Moreover, self-regulation was the only variable in the model which directly predicted physical activity. The strong relationship between self-regulation and physical activity extends previous research which has highlighted the importance of such self-regulatory skills as goal-setting, planning, and self-monitoring for promoting long-term maintenance of behavior (Weber & Wertheim, 1988; Winett, Whiteley, Rovniak et al., 1999). The findings suggest that self-regulation may be a critical variable to target in exercise interventions.

Why should self-regulatory skills be predictive of exercise behavior? Bandura (1997), suggests that when people set valued goals, they often become highly involved in tracking their progress in relation to some personal standard. The achievement of subgoals produces personal satisfaction, which leads to enhanced motivation for continuing exercise. Cziksentmihalyi

(1999) expanded on this explanation, suggesting that setting challenging goals and plans results in an experience called “flow”, in which personal skills and task challenges are optimally balanced. As a result, activities are experienced as engrossing and enjoyable. Deci (1995) suggested that in addition to enhancing intrinsic interest, goals and plans may be especially predictive of behavior because they often follow forethought about one’s reasons for engaging in an activity. Therefore, when goals and plans are developed, they often have personal meaning and significance, which enhances motivation to persevere with an activity. All of these explanations suggest a common theme: self-regulatory processes may lead to more active mental and emotional involvement in physical activity, through which activities are experienced as meaningful, enjoyable, engrossing, and challenging.

Contrary to previous findings, self-efficacy did not directly predict physical activity. This may seem surprising, particularly since self-efficacy has been one of the most consistent predictors of physical activity (DuCharme & Brawley, 1995; Hofstetter, Hovell, & Sallis, 1990; McAuley & Courneya, 1993). However, an important difference between this study and previous studies was that in our theoretical model, self-regulation and outcome expectations were included as intervening variables between self-efficacy and physical activity. Self-efficacy exhibited strong direct relationships with both self-regulation and outcome expectations. These two variables, especially self-regulation, mediated the effect of self-efficacy on physical activity, suggesting that the relationship between self-efficacy and physical activity is indirect. It may be that self-efficacy gives people the confidence to initiate exercise, but self-regulatory processes are essential to maintain it. In support of this hypothesis, in a study which looked at predictors of adherence to an exercise program (McAuley, 1992), self-efficacy predicted frequency of exercise at the beginning of an exercise program, but not at the end. It is likely that self-efficacy is a necessary condition for engaging in regular physical activity; but not a sufficient condition. As people attempt to adopt regular exercise, self-regulatory strategies may become increasingly important.

Although self-efficacy did not directly predict physical activity, self-efficacy had the strongest total effect on physical activity in the model, largely through its significant association with self-regulation. Because self-efficacy is strongly related to self-regulation and outcome expectations, both of which predict physical activity, self-efficacy is an important variable to target in physical activity interventions.

An expanded outcome expectations measure which included valued positive and negative outcome expectations was developed for this study, and administered along with a measure of exercise enjoyment (Kendzierski & DeCarlo, 1991). Although the outcome expectation measures did not significantly predict physical activity, a beta weight of .15, though small, may be considered a meaningful relationship, and would likely be significant in a larger population. The magnitude of the direct effect of outcome expectations on physical activity was comparable to other studies in which beta weights for this relationship have ranged from .08 to .24 (Sallis, Hovell, Hofstetter et al., 1989; Schneider, 1997). Although the effect of outcome expectations on physical activity was small, in cases where outcome expectations are based on insufficient knowledge, they may be easily modified. Thus, it may be worthwhile to include information about basic exercise principles and skills in exercise interventions.

Social support directly predicted self-efficacy, but not outcome expectations, self-regulation, or physical activity. Although no physical activity studies could be located which assessed the effect of social support on outcome expectations or self-regulation, in studies which have examined the relationship between social support and physical activity, the relationship has often been small (McAuley & Courneya, 1993). This is consistent with Bandura's (1997) prediction that social support should exert its strongest effect as a source of self-efficacy. Because the model suggests that social support may play an important role in initiating a sequence of processes leading to regular exercise, we believe that social support should also be targeted in exercise interventions.

It was interesting that all of the social-cognitive variables consistently exhibited a stronger relationship with the stage of change measure of physical activity, compared to the physical activity measures which assessed times per week engaged in vigorous activity and energy expended in kilocalories. The magnitude of the zero-order correlations between the social-cognitive variables and physical activity decreased in a linear fashion from the most general measure of physical activity (stage of change) to the most specific measure of physical activity (kilocalories). This finding is also very consistent with a previous study (McAuley, 1993) which included a general measure of "overall exercise behavior" and more specific measures of weekly and weekday energy expenditure. Self efficacy significantly predicted overall exercise behavior, but did not significantly predict weekly or weekday energy expenditure. It may be that many people find it easier to conceptualize their exercise behavior in

terms of general patterns of exercise participation, rather than in terms of the frequency and duration associated with specific activities (which were used to calculate energy expended in kilocalories). In addition, the more specific physical activity measures had higher recall demands, which can increase error (Durante & Ainsworth, 1996). General measures of exercise participation, which are based more on semantic memory and less on episodic memory, may have less error, and thus be more reliably associated with social-cognitive predictors (Durante & Ainsworth, 1996).

A limitation of the present study is that it mainly assessed individual-level variables. To account for the other 49 percent of the variance in physical activity not explained by this study, it may be necessary to assess the impact of broader societal level variables such as cultural norms for exercising, and norms within key social reference groups (Bandura, 1997). In addition, behaviors are more likely to be performed on a regular basis when they are socially institutionalized (Bandura, in press). For example while the "lunch break" is socially institutionalized and an acceptable part of the working day, most institutions have not yet established a scheduled "exercise break".

A second limitation of the study is that the sample was composed of university students who were predominantly Caucasian with relatively lean body mass indexes, and a higher mean level of exercise participation, than generally exists in a national adult samples. Therefore, the results of this study may not generalize to more diverse groups of individuals. This will need to be explored with other samples. However, an understanding of the determinants of physical activity in university students is important, because exercise participation often shows its most significant decline in early adulthood (Sallis, Calfas, Nichols, et al., 1999). By understanding which variables predict physical activity in this population, it may be possible to develop interventions which can prevent the precipitous drop-off in exercise participation that is often seen in young adults (Sallis et al., 1999).

Strengths of this study include the use of reliable and valid measures, the use of a structural equation modeling approach in which variables were arranged in a theoretical order, and direct, indirect, and total effects assessed, and the prospective design of the study.

The results help to clarify the pattern of relationships among social-cognitive variables and physical activity. They suggest that social support influences people's self-efficacy for exercising, that self-efficacy, in turn, influences people's self-regulatory strategies and expected

outcomes, and that engaging in the self-regulatory processes of planning and goal-setting, produces increased physical activity participation. The prospective data also suggest that these social-cognitive variables causally precede the performance of physical activity. Therefore, modification of these variables in an intervention may increase levels of exercise participation.

For many, the path to adopting regular exercise is fraught with frequent lapses and relapses (Sallis, Hovell, Hofstetter, et al., 1990; Simkin & Gross, 1994; Stetson, Rahn, Dubbert, Wilner, & Mercury, 1997). Physical aches and pains, fatigue and stress, and heavy work, family, and social demands may all make it difficult to sustain regular exercise. Those who can consistently plan around these obstacles, set goals, and persevere, even in the face of significant difficulties, may be more successful in incorporating regular exercise into their daily lives.

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Table 1

Scale Items and Factor Loadings for Self-Regulation Measures

Scale Item	*Factor Loading*
Exercise Goal-Setting Scale	
1. I often set exercise goals.	.83
2. I usually have more than one major exercise goal.	.75
3. I usually set dates for achieving my exercise goals.	.66
4. My exercise goals help to increase my motivation for doing exercise.	.77
5. I tend to break more difficult exercise goals down into a series of smaller goals.	.64
6. I usually keep track of my progress in meeting my goals.	.75
7. I have developed a series of steps for reaching my goals.	.72
8. I usually achieve the exercise goals I set for myself.	.73
9. If I do not reach an exercise goal, I analyze what went wrong.	.64
10. I make my exercise goals public by telling other people about them.	.58
11. My exercise goals tend to focus on improving my appearance and/or performance.	.45
Exercise Planning and Scheduling Scale	
1. I never seem to have enough time to exercise.*	.57
2. Exercise is generally not a high priority when I plan my schedule.*	.73
3. Finding time for exercise is difficult for me.*	.65
4. I schedule all events in my life around my exercise routine.	.73
5. I schedule my exercise at specific times each week.	.79
6. I plan my weekly exercise schedule.	.80
7. When I am very busy, I don’t do much exercise.*	.68
8. Everything is scheduled around my exercise routine—both classes and work.	.65
9. I try to exercise at the same time and same day each week to keep a routine going.	.70
10. I write my planned activity sessions in an appointment book or calendar.	.45

* reversely scored items.

Table 2

Correlations, Means, and Standard Deviations for Measured Variables (N = 277)

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. Gender[a,b]	__											
2. Social Support	.08	__										
3. Self-Efficacy (Time)	.04	.30**	__									
4. Self-Efficacy (Relapse)	.07	.26**	.70**	__								
5. Goals	.08	.35**	.54**	.44**	__							
6. Plans	-.007	.28**	.70**	.64**	.57**	__						
7. Positive outcomes	-.13*	.21**	.39**	.31**	.44**	.36**	__					
8. Negative outcomes	-.03	-.22**	-.48**	-.46**	-.23**	-.45**	-.13*	__				
9. Enjoyment	.02	.28**	.60**	.47**	.42**	.55**	.48**	-.51**	__			
10. Stage of exercise	.04	.29**	.56**	.49**	.41**	.58**	.38**	-.39**	.43**	__		
11. Times/week	.18**	.23**	.38**	.40**	.38**	.34**	.23**	-.25**	.27**	.60**	__	
12. Kilocalories/week	.22**	.20**	.31**	.29**	.30**	.30**	.14*	-.18**	.26**	.46**	.50**	__
M	0.31	2.57	3.76	3.32	2.95	2.66	16.77	6.52	5.59	3.75	4.19	2381.70
SD	0.46	1.16	0.74	0.86	0.86	0.89	4.65	2.88	0.95	1.11	3.03	2492.83

[a]Gender is coded 1 for males and 0 for females. [b]Correlation coefficients shown are Pearson product-moment correlations.
*p<.05 **p<.01

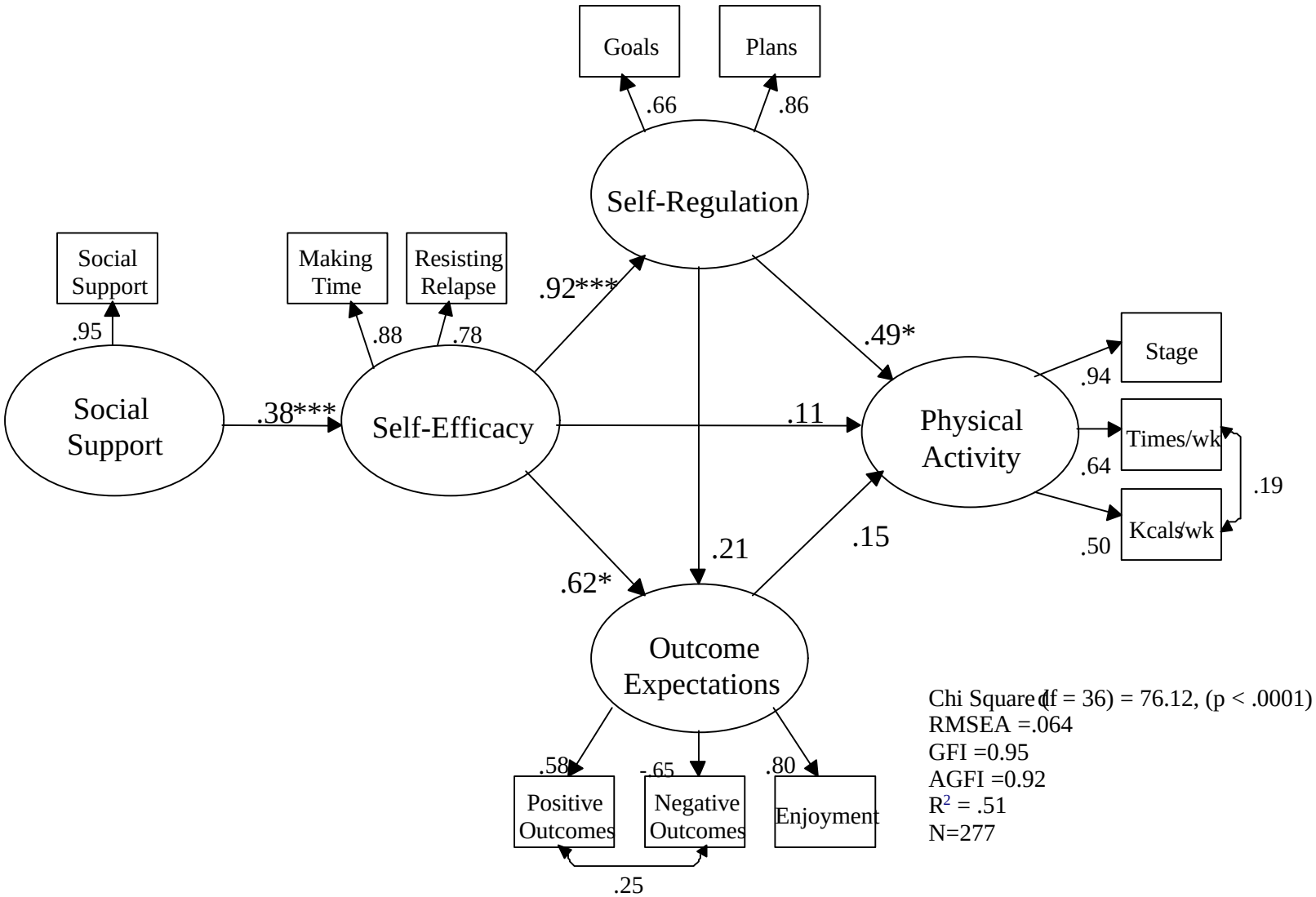

Figure 1 Final social-cognitive model of physical activity. Ovals designate latent variables; rectangles represent measures of latent variables. Parameter estimates are standardized. *p<.05 ***p<.001

Curriculum Vita

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Education

Virginia Polytechnic Institute and State University, Clinical Health Psychology, 1997-present
B.A., Psychology, with Distinction, McGill University, October, 1996
D.E.C., Liberal Arts Degree, with Honors, Dawson College, June 1993

Professional Affiliations and Organizations

American Psychological Association (student affiliate).
Association for the Advancement of Behavior Therapy (student affiliate).
Society of Behavioral Medicine (student affiliate).

Research Experience

Research Assistant, Department of Psychology, Virginia Tech, January 1999 to present. Responsibilities: Coordinated data collection to prepare for the clinical psychology program's site visit for reaccreditation. Designed a survey to track student outcomes; collected outcome data from current and former students, coordinated meetings with clinical psychology faculty and university officials; summarized and analyzed data; assisted in writing accreditation report; developed material to update clinical psychology program's web site. Supervisor: Richard A. Winett, Ph.D., 20 hours weekly.

Master's Thesis, Virginia Tech, September 1997 to December 1999. Responsibilities: Investigated predictors of regular physical activity among 277 university students, using a prospective design. Conducted structural equation modeling with LISREL 8.30 to analyze data. Developed reliable and valid measures of exercise self-regulation.

Research Assistant, Virginia Tech, Center for Research in Health Behavior, May 1998 to January, 1999. Responsibilities: Analyzed and coded outcome data from a web-based health behavior change intervention, designed physical activity component of web-based intervention; tailored web-based modules for boys and girls; researched physical activity outcome measures. Supervisors: Richard A. Winett, Ph.D., Jessica A.Whiteley, M.S., 20 hours weekly.

Research Assistant, Virginia Tech, Center for Research in Health Behavior, September 1 to September 30, 1997. Responsibilities: Administered web-based nutrition-education modules to female high school students and attended research meetings. Supervisor: Allison Roodman, M.S., 5 hours weekly.

Research Assistant, McGill University, Department of Psychology, September 1996 to July 1997. Responsibilities: Assisted in developing a meta-analysis on the effects of rewards on people's intrinsic motivation for an activity, searched research databases for information on several research projects, coded experimental data, pilot-tested research projects, data analysis using SPSS for Windows.

Supervisor: Richard Koestner, Ph.D., 8 hours weekly Sept. 1996 to Dec. 1996, 16 hours weekly, January 1997 to July 1997.

Independent Research Project, McGill University with Richard Koestner, Ph.D., September 1996 to July 1997. Responsibilities: Proposed an original project on exercise motivation, conducted the study at a fitness club, analyzed the data using SPSS for Windows, prepared a manuscript. *Research Assistant*, McGill University, Department of Psychology, May 1995 to July 1996. Responsibilities: Organized and produced an annotated bibliography covering approximately 150 articles on deafness, health, and mental health issues; prepared a written report. Supervisor: James MacDougall, Ph.D., 15 hours weekly.

Professional Experience

Psychology Intern, Center for Rehabilitative Medicine, Radford, VA, August 1999 to present. Co-lead psycho-educational group therapy for adults with chronic pain. Topics covered include pain education, relaxation training, stress management, cognitive therapy, sleep education, assertiveness training, problem solving, and goal-setting. Researched assessment instruments to improve intake procedures. Supervisor: Roy H. Crouse, Ph.D., 7 hours weekly.

Psychology Intern, Sleep Disorders Center of Southwest Virginia, Christiansburg, VA, June 1999 to July 1999. Completed sleep medicine training program. Received training in scoring sleep studies; observed sleep consultations; attended surgical meetings; administered sleep questionnaire to clients.

Practicum, Virginia Tech Psychological Services Center, September 1998 to May 1998. Conducted individual psychotherapy and assessments with adult clients using a cognitive-behavioral approach. Participated on a practicum team. Supervisors: George A. Clum, Ph.D., Lee D. Cooper, Ph.D., 10-15 hours hours weekly.

Practicum, Virginia Tech, Psychological Services Center, September 1997 to May 1997. Participated in a practicum team which involved observing, evaluating, and discussing a wide range of clientele seen at the Virginia Tech Psychological Services Center. Supervisors: Robert Stephens, Ph.D., Angela Scarpa, Ph.D., 22 hours weekly.

Peer Health Educator, McGill University, Student Health Services, September 1996 to April 1997. Responsibilities: Developed an electronic-mail hotline system to answer students' health questions, conducted health education seminars, assisted with health newsletter, 3 hours weekly.

Literacy Teacher, Reading Council for Literacy Advance in Montreal, September 1992 to June 1994. Responsibilities: Instructed English-speaking adults in basic reading and writing skills on a one-to-one basis, 2 hours weekly.

Introductory Psychology Office Assistant, Virginia Tech, Department of Psychology, August 1997 to May 1998. Responsibilities: answering students' questions both in person and through e-mail, photocopying, assisting in the creation of web-based psychology tutorials, word-processing documents, administering make-up exams. Supervisor: Dan LeBreton, 12 hours weekly.

Publications

Winett, R.A., Anderson, E.S., Whiteley, J.A., Wojcik, J., Winett, S.G., Rovniak, L., Graves, K.D., & Galper, D.I. (1999). Church-based health behavior programs: Using social cognitive theory to formulate interventions for at-risk populations. *Applied and Preventive Psychology, 8*, 129-142.

Winett, R.A., Roodman, A.A., Winett, S.G., Bajzek, W., Rovniak, L.S., & Whiteley, J.A. (1999). The effects of the Eat4Life internet-based health behavior program on the nutrition and activity patterns of high school girls. *Journal of Gender, Culture, and Health*, *4*(3), 239-254.

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Conference Presentations and Posters

Rovniak, L.S., Anderson, E.S., Winett, R.A., & Whiteley, J.A. (to be presented, April, 2000). *The Development of Measures to Assess Self-Regulation for Exercise: The Exercise Goal-Setting and Planning Scales*. Poster session to be presented at the 21st annual convention of the Society of Behavioral Medicine, Nashville, TN.

Rovniak, L., Finkelberg, D., & Koestner, R. (1998, August). *Rewards and Intrinsic Motivation: The Importance of Considering the Interest Level of the Activity*. Paper presented at the 106th annual convention of the American Psychological Association, San Francisco, CA.

Rovniak, L.S., & Winett, R.A. (1999, November). *Social-Cognitive Determinants of Exercise Participation: A Prospective Investigation.* Poster session presented at the 33rd annual convention of the Association for the Advancement of Behavior Therapy, Toronto, Canada.

Rovniak, L. (1998, April). *Strategies for Overcoming Exercise Barriers*. Poster session presented at the 2nd annual Virginia Collegiate Psychology Conference, Blacksburg, VA.

Whiteley, J., Psujek, J., Rovniak, L. (1998, April). *A New Measure to Assess Women=s Physical Activity Outcome Expectations*. Poster session presented at the 2nd annual Virginia Collegiate Psychology Conference, Blacksburg, VA.

Whiteley, J.A., Winett, R.A., Winett, S.G., Bajzek, W., Rovniak, L., & Williams, D. (1999, November). *The Application of Social Cognitive Theory to the Dissemination of Eat4Life: An Internet-Based Health Behavior Program for Rural Adolescents.* Poster session presented at the 33rd annual convention of the Association for the Advancement of Behavior Therapy, Toronto, Canada.

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References available upon request.