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Measuring Stage of Change for Exercise

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MEASURING STAGE OF CHANGE

FOR EXERCISE

BY

GABRIELLE RICHARDS REED

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE OF

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IN

PSYCHOLOGY

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Abstract

This project continues the development and refinement of the URICA-E2, an instrument to measure stage of change for regular exercise based on the Transtheoretical Model of Behavior Change. In Study One, the URICA-E2, which is a proportionate measure of stage of change, was analyzed using Principal Component Analysis and refined into a 24-item instrument capturing not five, but six components of change: Precontemplation-Non Believer (PCN), Precontemplation-Believer (PCB), Contemplation (C), Preparation (P), Action (A), and Maintenance (M). The standardized scale scores from the URICA-E2 were clustered and seven profiles were found. They duplicated the six components and added a seventh which was tentatively named Ambivalent (ABV). In Study Two, a series of models were tested using Confirmatory Factor Analysis in order to better understand the relationship between the stage constructs. Nine models were tested: two types of simplex, four types of circumplex, and three types of punctuated equilibrium. A circumplex model where the strongest relationships were found among the stages which are adjacent, alternate, and opposite was found to nearly mimic the exercise data. This supports the very common experience of people frequently relapsing and frequently restarting regular exercise. Study Three sought confirmation of the URICA-E2 by validating it against two short form staging algorithms, the Decisional Balance instrument, the Confidence instrument, and a measure of hours of exercise. The Single Question Algorithm was found to outperform the other algorithms. The profiles of the URICA-E2 demonstrated the

classic crossover of pros with cons around the Preparation stage. Confidence was seen to rise across the profiles.

In conclusion, it was found that the URICA-E2 is a multipurpose tool, well worth the effort required to use it. What other instrument could give you stages of change, profiles, and show a circumplex to be the best way to describe the relationship between the stages? For situations that demand a shorter staging instrument, the Single Question Algorithm has proved to be an instrument of choice. It has the advantage of simplicity, ease of administration, and it performs as well as, if not better than, its five question counterpart.

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To Jim Prochaska for the Transtheoretical Model and getting me to think about the relationships between the stages of change.

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Preface

Measuring Stage of Change for Exercise: Overview

Regular physical exercise plays a prominent role in health, contributing to both good health and disease reduction. Among its benefits, exercise reduces coronary heart disease by reducing obesity (Buskirk, 1986), improves blood lipid profiles (Haskell, 1984) and controls hypertension (Hagberg, 1990). It also reduces the risk of osteoporosis (Drinkwater, Nilson & Chestnut, 1989), reduces insulin dependence in diabetics (Siscovick, Laporte, & Newinan, 1985), improves immune system functioning (Calabrese, 1990), and alleviates depression (Harris & Associates, Inc., 1989). Exercise is recommended as an effective nonpharmacologic therapy for stress, sleep disorders, and constipation, as well as, the chronic conditions of aging, such as hypertension, obesity, diabetes mellitus, coronary heart disease, and hyperlipidemia, and therefore, may be particularly useful for elderly populations (Klingman & Pepin, 1992). Activity has also been found to be protective against colon cancer (Sternfeld, 1992).

Since the benefits of regular exercise are well established, the problem is how to get individuals to initiate and maintain a regular physical exercise program. The Transtheoretical Model of Behavior Change (Prochaska & DiClemente, 1983) is a theoretical model which describes the initiation and maintenance of healthful behavior changes. Investigating regular exercise from a Transtheoretical perspective will provide both a test for the theory and provide researchers interested in exercise more

accurate tools to measure a subject's stage of change and then match interventions to the appropriate stage. This should enhance the initiation and maintenance of regular exercise.

Choice of Definition

The field of exercise research is in flux over what should be the appropriate definition of a regular exercise program. Should the criteria be vigorous regular exercise as espoused by the American College of Sports Medicine (1989) or lifestyle exercise (Blair, S. N., August, 1993) which advocates more frequent, shorter bouts of exercise. An inclusive example of a definition of vigorous regular exercise used with a worksite sample is:

“Vigorous exercise is defined as: Regular exercise = 3 times or more per week for 20 minutes or longer. Exercise includes activities, such as brisk walking, jogging, swimming, aerobic dancing, biking, rowing, etc. Activities that are primarily sedentary, such as bowling or playing golf with a golf cart, would not be considered exercise.” (Marcus, Rakowski, & Rossi, 1992; Marcus, Rossi, Selby, Niaura, & Abrams, 1992; Marcus, Selby, Niaura, & Rossi, 1992; Marcus, Emmons, Abrams, Marshall, Kane, Etzel, & Novotny, 1992).

An example of a definition of moderate or lifestyle regular exercise is:

Physical activity or exercise means walking briskly, vacuuming, jogging, digging in the garden, climbing stairs, or any other physical activity where the exertion is similar to these.

Regular physical activity or exercise means accumulating 30 minutes or more in the above activities most days of the week. For example, you could take one 30-minute walk, jog, bike, swim or three 10 minute walks or 5 minutes of vacuuming, 10 minutes of walking, 10 minutes of digging in the garden, and 5 minutes of climbing stairs. (Blair, S. N., August, 1993).

In order to determine which definition of regular exercise to use in this study, a review of the established benefits of vigorous exercise resulted in 50 known benefits (see Table Preface - 1.).

Table Preface - 1. Fifty Benefits of Aerobic Exercise

BENEFIT	REFERENCES
Part I.	
EXERCISE INCREASES:	
Sleep	Klingman & Pepin, 1992
Well-being	Taylor, Sallis, & Needle, 1985
Self esteem	Sonstroem, Harlow & Josephs, 1994
Joy in life	Congdon, K. (1993)
Connectedness with the world	Congdon, K. (1993)
Perceptions of ones ability	Sonstroem, Speliotis,& Fava, 1992; Sonstroem, Harlow, Gemma & Osborne, 1991
Libido and sexual performance	Taylor , Sallis, & Needle, 1985
Ability to eat more and gain less	Wood, 1994
High density lipoproteins	Doshi, Hurley, Garrison, Stombaugh et al 1994; Wood, 1994
Respiratory capacity	Belman, Botnick, Nathan, & Chon,1994
Oxygen carrying capacity	Belman, Botnick, Nathan, & Chon,1994
Oxygen perfusion	Belman, Botnick, Nathan,& Chon,1994
Ventilatory muscle capacity	Belman, Botnick, Nathan,& Chon,1994
Efficiency and cardiovascular capacity	Morris, et al., 1980; Paffenbarger& Hyde 1984, 1986;
Stamina	Helm & Ellson, 1988
Flexibility of muscles and joints	Danner & Edwards, 1992; McMurdo & Burnett, 1992

(Table continues)

EXERCISE INCREASES:

Bone density

Tolerance of heat and cold

Dissipation of anger

Beta endorphin production

Bowel regularity

Insulin sensitivity

Number of insulin receptors

Insulin effectiveness

Glucose tolerance

The possibility that a NIDDM could
reduce the amount or no longer need
hypoglycemics

Prevention of NIDDM with physical
activity

Coronary circulation

Peripheral circulation

REFERENCES

- Drinkwater, Nilson, & Chestnut, 1989
Nelson, McIntyre, LaBrie, & Csiky,
1991; Pandolf, 1991
Szabo, Peronnet, Boudreau, Cote, et al.,
1993; Kubitz, & Landers, 1993
Morgan & O'Connor, 1988; Droste,
Greenlee, Schreck, & Riskamm, 1991;
Hamachek, 1986
Klingman & Pepin, 1992
Siscovick, Laporte, & Newman, 1985;
Sigal, Purdon, Bilinski, Vranic, Halter
& Marliss, 1994
Siscovick, Laporte, & Newman, 1985;
Sigal, Purdon, Bilinski, Vranic, Halter
& Marliss, 1994
Siscovick, Laporte, & Newman, 1985;
Siscovick, Laporte, & Newman, 1985;
Barnard, Ugianskis, Martin & Inkeles,
1992; Jennings et al. 1986
Siscovick, Laporte, & Newman, 1985;
Barnard, Ugianskis, Martin & Inkeles,
1992
Helmrich, Ragland & Paffenbarger,
1994
Haskell, Leon, Caspersen, Froelicher et
al, 1992
Haskell, Leon, Caspersen, Froelicher et
al, 1992

EXERCISE INCREASES:

Collateralization around blockages

Fibrinolysis

Red cell mass and blood volume

Stroke volume and cardiac output

The chance of surviving a second myocardial infarction

Part II.

EXERCISE DECREASES:

Low density lipoproteins

Triglycerides

Serum cholesterol

Problems with hemoconcentration

Platelet adhesion

Embolic and thrombotic incidences

Risk of coronary heart disease

Inappropriate catecholamine response to stress

The perception of effort upon exertion

Dysrhythmia

Dyspnea

REFERENCES

Haskell, Leon, Caspersen, Froelicher et al, 1992

Haskell, Leon, Caspersen, Froelicher et al, 1992

Haskell, Leon, Caspersen, Froelicher et al, 1992

Froelicher, 1987

Shephard, 1992

REFERENCES

Doshi, Hurley, Garrison, Stombaugh et al 1994; Wood, 1994

Barnard, Ugianskis, Martin & Inkeles, 1992

Wood, 1994

Haskell, Leon, Caspersen, Froelicher et al, 1992

Haskell, Leon, Caspersen, Froelicher et al, 1992

Haskell, Leon, Caspersen, Froelicher et al, 1992

Morris et al., 1980; Paffenbarger, 1986

Dienstbier, LaGuardia, Barnes, Tharp et al., 1987

McAuley, & Courneya, 1992

Belman, Botnick, Nathan, & Chon, 1994

Belman, Botnick, Nathan, & Chon, 1994

EXERCISE DECREASES:

Depression

Illness and absences from work

Inappropriate hospitalizations

Bone demineralization

Risk of colon cancer

REFERENCES

Harris & Associates, 1989

Shephard, 1992

Siscovick, Laporte, & Newman, 1985;

Aloia et al., 1978; Dalen & Olsson,

1974; Krolner & Taft, 1983

Sternfeld, 1992; Lee &

Paffenbarger, 1994

Because vigorous aerobic exercise has been shown to account for these beneficial increases and decreases, and it is still unknown how many of these changes can be accounted for by lifestyle exercise, vigorous regular exercise has been chosen as the criterion in the development of a staging measure for stage of change.

Staging Measure for Stage of Change

The measure tested was based on the University of Rhode Island Change Assessment (URICA) (McConaughy, Prochaska, & Velicer, 1983; McConaughy, DiClemente, Prochaska, & Velicer, 1989) and the University of Rhode Island Change Assessment for Exercise (URICA-E1) adapted for exercise by Bess Marcus for a worksite study and analyzed by this author (Reed, Velicer, Rossi, & Marcus, 1993, August; 1994, March). The URICA and the URICA-E1 both measured four scales that represent Precontemplation (PC), Contemplation (C), Action (A), and Maintenance (M). In early work and again in more recent work, the Transtheoretical Model has been conceptualized as including five stages of change (Velicer, Prochaska, Rossi & Snow, 1992): Precontemplation (PC), a stage where no change in behavior is planned for at least the next six months; Contemplation (C), where change is planned within the next six months; Preparation (P), where change is planned in the next 30 days and some type of action has been attempted in the last year; Action (A), where change has begun and has been sustained for less than six months; and Maintenance (M), where change has been maintained for longer than six months.

Brief Description of Study

In Study One, a revised version of the URICA-E1 was developed, the URICA-E2. The URICA-E2 added a fifth stage, Preparation, to the four stages of Precontemplation, Contemplation, Action, and Maintenance found in the URICA and URICA-E1. The URICA-E2 also attempted to clear up a confusion that appeared in URICA-E1 between Precontemplation and Maintenance and to improve the item content.

In Study One, URICA-E2 was administered to an adult sample of convenience and was then analyzed using Principal Component Analysis (PCA) in replication of the work done by McConnaughy et al. (1983) and McConnaughy et al. (1989). Upon examination it was found that not only had Preparation been added to Precontemplation, Contemplation, Action, and Maintenance, but Precontemplation had split in two giving a six component solution.

Validation of this six component model was done using Confirmatory Factor Analysis (CFA) (Bentler, 1989; Joreskog & Sorbom, 1989). Fifteen models were tested. The correlated six-factor model proved to have the best fit.

PCA was then used to refine the instrument to a more parsimonious version. A 24 item version with four items per construct was chosen. To validate the parsimonious version, a CFA was then done using the same items. These items were then used to form standardized scale scores. These standardized scale scores were used in a cluster analysis to determine if discrete subtypes exist with respect to the stages of change for exercise. Seven profiles were found and named. Each of the six profiles

corresponded to a single stage of change and the seventh was a complex profile labeled Ambivalent.

In Study Two, using the data from Study One, possible second-order models were evaluated using Confirmatory Factor Analysis. These second-order models included investigating two versions of simplex models (Guttman, 1954), four versions of circumplex models (Guttman, 1954;), and finally three models representing the theory of Punctuated Equilibrium (Gersick, 1991). The series of Punctuated Equilibrium models represented three versions of where the revolutionary punctuations might occur in the six components of change.

In Study Three, the URICA-E2 was validated against external instruments from the Transtheoretical Model of Behavior Change: two short form staging algorithms, the Pro and Cons of regular exercise (Marcus, Rakowski, & Rossi, 1992), the Confidence instrument (Marcus, Selby, Niaura, & Rossi, 1992), and a self-report measure of time spent exercising (Blair, 1984; Taylor et al., 1984, Sallis et al., 1985).

TABLE OF CONTENTS

ABSTRACT	ii
ACKNOWLEDGMENTS.....	iv
PREFACE	v
MEASURING STAGE OF CHANGE FOR EXERCISE: OVERVIEW.....	v
STAGING MEASURE FOR STAGE OF CHANGE.....	xii
TABLE OF CONTENTS	xv
LIST OF TABLES.....	xxi
LIST OF FIGURES.....	xxiii
STUDY ONE: INSTRUMENT DEVELOPMENT AND TYPOLOGY.....	1
PRACTICAL IMPLICATIONS.....	2
WHY IS STAGE IMPORTANT FOR EXERCISE?	2
IMPORTANCE OF A CONTINUOUS MEASURE OF STAGE	3
SEQUENTIAL INSTRUMENT DEVELOPMENT	4
INSTRUMENT	5
TYPOLOGIES	7
METHOD.....	9
PILOT STUDY.....	9
SUBJECTS	10
PROCEDURE.	10
RESULTS.....	13

FREQUENCIES.....	13
PRINCIPAL COMPONENT ANALYSIS (PCA).....	13
<i>Component One</i>	14
<i>Component Two</i>	14
<i>Component Three</i>	14
<i>Component Four</i>	15
<i>Component Five</i>	15
<i>Component Six</i>	15
CONFIRMATORY FACTOR ANALYSIS (CFA-REPLICATION):MODEL TESTING.....	17
PCA ITEM REDUCTION.	19
CLUSTER ANALYSIS	23
<i>Precontemplation-Non Believers (PCN)</i>	23
<i>Precontemplation-Believers (PCB)</i>	25
<i>Contemplation (C)</i>	27
<i>Preparation (P)</i>	29
<i>Ambivalent (ABV)</i>	31
<i>Action (A)</i>	33
<i>Maintenance (M)</i>	35
DISCUSSION	37
CONCLUSIONS.	39
STUDY TWO	41
INTRODUCTION.....	41
SIMPLEX MODEL	41
<i>Description of a simplex</i>	41
<i>Examples of applications of a simplex</i>	42
<i>How a simplex is appropriate to the stage model</i>	44

CIRCUMPLEX MODEL	50
<i>Description of a circumplex</i>	50
<i>Examples of applications of a circumplex</i>	52
<i>How a circumplex is appropriate to the stage model</i>	56
PUNCTUATED EQUILIBRIUM.....	61
<i>Description of Punctuated Equilibrium</i>	61
<i>Examples of applications of Punctuated Equilibrium</i>	62
<i>How Punctuated Equilibrium is appropriate to the stage model</i>	64
RECAPITULATION OF PRELIMINARY ANALYSES	75
STAGES OF CHANGE	76
THE URICA-E2	76
METHOD	78
SUBJECTS	78
PROCEDURE	78
RESULTS	83
DISCUSSION	91
STUDY THREE	95
INTRODUCTION	95
THE TRANSTHEORETICAL MODEL.....	95
DEPENDENT MEASURES	97
<i>Decisional Balance for Regular Exercise</i>	97
<i>Confidence For Regular Exercise</i>	97
<i>Hours of Regular Exercise</i>	98
MEASURES OF STAGE OF CHANGE	98

<i>Single Question Algorithm of Vigorous Exercise</i>	<i>98</i>
<i>Continuous Measure for Stage of Change.....</i>	<i>98</i>
METHOD.....	98
SUBJECTS	98
PROCEDURE	99
INSTRUMENTS	99
<i>URICA-E2.....</i>	<i>99</i>
<i>Single Question Algorithm for regular exercise</i>	<i>100</i>
<i>Decisional Balance for regular exercise</i>	<i>100</i>
<i>Confidence for regular exercise</i>	<i>101</i>
<i>Hours of regular exercise</i>	<i>101</i>
ANALYSIS.....	101
STAGES: DISCRETE VERSUS CONTINUOUS.....	101
<i>Cross Classification: Profiles by Single Question Algorithm.....</i>	<i>101</i>
DISCRIMINANT FUNCTION ANALYSIS.....	102
<i>Scale Scores by Single Question Algorithm.....</i>	<i>102</i>
<i>Twenty Four Items by Single Question Algorithm.....</i>	<i>102</i>
STAGE BY DEPENDENT MEASURES	102
STAGE BY HOURS OF EXERCISE	102
<i>Profiles by Hours of Exercise</i>	<i>103</i>
<i>Single Question by Hours of Exercise</i>	<i>103</i>
STAGE BY DECISIONAL BALANCE	103
<i>Profiles by Decisional Balance.....</i>	<i>103</i>
<i>Single Question by Decisional Balance.....</i>	<i>103</i>
STAGES BY CONFIDENCE.....	103
<i>Profiles by Confidence.....</i>	<i>103</i>

<i>Single Question by Confidence</i>	104
EFFECT SIZE	104
RESULTS	104
STAGE : DISCRETE VERSUS CONTINUOUS.....	104
<i>Cross Classification: Profiles by Single Question</i>	104
<i>Discriminant Function Analysis : Scale Scores to Single Question Algorithm</i>	107
<i>Discriminant Function Analysis: Twenty Four Items to Single Question Algorithm</i>	111
STAGE BY DEPENDENT MEASURES	115
STAGE BY HOURS.....	116
<i>Profiles by Hours of Exercise</i>	116
<i>Single Question by Hours of Exercise</i>	119
STAGE BY DECISIONAL BALANCE	121
<i>Profiles by Decisional Balance</i>	121
<i>Single Question by Decisional Balance</i>	124
<i>Profiles by Confidence</i>	127
<i>Single Question by Confidence</i>	130
EFFECT SIZE	133
DISCUSSION	135
OVERALL DISCUSSION	145
WHY USE A CONTINUOUS MEASURE OF STAGE OF CHANGE ?	145
WHY USE SEQUENTIAL INSTRUMENT DEVELOPMENT?	146
WHY USE CLUSTER ANALYSIS?	147
WHY TEST MODELS?	150
APPENDIX	150-168

BIBLIOGRAPHY	169
---------------------------	------------

LIST OF TABLES

TABLE PREFACE - 1. FIFTY BENEFITS OF AEROBIC EXERCISE	viii
TABLE 1 - 1. MEANS, STANDARD DEVIATIONS, COEFFICIENT ALPHAS AND CORRELATIONS OF THE 6 SCALES	16
TABLE 1 - 2. MODEL COMPARISONS USING CFA (51 ITEMS)	18
TABLE 1 - 3. TWENTY FOUR ITEM URICA-E2: FACTOR LOADINGS FOR PCA AND CFA	21
TABLE 2 - 1. MODEL COMPARISONS USING CFA (24 ITEMS)	84
TABLE 2 - 2. REPRODUCED CORRELATION MATRICES OF STAGE CONSTRUCTS: UNRESTRAINED MODEL AND SIMPLEX I & II	86
TABLE 2 - 3. REPRODUCED CORRELATION MATRICES OF STAGE CONSTRUCTS: CIRCUMPLEX MODELS I, II, III, & IV	87
TABLE 2 - 4. REPRODUCED CORRELATION MATRICES: PUNCTUATED EQUILIBRIUM MODELS I, II, & III	88
TABLE 3 - 1. URICA-E2 PROFILES BY SINGLE QUESTION ALGORITHM (COL %)	105
TABLE 3 - 2. DISCRIMINANT FUNCTION ANALYSIS: SCALE SCORES OF URICA-E2 AS PREDICTOR VARIABLES AND SINGLE QUESTION ALGORITHM AS CRITERION	107
TABLE 3 - 3. DISCRIMINANT FUNCTION ANALYSIS: TWENTY FOUR ITEMS OF URICA-E2 AS PREDICTOR VARIABLES AND SINGLE QUESTION ALGORITHM AS CRITERION	111
TABLE 3 - 4. URICA -E2 PROFILES BY HOURS OF VIGOROUS EXERCISE IN THE LAST SEVEN DAYS(ROW % OF PEOPLE)	116
TABLE 3 - 5. MEANS AND STANDARD DEVIATIONS OF HOURS OF EXERCISE BY PROFILES	117

TABLE 3 - 6. MEANS AND STANDARD DEVIATIONS OF HOURS OF EXERCISE BY STAGES OF THE SINGLE QUESTION	119
TABLE 3 - 7. T-SCORES AND STANDARD DEVIATIONS FOR PROS AND CONS BY THE PROFILES	121
TABLE 3 - 8. T-SCORES AND STANDARD DEVIATIONS OF PROS AND CONS BY STAGES OF THE SINGLE QUESTION ALGORITHM	124
TABLE 3 - 9. T-SCORES AND STANDARD DEVIATIONS OF CONFIDENCE BY PROFILES	127
TABLE 3 - 10. T-SCORES AND STANDARD DEVIATIONS OF CONFIDENCE BY STAGES OF SINGLE QUESTION ALGORITHM	130
TABLE 3 - 11. COMPARISON OF EFFECT SIZES (ω^2) OF PROS, CONS, CONFIDENCE, AND VIGACT7 FOR SINGLE QUESTION ALGORITHM AND PROFILES.	133
TABLE 3 - 12 HOURS BY PROFILES AND SINGLE QUESTION	137
TABLE 3 - 13 PROS AND CONS BY PROFILES AND SINGLE QUESTION	139
TABLE 3 - 14 CONFIDENCE BY PROFILES AND SINGLE QUESTION	141

LIST OF FIGURES

FIGURE 1 - 1 PRECONTEMPLATION-NON BELIEVER (PCN) PROFILE N-35	24
FIGURE 1 - 2 PRECONTEMPLATION-BELIEVER (PCB) PROFILE N-65	26
FIGURE 1 - 3 CONTEMPLATION (C) PROFILE N-44	28
FIGURE 1 - 4 PREPARATION (P) PROFILE N-26	30
FIGURE 1 - 5 AMBIVALENT (ABV) PROFILE N-69	32
FIGURE 1 - 6 ACTION (A) PROFILE N-54	34
FIGURE 1 - 7 MAINTENANCE (M) PROFILE N-25	36
FIGURE 2 - 1 SIMPLEX	43
FIGURE 2 - 2 SIMPLEX	46
FIGURE 2 - 3 SIMPLEX MODEL, NUMERICAL REPRESENTATION OF ITEM COMPOSITION	48
FIGURE 2 - 4 AN EXAMPLE OF A CORRELATION MATRIX ($R_{\eta\eta}$) OF A SIMPLEX MODEL	49
FIGURE 2 - 5 GUTTMAN - HYPOTHETICAL UNIFORM CIRCUMPLEX-5 TESTS	51
FIGURE 2 - 6 OLSON CIRCUMPLEX MODEL OF FAMILY SYSTEMS	54
FIGURE 2 - 7 CIRCUMPLEX MODEL FOR EXERCISE	58
FIGURE 2 - 8 CIRCUMPLEX MODEL, NUMERICAL REPRESENTATION OF ITEM COMPOSITION	59
FIGURE 2 - 9 AN EXAMPLE OF A CORRELATION MATRIX ($R_{\eta\eta}$) OF A CIRCUMPLEX MODEL	60
FIGURE 3 - 1 GROUP CENTROIDS PLOTTED FOR FUNCTION 1 BY FUNCTION 2, SCALE	
SCORES OF URICA-E2 BY SINGLE QUESTION ALGORITHM	108
FIGURE 3 - 2 GROUP CENTROID PLOTTED FOR FUNCTION 2 BY FUNCTION 3, SCALE SCORES	
OF URICA-E2 BY SINGLE QUESTION ALGORITHM	109
FIGURE 3 - 3 GROUP CENTROIDS PLOTTED FOR FUNCTION 1 BY FUNCTION 2, TWENTY	
FOUR ITEMS OF URICA-E2 BY SINGLE QUESTION ALGORITHM	112

FIGURE 3 - 4 GROUP CENTROIDS PLOTTED FOR FUNCTION 2 BY FUNCTION 3, TWENTY FOUR ITEMS OF URICA-E2 BY SINGLE QUESTION ALGORITHM	113
FIGURE 3 - 5 URICA-E2 PROFILES BY PROS AND CONS	122
FIGURE 3 - 6 SINGLE QUESTION STAGES BY PROS AND CONS	125
FIGURE 3 - 7 URICA-E2 PROFILES BY CONFIDENCE	128
FIGURE 3 - 8 SINGLE QUESTION STAGES BY CONFIDENCE	131

Study One: Instrument Development and Typology

Several prominent theories employ a stage concept as a central organizing construct. It has been used to organize and track the process of development. Piaget (1960, 1972) presented cognitive development as a series of four stages. Kohlberg (1976) presented moral development as a series of seven stages. Stage has also been used to break a complicated topic into more manageable units. Kubler-Ross (1969) used stages to analyze the complex period of dying. Her five stages could be moved through sequentially, but more often than not, the progress was variable. Some individuals would become stuck in a single stage, while others would fluctuate back and forth between stages. Stage can also be used to differentiate treatment modalities. The medical profession stages serious illnesses such as cancer in order to determine what protocol will be used as an intervention.

The theory of stage implies that within a larger idea, smaller discrete concepts are contained. It also implies that each of these smaller concepts are unique enough to be distinguished one from another, yet they have a relationship to each other. In the field of behavior change, the construct of stage is the central tenet of the Transtheoretical Model of Behavior Change (Prochaska & DiClemente, 1983). The model describes the general area of behavior change and conceptualizes it as a series of stages of change. The five stages of change are labeled: Precontemplation, Contemplation, Preparation, Action, and Maintenance.

The theory of stage also implies that although the discrete stages are unique, there is a relationship of the units that is often either temporally or developmentally ordered. There is an inherent pattern or sequence to the stages. In the Transtheoretical Model, the pattern is Precontemplation as the earliest stage, followed by a linear progression of Contemplation, Preparation, Action, and Maintenance.

In the original analysis of the URICA, the relationship between the stages was found to represent a simplex pattern (McConaughy et al. 1983); McConaughy et al. 1989). Exploring the relationship patterns among the stages of change for regular exercise is a goal of this study.

Practical Implications.

What are the practical implications of stage. The most obvious implication is that stage allows a match of intervention to stage of change. Each stage of change has both cognitive and behavioral components. The goal of intervention becomes moving a subject from one stage to the next. Study of the most common sequential patterns is necessary to help interventionists guide subjects through the stages to the goal of behavior change.

Why is Stage Important for Exercise?

Stage is important for exercise behavior because regular exercise isn't a linear behavior, i.e., one where you progress through the stages once and are done. A revolving-door schema appears to be a more appropriate model. (Sonstroem, August, 1987). Adherence rates and patterns overall are very similar for apparently healthy adults in community, worksite, and unsupervised self-initiated exercise programs. It is

remarkable that the rate of dropout is similar in magnitude and form to those observed for other behavior change programs like smoking and weight loss (Dishman, 1988). Even high performance athletes get sick, get hurt, go on vacation, and break their routine. They relapse back and must start exercising regularly again. We also know that 50% of all people who start exercise programs quit within one year (Dishman, 1988). If people are constantly recycling back and forth through the stages of exercise, it is even more important to correctly assess what stage a person is in and match the interventions to their stage.

Importance of A Continuous Measure of Stage

The URICA-E2 is a continuous measure as opposed to a discrete measure such as the Single Question algorithm. This continuous measure gathers six pieces of information about each person as opposed to the single stage of change that the algorithm can offer. The continuous measure shows how much of each stage of change make up a person's overall Stage of Change.

Since exercise is such a circular behavior, it is of paramount importance to (1) accurately put people in the right stage; and (2) to understand the characteristics unique to each stage. An algorithm can only group people in a very general way. The two exercise algorithms used in this study (five questions and a single question) are limited to asking about future intention for those in the early stages of Precontemplation, Contemplation, and Preparation and past behavior for those in Action and Maintenance. The alternative to an algorithm is a continuous measure of stage of change. Although it has the drawback of involving a large number of questions, its

advantages far outweigh its disadvantages. The first advantage is that both cognitive and behavioral dimensions can be combined to better flesh out the dimensions of a stage. A second methodological advantage is that the instrument can be used in a cluster analysis to develop typologies or profiles of changers.

Sequential Instrument Development

The steps to develop a reliable and valid continuous measure of stage of change are based on a sequential process of instrument development clearly explicated by the developers of personality instruments (Jackson, 1970; 1971; Comery, 1988).

To develop a continuous or proportionate measure of stage of change using the Transtheoretical Model, one starts with the underlying premise that there is a concept called stage of change and that it is made up of unique constructs or stages that have been named Precontemplation, Contemplation, Preparation, Action, and Maintenance. You then have to flesh out a definition for each of those names. This starts with a focus group or by talking with people that you have staged with an algorithm. From the algorithm, you have the intentions of the early stage people and you know the behavior of the later staged subjects. What you want to learn is the missing half of the picture. What do early stage people do? Why do they intend to do what they say they are going to do? What do the later stage people think? Are they going to continue? Why do they exercise? This information will help the researcher write a large number of questions that capture the breadth and depth of what it means to be in a certain stage. There may be 20 or more questions per stage. These questions and a descriptive definition of each of the stages are then given to sorters who are familiar

with the stages of change. They are asked to separate the questions into the stages. Items that sorters don't agree on are either reworked until agreement is reached or they are discarded. New items may be added and the process repeated until a set of items is decided upon. This first generation instrument is then administered and analyzed. The analysis will produce a reduced and refined instrument which may or may not be able to be a second generation instrument. Often flaws are discovered which require reworking sections of an instrument. Sometimes, whole new sections need to be added which requires going back to the focus group step and preceding again through the writing, sorting and rewriting phase. The instrument used in this study has such a history.

The Instrument

The instrument that is the focal point of this study is the URICA-E2. This measure was based on the University of Rhode Island Change Assessment (URICA) (McConnaughy, Prochaska, & Velicer, 1983; McConnaughy, DiClemente, Prochaska, & Velicer, 1989) and the University of Rhode Island Change Assessment for Exercise (URICA-E1) adapted for exercise by Bess Marcus for a worksite study and analyzed by this author (Reed, Velicer, Rossi, & Marcus, August, 1993; March, 1994). The URICA and the URICA-E1 both measure four stages of change: Precontemplation (PC), Contemplation (C), Action (A), and Maintenance (M). In recent work, the model is conceptualized as having five stages (DiClemente, et al. 1991; Velicer et al., 1992): Precontemplation (PC), a stage where no change in behavior is planned for at least the next six months; Contemplation (C), where change is planned within the next

six months; Preparation (P), where change is planned in the next 30 days and some type of action has been attempted in the last year; Action (A), where change has begun and has been sustained for less than six months; and Maintenance (M), where change has been maintained for longer than six months.

The URICA-E2 is a third generation continuous measure of stage of change and a second generation continuous measure of stage of change for regular exercise. The URICA-E2 was written because of the results of the analyses of the URICA-E1. E1 only had four stages because analysis of the original URICA could not identify a fifth stage. The items written originally to measure the middle stage were very different in content from the current definition of Preparation. When E1 was adapted from the original URICA, it was done as a strict translation and substitution of the word “exercise” for the word “problem” in the original. The original URICA was a clinical tool, used in a therapy setting. When a clients came in for therapy, they were asked to fill out this tool to assess their readiness to tackle the problem for which they started therapy. They all had a recognized problem. The strict translation of E1 into exercise meant that the tool should only be used with people for whom regular exercise was a problem. The instrument was then administered to a general worksite population where some people did have a problem with exercising regularly, but some didn’t. This caused confusion with questions like, “I don’t have any concerns about my exercise habits.” This item intended to depict a Precontemplator who has no interest in changing. However, it was also endorsed by Maintenance people who were doing enough exercise and also did not plan to change.

The new URICA-E2 was written so that it could be administered to a general population, and it attempted to eliminate the confusion between PC and M. It was also hoped that if each stage tried to capture both behavior and intention, the fifth stage of Preparation might be realized. The 32 items of the URICA-E1 were carefully examined and rewritten, when appropriate. Nineteen additional items were created, some to measure a Preparation stage and others to flesh out the missing aspects of the other four stages. In the URICA-E2, there were 11 Precontemplation questions, 10 Contemplation questions, 11 Preparation questions, 8 Action questions, and 11 Maintenance questions in the unanalyzed instrument. After analysis, there were four items per stage chosen that best represented the stage. Totaling the four items and dividing by four gave each person a score on each of the stages. These scores were then standardized to a mean of 50 and a standard deviation of 10 so they could be compared to each other. These standardized scores were used in a cluster analysis.

Typologies

A critical question is whether stage represents a series of discrete steps or somewhat arbitrary slices of a continuum. The usual method of staging subjects in the area of smoking cessation is an algorithm which produces a series of ordered discrete stages. This method produces discrete stages a priori and does not provide a direct test of the question. Recently, a cluster analysis of the critical set of outcome measures for smoking cessation (Velicer, Hughes, Fava, Prochaska, & DiClemente, 1995) used cluster analysis to test this question and concluded that discrete stages did exist, but that some subjects were misclassified by the algorithm.

An alternative approach to assessing stage is to employ a continuous measure such as the URICA-E2. The set of scores for the scales of the continuous measure are employed in a cluster analysis to determine if discrete subtypes exist. Previous studies of both the URICA (McConnaughy, Prochaska, & Velicer, 1983; McConnaughy, DiClemente, Prochaska, & Velicer, 1989) and URICA-E1 (Reed, Velicer, Rossi, & Marcus, August, 1993) have found discrete subtypes. After determining that discrete groups exist, the next problem is to determine the number of subgroups. When the algorithm is employed for assessing stage, the number of stages is determined a priori and is set as five for most recent formulations of the model. When a continuous measure is employed, determining the number of discrete subgroups is one of the decisions involved in performing the cluster analysis.

When doing a cluster analysis, a variety of different metrics can be used to choose how to measure the distance between patterns. A Euclidean distance measure is recommended when the variables being clustered are thought to be unrelated, discrete constructs. The clustering methods also can vary. Ward's method is highly recommended and used as the default method in the analytical package SAS (1985). The analysis produces groups of people who have similar patterns. These groups can be called clusters, profiles, or typologies. A typology provides much more information than an algorithm. An algorithm presents a person's single stage of change. A continuous measure represents the proportion of each of the stages that constitute a person's Stage of Change. A typology demonstrates the patterns of your most common

types of changers. An important issue that can be explored is whether scales or clusters best represent stage of change.

Method

Pilot Study

In a pilot study, a preliminary version of the URICA-E2 containing 47 items was administered to 159 college students enrolled in Introductory Psychology. The data were analyzed to see if the instrument would yield five stages. The data were run using Confirmatory Factor Analysis (CFA) for a correlated five factor model. The results, using 51 items, was $\chi^2 = 3099.73$, $df = 1214$, $RMS = .145$ and a $CFI = .692$. In the standardized solution the factor loadings showed four Precontemplation items loading between .460 and .910. Ten Contemplation items loaded between .542 and .909. Nine Preparation items loaded between .504 and .824. Four Action items loaded between .641 and .965. Finally, ten Maintenance items loaded between .572 and .920. A model was then run using the four best items for each of the five scales. This yielded a $\chi^2 = 258.97$, $df = 160$, $RMS = .075$, and a $CFI = .956$. The factor loadings showed four Precontemplation items loading between .430 and .934. The four Contemplation items loaded between .593 and .902. The four Preparation items loaded between .598 and .830. The four Action items loaded between .630 and .973. Finally, the four Maintenance items loaded between .738 and .918. The twenty-item

results showed an acceptable ratio of 1.62, a CFI of above .9 and a borderline RMS of .075. It was decided that the results supported proceeding with Study One.

Subjects

The URICA-E2 was collected on 327 subjects who returned questionnaires mailed to a sample of convenience of both people having telephone numbers listed in the phone directories of six New England States and of people included on the wedding invitation lists of three recent weddings to which the researcher had access. The sample was 53.2% male, 91.7% white, 3.7% Native American, 61.5% married, 13.5% divorced, and 15.7% never married. Of those surveyed 45% had attended college and another 35% graduate school, 39% had a family income of at least \$60,000 and their age ranged from 18 to 91 years ($M=47.8$). Their height ranged from 4 feet 10 inches to 6 feet 8 inches and their weight from 93 lb. to 275 lb.

Procedure.

Questionnaires containing the URICA-E2 were mailed to the random sample of convenience. Three hundred and twenty seven subjects returned completed instruments. The first step was to clean the data and run frequencies. The second step was to analyze the structure of the URICA-E2 using Principal Component Analysis (PCA) in replication of the work done by McConaughy et al. (1983) and McConaughy et al. (1989). Principal Component Analysis (CAX program); (Velicer, Fava, Harrop & Zwick, 1991) was performed with five components specified a priori.

The number of components to extract was tested by the minimum average partial (MAP) procedure (Velicer, 1976). The MAP procedure indicated six components should be retained. Four components corresponded to expected scales. However, the expected Precontemplation scale resulted in two components. The first was labeled Precontemplation-Nonbelievers (PCN) and involved items that expressed no belief in the value of regular exercise. The second was labeled Precontemplators-Believers (PCB) and reflected a belief in the positive aspects of regular exercise. Both PCN and PCB were not planning to exercise in the next six months.

The third step was to fit the data to a variety of possible models using CFA (Bentler, 1989; Joreskog & Sorbom, 1989). The program employed was LISREL VII (Joreskog & Sorbom, 1990). Fifteen different models were fit to the data: (1) a one factor model that conceptualized change as a single dimension; (2) an uncorrelated and (3) a correlated two factor model that sees change as action (A/M) versus no action (PC/C/P); (4) an uncorrelated and (5) a correlated three factor model based on Stern et al. (1987) that differentiated people who have no intention of changing (PC) from those who are thinking and perhaps making some change (C & A) from those who have been changed for some time (M); (6) an uncorrelated and (7) a correlated four factor model using the four stages of PC, C/P, A, M; (8) an uncorrelated and (9) a correlated four factor model which used the following four stages of PC, C, P, A/M; (10) an uncorrelated and (11) a correlated four factor model using the four stages of PC, C, P/A, M, (12) an uncorrelated and (13) a correlated six factor (PC, C, P, A, M) and

(14) an uncorrelated and (15) a correlated six factor model (PCN, PCB, C, P, A, M) reflecting the PCA results.

Model fit was assessed by a variety of overall fit indices including: chi square (χ^2), Root Mean Square Residual (RMS) (Joreskog & Sorbom, 1986), Goodness of Fit Index (GFI) (Joreskog & Sorbom, 1986), and Comparative Fit Index (CFI) (Bentler, 1990).

This series of CFAs supported the results of the PCA and found the correlated six factor solution to have the best fit. The PCA results were used to reduce the number of items in the URICA-E2. Items were deleted if they had low factor loadings, loaded on more than one factor (complex items) or were theoretically inconsistent. A 24-item (four items per component) version was validated in a CFA.

Scale scores for the URICA-E2 were formed by calculating the unweighted sum of the scores on the four items allocated to each of the six components. This score was standardized to a T-score metric (mean of 50 and a standard deviation of 10). Six scores were calculated for each subject, one for each stage.

A cluster analysis was performed on the six standardized scale scores to determine if different subtypes exist, following McConaughy et al. (1983), McConaughy et al. (1989). A variety of different metrics can be used to measure the distance between patterns. As the stages are thought to be discrete constructs, a Euclidean distance measure was used. Although it is biased in favor of a tight, hyperspherical cluster (Aldenderfer and Blashfield, 1984), Ward's is a hierarchical agglomerative method of clustering. It is designed to optimize the minimum variance

within clusters. (Ward, 1963). It is widely used in the social sciences (Blashfield, 1980). It is highly recommended and used as the default method in the analytical package SAS (1985). Clusters three through thirteen were examined. Decisions on how many clusters to interpret were made using the cubic clustering criterion, and investigation of the dendogram, keeping in mind the theoretical constructs upon which the instrument was based. Choosing the correct number of profiles is a difficult task for which no single method is broadly accepted as correct. The cubic clustering criterion is a numeric value that starts out as a positive number, descends to zero, and starts to grow negatively. When this number disrupts its linear sequence and starts to bobble, it is "around" the number of clusters that should be interpreted. Interpreting the dendogram is also an inaccurate experience. It is approximately the number of first level breaks, depicted on a schematic representation of the scores, that indicates the number of clusters to interpret. With the numeric criterion so vague, more dependence was put on choosing the number of clusters that kept the theoretical intent intact.

Results

Frequencies

Means, standard deviations, and frequencies were calculated using SAS (1985). Skewness and kurtosis were assessed. All values fell within an acceptable range. Since the data set was not large enough to split into an exploratory and a confirmatory sample, all analyses were done on the complete data set (N=327).

Principal Component Analysis (PCA)

The component structure was analyzed using PCA with a pre-specified five component solution. The MAP procedure (Velicer, 1976), indicated a six component solution was best. Both a Varimax (orthogonal) and Promax (oblique) rotation were performed. The percent variance accounted for by the six components was 66.93%. The coefficient alphas, a measure of reliability (Cronbach, 1951) for the total 51 items were: PCN = .8054, PCB = .9052, C = .9086, P = .8752, A = .9218, and M = .9366.

Component One. Component one had high positive loadings for 10 Maintenance items. The Component represents people who have been exercising regularly for a long time and plan to continue. They have been successful at exercising regularly and have managed to keep going for the last six months. The component also had high positive loadings for six Action items and high negative loadings for seven PCB items.

Component Two. Component two had high positive loadings for all 10 Contemplation items. This component represents people who have been thinking that they might want to start exercising, people who are wondering about whether they will be able to exercise, and people that think they should get started on a regular exercise program in the next six months. It also had moderately high loadings for six Preparation items.

Component Three. Component three had the four Precontemplation items that seem to describe people who do not believe in regular exercise. The component represents people who endorse that they don't exercise and feel they don't need to.

They don't care and are satisfied with being sedentary. They could exercise, but they don't plan to.

Component Four. The fourth component had six Preparation items. This component is represented by such behavior as having set up a day and time to start exercising, having lined up a friend to start exercising with, having called friends to find someone to exercise with, and having prepared to start in a exercise group in the next few weeks. Both aspects, the overt behavior and the time element of getting started in the next few weeks, seem to be important to the component.

Component Five. The fifth component loaded six Precontemplation items that seem to capture people who believe in regular exercise but are not planning to exercise in the near future. This Component represents people who feel they don't have the time or energy now, people who know exercise is worthwhile but don't have time in the near future, people who think it is good, but can't fit it into their schedule, and those who are aware of its importance, but can't fit it in right now.

Component Six. Component six loaded four Action items. This last component captures the idea of people who are finally exercising regularly, people that have started exercising regularly within the last six months, people that have recently started to exercise regularly, and those that have started to exercise and plan to continue. Table 1 - 1 contains the means, standard deviations, coefficient alphas of the six components, and the correlations among the six components.

Table 1 - 1

Means, Standard Deviations, Coefficient Alphas and Correlations of the Six Scales

Scale	Mean	SD	Alph	<u>Correlations</u>				
				PCN	PCB	C	P	A
PCN	1.62	0.81	.8054					
PCB	2.20	1.06	.9052	.641	1			
C	2.59	1.05	.9086	.158	.663			
P	2.32	0.83	.8752	-.021	.227	.769		
A	3.05	1.21	.9218	-.546	-.879	-.588	-.098	
M	2.82	1.15	.9366	-.521	-.813	-.613	-.136	.940

Confirmatory Factor Analysis (CFA-Replication):Model Testing

Fifteen models were fit to the data. Table 1 - 2 presents the five goodness of fit indices for the fifteen models and the Null model. The models considered were: (1) a one factor model that conceptualized change as a single dimension; (2) an uncorrelated and (3) a correlated two factor model that sees change as action (A/M) versus no action (PC/C/P); (4) an uncorrelated and (5) a correlated three factor model based on Stern et al. (1987) that differentiated people who have no intention of changing (PC) from those who are thinking and perhaps making some change (C & A) from those who have been changed for some time (M) (6) an uncorrelated and (7) a correlated four factor model using the four stages of PC, C/P, A, M;.(8) an uncorrelated and (9) a correlated four factor model which used the previous four stages of PC, C, P, A/M; (10) an uncorrelated and (11) a correlated four factor model using the four stages of PC, C, P/A, M, (12) an uncorrelated and (13) a correlated five factor (PC, C, P, A, M) and (14) an uncorrelated and (15) a correlated six factor model (PCN, PCB, C, P, A, M) reflecting the PCA results. The correlated six factor model exceeded the correlated five factor model with better fit and verified the results of the PCA. However, the CFI of .731 and the RMS of .119 are well short of commonly accepted criterion for "good" fit (CFI > .90 and RMS < .06).

Table 1 - 2

Model Comparisons using CFA (51 Items)

STAGE PATTERN	MODEL	d.f.	χ^2	GFI	CFI	RAT IO	RMS
	NULL	1275	11920.44			9.3	
(PC-C-P-A-M)	1 FACT	1224	7242.83	.303	.435	5.9	.167
(PC-C-P), (A-M)	CORR 2	1223	6136.92	.389	.538	5.0	.175
(PC-C-P), (A-M)	UNCRR 2	1224	6296.08	.403	.524	5.1	.248
(PC),(C-P-A),(M)	CORR 3	1222	7023.49	.381	.455	5.8	.209
(PC),(C-P-A),(M)	UNCRR 3	1225	7425.63	.376	.418	6.1	.294
(PC),(C),(P),(A-M)	CORR 4A	1219	5004.74	.555	.644	4.1	.155
(PC),(C),(P),(A-M)	UNCR 4A	1225	5762.53	.526	.574	4.7	.282
(PC),(C-P),(A),(M)	CORR 4 B	1218	4713.63	.549	.672	3.9	.145
(PC),(CP),(A),(M)	UNCR 4B	1224	5694.06	.518	.580	4.7	.290
(PC),(C),(PA),(M)	CORR 4 C	1219	6848.50	.432	.642	5.6	.244
(PC),(C),(PA),(M)	UNCR 4C	1225	7494.87	.389	.411	6.1	.315
(PC),(C),(P),(A)(M)	CORR 5	1214	4335.06	.588	.707	3.6	.124
(PC),(C),(P),(A)(M)	UNCR 5	1224	5665.26	.543	.583	4.6	.306
(PCN),(PCB),(C)	CORR 6	1209	4074.63	.617	.731	3.4	.119
(P),(A),(M)							
(PCN),(PCB),(C),	UNCR 6	1224	5596.59	.555	.590	4.6	.310
(P),(A),(M)							

In the 51-item CFA results for the correlated six factor model, the ratio of χ^2 to d.f. was 3.4 to 1 (4074.63 to 1209). It is recommended that a ratio of χ^2 to d.f. be less than 2 to 1 (Joreskog & Sorbom, 1979) or at least less than 5 to 1 (Hayduk, 1987). The RMSR (.119) was well over .06 which is the acceptable limit for good fit (Hayduk, 1987). The Comparative Fit Index (CFI)(.731) was poor. A value of .90 is the minimum desired value for good fit (Bentler, 1990).

The standardized solution did produce six, clear, correlated factors. Factor One had the four PCN items loading between .660 and .745. Factor Two had seven PCB items loading between .629 and .837. Factor Three had all 10 C items loading between .535 and .911. Factor Four had the 10 P items loading between .573 and .731. Factor Five had six of the A items loading between .682 and .951. Factor Six had the 10 M items loading between .524 and .941. This suggests that, although the six factor model fits the data better than any of the other models, some of the manifest variables (items) are not contributing to the overall fit of the model.

PCA Item Reduction.

Since 51 items creates a significant response burden on the participants and the fit of the 51 items was poor, the URICA-E2 was analyzed to see if a more parsimonious version could be developed. A series of PCAs was run, reducing the item set to 39 items, 28 items, and 24 items. The final version was balanced with an equal number of items on each scale (four), and close to the minimum required for factor identifiability (three per factor) (Anderson & Rubin, 1957).

A CFA was performed on the reduced set of items to confirm the structure. The CFA for the 24 items resulted in a χ^2 of 852.30 with 237 degrees of freedom, a GFI of .818, a CFI of .893, a RSM of .093 and a ratio of χ^2 to d.f. of 3.5. Table 1 - 3 presents the 24 items chosen and their loadings for both the PCA using an oblique rotation and the standardized solution of the CFA.

Table 1 - 3

Twenty-Four Item URICA-E2: Factor loadings for PCA and CFA

Part I. Precontemplation Non Believer Items (PCN)	PCA	CFA
As far as I am concerned, I don't need to exercise regularly.	.804	.650
I don't exercise and right now I don't care.	.752	.744
I am satisfied with being a sedentary person.	.822	.698
I could exercise regularly, but I don't plan to.	.784	.757
Part II. Precontemplation Believer Items (PCB)		
I don't have the time or energy to exercise regularly now.	.825	.749
I know that regular exercise is worthwhile, but I don't have time for it in the near future.	.861	.810
I think regular exercise is good, but I can't fit it into my schedule right now.	.901	.858
I am aware of the importance of regular exercise, but I can't do it right now.	.873	.871
Part III. Contemplation Items (C)		
I have been thinking that I might want to start exercising regularly.	.821	.779
I have been thinking about whether I will be able to exercise regularly.	.834	.759
I have been thinking that I may want to begin exercising regularly.	.911	.912
I really think I should work on getting started with a regular exercise program in the next six months.	.911	.922

(table continues)

Part IV. Preparation Item (P)

I have set up a day and a time to start exercising regularly within the next few weeks.	.699	.693
I have lined up a friend to start exercising regularly with in the next few weeks.	.908	.831
I have been calling friends to find someone to start exercising with in the next few weeks.	.901	.830
I am preparing to start a regular group in the next few weeks.	.712	.686

Part V. Action Items (A)

I am finally exercising regularly.	.748	.817
I have started exercising regularly within the last six months.	.867	.680
Recently, I have started to exercise regularly.	.833	.536
I have started to exercise regularly, and I plan to continue.	.732	.882

Part IV. Maintenance Items (M)

I have been exercising regularly for a long time and I plan to continue.	.923	.884
I have been successful at exercising regularly and I plan to continue.	.900	.888
I have managed to keep exercising regularly through the last six months.	.939	.947
I have completed six months of regular exercise.	.928	.931

Cluster Analysis

A cluster analysis was performed using the standardized scale scores of the 24-item version of the URICA-E2. The shape, elevation, and scatter of the profiles were employed to describe the characteristics of the different subtypes of changers. A variety of different metrics can be used to measure the distance between patterns. As the stages are thought to be discrete constructs, a Euclidean distance measure was used. The clustering method was Ward's (Ward, 1963). Decisions on how many clusters to interpret were made using the cubic clustering criterion, and investigation of the dendrogram, keeping in mind the theoretical constructs upon which the instrument was based. Based on these three criteria, seven clusters were retained. Naming of clusters is influenced heavily by previous work and the researcher's personal interpretation. The seven distinct subtypes were labeled: (1) Precontemplation-Non Believers (PCN), (2) Precontemplation-Believers (PCB), (3) Contemplation (C), (4) Preparation (P), (5) Ambivalent (ABV), (6) Action (A), and (7) Maintenance (M).

Precontemplation-Non Believers (PCN). The PCN cluster consisted of 35 subjects. Their profile consisted of an extremely high score on the first scale, Precontemplation-Non Belief, a high score on the second scale, Precontemplation-Belief, and low scores on the remaining four scales. The scatter was exaggerated with an almost three standard deviation difference between the high and the low score. The shape of the scale, involving a single exaggerated peak, was the basis for the cluster label. Figure 1 - 1. illustrates this profile.

**Figure 1 PRECONTEMPLATION-NON BELIEVER PROFILE
(N-35)**

Precontemplation-Believers in Exercise (PCB). The PCB cluster was made up of 65 individuals. Their profile consisted of a score at the mean for the first scale, PCN, and very high scores for both PCB and C. The fourth scale, P, was again at the mean. The last two scales, A & M, were quite low. The scatter was moderate, only a standard deviation and one half between the highest and lowest scores. The shape of the profile looked like a slanted plateau between PCB and C. PCB had a slight prominence, hence the cluster was labeled PCB. Figure 1 - 2. depicts this profile.

Figure 2 PRECONTEMPLATION-BELIEVERS PROFILE (N-65)

Contemplation (C). The Contemplation cluster consists of 44 subjects. Their profile consists of scores near the mean for the first two scales, PCN and PCB. There is a high score for the third scale, C and a moderately high score for the fourth scale, P. The last two scales, A and M, taper off. The shape of the scale involving a peak at C is the basis for the cluster label. Figure 1 - 3. illustrates a moderate scatter of two standard deviations difference between the highest and lowest scores.

Figure 3 CONTEMPLATION PROFILE (N-44)

Preparation (P). The Preparation cluster consisted of 26 subjects. Their profile was made up of scores near the mean on the first three scales (PCN, PCB, and C). The scores on the P scale were extremely high, while the last two scales, A and M, tapered off. The scatter was extended with a two and one half standard deviation difference between the high and low scores. The shape of the scale involved a single exaggerated peak which was the basis for the cluster label. Figure 1 - 4. illustrates this profile.

Figure 4 PREPARATION PROFILE (N-26)

Ambivalent (ABV). The Ambivalent cluster was made up of 69 subjects. Their profile consisted of scores near the mean on all six scales: PCN, PCB, C, P, ABV, A, and M. The shape of the scale is nearly a flat line which led to the name of the cluster. Figure 1 - 5. illustrates a minimal scatter of only one standard deviation difference between high and low scores.

Figure 5 AMBIVALENT PROFILE (N-69)

Action (A). The Action cluster consisted of 54 subjects. Their profiles were made up of low scores on the first four scales: PCN, PCB, C, and P. Both the Action and Maintenance scales had high scores. The scatter was moderate with about two standard deviation's difference between the high and low scores. The shape of the profile looked somewhat like a step made up of the scales A and M rising above the other scales. To be more precise, this cluster could have been named Action-Maintenance. Figure 1 - 6. depicts this profile.

Figure 6 ACTION PROFILE (N-54)

Maintenance (M). The Maintenance cluster consisted of 25 subjects. Their profile consisted of low scores on the first five scales: PCB, PCB, C, P, and A, and a high score only on the M scale. The scatter was extensive with a two and one half standard deviation difference between high and low scores. The shape of the scale, involving a single exaggerated peak, was the basis for the cluster label. Figure 1 - 7. illustrates this profile.

Figure 7 MAINTENANCE PROFILE (N-25)

Discussion

Study One concentrated on refining the continuous measure of stage of change for regular exercise, the URICA-E1, that had been developed for a worksite study (Marcus, Selby, Niaura, & Rossi, 1992; Marcus, Rossi, Selby, Niaura, & Abrams, 1992) and had been analyzed by this author (Reed, Velicer, Rossi, & Marcus, August, 1993; March, 1994). The refined instrument analyzed here, the URICA-E2, had been written to add the stage of Preparation to the four stages of Precontemplation, Contemplation, Action, and Maintenance. It also attempted to clarify a confusion between the Precontemplators who were not planning to change and Maintenance people who were also not planning to change. These aims were successfully accomplished. A clear Preparation stage appeared in both the PCA, the CFA, and the cluster analysis profiles. Precontemplation and Maintenance were also clearly separated. In addition, two interesting new pieces of information appeared: (1) the splitting of Precontemplation into two pieces named Believers and Non Believers; and (2) the reappearance of the Ambivalent profile. The only real disappointment with the instrument was its inability to distinguish Action as clearly as hoped for from the Maintenance stage.

Principal Component Analysis, the analytical tool used with the URICA, but not with the URICA-E1, was also used with the URICA-E2. Only Confirmatory Factor Analysis was used with the URICA-E1 after a preliminary PCA proved to be uninterpretable. If only CFA had been used with the URICA-E2, the splitting of

Precontemplation into two piece would never have been discovered. The model was, of course, set up to represent the five stages for which the instrument had been written.

The seven exercise profiles formed in the cluster analysis did a good job of capturing, not just the classic five stages of Precontemplation, Contemplation, Preparation, Action and Maintenance, but duplicated the split of Precontemplation into PCN (Nonbelievers in exercise) and PCB (Believers in regular exercise). In addition to these six components, there appeared a profile named Ambivalent where the scores on all the stages hover near the mean. This profile had appeared in a cluster analysis of the URICA-E1 and was thought to represent some type of Contemplation.

Making comparisons between the profiles generated using the four stage URICA-E1 and those from the six stage URICA-E2 can only be made in the broadest of terms. The startling thing is how well the URICA-E2 profiles isolate and highlight each of the six components: PCN, PCB, C, P, A, M (with perhaps the exception of Action which isn't clearly delineated from Maintenance). Action and Maintenance rise above all others almost equally in the Action profile showing an unclear distinction between these two stages. This problem had first appeared in a number of Action items that showed a high degree of complexity by loading on both Action and Maintenance. The Action items will need further refinement in an attempt to get them to discriminate between Action and Maintenance.

The profiles from the cluster analysis validate that each of the six components is discrete and unique. Study Two will examine whether there is an identifiable pattern of relationship between these discrete stages.

Conclusions.

The analyses confirmed and strengthened the value of using a continuous measure in addition to a algorithm to stage regular exercise behavior.

Both Principal Component Analysis and Confirmatory Factor Analysis discovered the URICA-E2 to be a six stage instrument that captured the stages of Precontemplation-Nonbelievers of regular exercise (PCN), Precontemplation-Believers in exercise who can not conceive of regular exercise in the near future (PCB), Contemplation (C), Preparation (P), Action (A), and Maintenance (M). This information would never have been discovered with the classic five stage algorithm.

Both analysis techniques demonstrated that the instrument was improved by refinement down to a more parsimonious 24-item (four per construct) tool. The major weakness discovered in the instrument was its inability to clearly discriminate Action from Maintenance. Action items proved to show complexity and load on Maintenance also. The so called Action profile showed an almost equal peaking of Action and Maintenance scores. By following the steps of sequential instrument development (Jackson, 1970, 1971; Comery 1988) the Action items can and will be taken back to the rewriting stage. New items will be developed for the next generation instrument (URICA-E3).

In Study Three URICA-E2 was validated against external instruments from the Transtheoretical Model of Behavior Change, such as the Pros and Cons of regular exercise (Marcus, Rakowski, & Rossi, 1992;), The confidence instrument (Marcus, Selby, Niaura, & Rossi, 1992), and self report measures of time spent exercising

(Blair, 1984; Taylor et al., 1984, Sallis et al., 1985). The instruments will be looked at across both the six components of change and the seven exercise profiles.

Study Two

Introduction

The comparison of patterns of correlations of structural equation models has previously been used to compare a simplex model with a one-factor model (Marsh, 1993). This methodology was used to test a series of models to see if any produced a pattern of correlations between the stage constructs similar to the pattern discovered in Study One. Three basic pattern types were chosen to test: a simplex model, a circumplex model, and a punctuated equilibrium model.

Simplex Model

Description of a simplex. A simplex model (Guttman, 1954) is one whose elements come from the same domain, but differ in degree of complexity. The elements can be thought of as lying along a continuum. The degree of complexity increases in a linear fashion with each element more complex than the one before it, and less complex than the one after it. Element one is contained within element two. Element two is contained within element three, and so forth. Because of this, elements next to each other are more highly correlated than elements that are more distant. For instance, a curriculum in mathematics would be composed of Math I for first graders, Math II for second graders, Math III for third graders and so forth. The knowledge entailed in Math I is an integral part of Math II. Math II contains Math I content plus something more. The knowledge entailed in Math II is an integral part of Math III. This is the reason that elements correlate most strongly with the elements on either side

of them in the progressive sequence that makes up all the mathematics courses in the curriculum. Math I is more highly correlated to Math II than Math I is to Math III.

Examples of applications of a simplex. Boom and Molenaar (1989) looked at stage score correlations of a Defining Issues Test (importance ratings of moral issues) in 180 high school and university students. They found a simplex model to fit the data. Four possible models were tested in an examination of adolescent substance use. Results supported a four variable simplex model: alcohol use predicted marijuana use, marijuana use predicted enhancer and dampener hard drug use (Windle, Barnes, & Welte, 1989). As seen in Figure 2 - 1., the largest group uses alcohol. Some percentage of this group goes on to use marijuana. Some percentage of that group goes on to use either enhancer or dampener hard drugs. The simplex relationship exists in that when you examine hard drug users, a very high percent will have also used marijuana. When you examine users of marijuana, there is a very high percent who will also have used alcohol. In other words hard drug users, usually have already used both marijuana and alcohol first. The correlation between alcohol and marijuana use is higher than the correlation between alcohol and hard drug use. The relationship between marijuana use and hard drug use is also higher than the relationship between alcohol and hard drug use.

Figure 2 - 1. Simplex.

Windle, Barnes, and Welte, 1989

A simplex model has also been used to explain the relationship between five Diagnostic and Statistical Manual of Mental Disorders (DSM-III) personality disorders: antisocial, borderline, avoidant, passive aggressive and compulsive. They were found to be able to be ordered sequentially according to their degree of impulsiveness. (Romney & Bynner, 1992). Dolan, Molenaar, and Boomsma (1991) and Boomsma, and Molenaar (1987) applied Sorbom's simplex model approach to simultaneous analysis of means and covariance structure to analyze the observed means in a single group of female twin pairs. The Life Style Inventory (Lafferty, 1973) was expected to produce a perfect circumplex, but it was found that a linear simplex was a better explanation of the relationships between the 12 life style constructs (Nediger & Chelladurai, 1989). Hays, Widaman, DiMatteo, and Stacy (1987) did a similar study with a sample of high school students and a sample of industrial workers and found the common factor model to better fit the data than a simplex model.

How a simplex is appropriate to the stage model. A continuous measure of stage of change like the URICA-E2, as we have seen in Study One, is made up of discrete constructs linked in some type of pattern. In the past, Confirmatory Factor Analysis (CFA) of the continuous measure of stage of change, the URICA, has found, more often than not, a correlated four factor model to offer the best fit to the data. The relationship of the correlations between the stages has been described as a simplex (McConaughy, Prochaska, & Velicer, 1983; McConaughy, DiClemente, Prochaska, & Velicer, 1989). With the adaptation of this instrument to regular exercise, it is important to explore what pattern of relationships exist for the six exercise stage of change constructs. When choosing models to test, it is only logical to start with the

simplex pattern that had previously showed promise with the instrument from which the URICA-E2 was developed.

Within the Transtheoretical Model, it is possible to conceive of Action as being subsumed in Maintenance; Preparation being subsumed in Action; and even, Contemplation being subsumed in Preparation. Maintenance could be seen as Action plus more time. Preparation could be conceived of exercising without regularity and Action as exercise with the addition of regularity. Preparation can be visualized as the plan to change in the future (Contemplation) plus the addition of an approximate behavioral criteria, like the 24 hour quit attempt used in smoking cessation. Precontemplation-Believers (PCB) in regular exercise could be theorized as cognitively similar to Contemplators although missing the intention to make a change in the foreseeable future. The possibility that Precontemplation-Nonbelievers can be subsumed by Precontemplation-Believers is open to dispute and consequently investigation. If the stages of change form a true simplex it could be pictured as it is seen in Figure 2 - 2.

Figure 2 - 2. Simplex

The simplex will look for a relationship of elements of one domain that differ in degree of complexity. See Figure 2 - 3. for a numerical representation of the item content of a simplex model and Figure 2 - 4. for an example of the correlation matrix of a simplex model.

Figure 2 - 3. Simplex Model, Numerical Representation of Item Composition

$$\begin{aligned} Y_1 &= X_1 \\ Y_2 &= X_1 \\ Y_3 &= X_1 \\ Y_4 &= X_1 \end{aligned}$$

Precontemplation
Nonbeliever

$$\begin{aligned} Y_5 &= X_1 + X_2 \\ Y_6 &= X_1 + X_2 \\ Y_7 &= X_1 + X_2 \\ Y_8 &= X_1 + X_2 \end{aligned}$$

Precontemplation
Believer

$$\begin{aligned} Y_9 &= X_1 + X_2 + X_3 \\ Y_{10} &= X_1 + X_2 + X_3 \\ Y_{11} &= X_1 + X_2 + X_3 \\ Y_{12} &= X_1 + X_2 + X_3 \end{aligned}$$

Contemplation

$$\begin{aligned} Y_{13} &= X_1 + X_2 + X_3 + X_4 \\ Y_{14} &= X_1 + X_2 + X_3 + X_4 \\ Y_{15} &= X_1 + X_2 + X_3 + X_4 \\ Y_{16} &= X_1 + X_2 + X_3 + X_4 \end{aligned}$$

Preparation

$$\begin{aligned} Y_{17} &= X_1 + X_2 + X_3 + X_4 + X_5 \\ Y_{18} &= X_1 + X_2 + X_3 + X_4 + X_5 \\ Y_{19} &= X_1 + X_2 + X_3 + X_4 + X_5 \\ Y_{20} &= X_1 + X_2 + X_3 + X_4 + X_5 \end{aligned}$$

Action

$$\begin{aligned} Y_{21} &= X_1 + X_2 + X_3 + X_4 + X_5 + X_6 \\ Y_{22} &= X_1 + X_2 + X_3 + X_4 + X_5 + X_6 \\ Y_{23} &= X_1 + X_2 + X_3 + X_4 + X_5 + X_6 \\ Y_{24} &= X_1 + X_2 + X_3 + X_4 + X_5 + X_6 \end{aligned}$$

Maintenance

Figure 2 - 4. An example of a correlation matrix ($R_{\eta\eta}$) of a simplex model

	PCN	PCB	C	P	A	M
PCN	1.00	.80	.75	.50	.30	.10
PCB		1.00	.80	.75	.50	.30
C			1.00	.80	.75	.50
P				1.00	.80	.75
A					1.00	.80
M						1.00

Circumplex Model

Description of a circumplex. A circumplex model (Guttman, 1954), on the other hand, is made up of elements from different domains which all have the same degree of complexity. In describing a particular example of an uniform, perfect, additive circumplex model, Guttman (1954) proposes that we have five tests (t_1 , t_2 , t_3 , t_4 , and t_5) which have a circular order determined by five elementary components (c_1 , c_2 , c_3 , c_4 , and c_5). The circumplex is called uniform because each test is a function of an equal number of the n elementary components. If our $n = 5$, tests form a uniform circumplex with $m = 3$, and if the components are additive, the structure in terms of components can be written as follows:

$$t_{1i} = c_{1i} + c_{2i} + c_{3i}$$

$$t_{2i} = \quad c_{2i} + c_{3i} + c_{4i}$$

$$t_{3i} = \quad \quad c_{3i} + c_{4i} + c_{5i}$$

$$t_{4i} = c_{1i} \quad \quad + c_{4i} + c_{5i}$$

$$t_{5i} = c_{1i} + c_{2i} \quad \quad + c_{5i}$$

See Figure 2 - 5. for an example of Guttman's Hypothetical Uniform Circumplex for 5 tests.

Figure 2 - 5. Guttman's (1954) Hypothetical Uniform Circumplex for 5 tests.

$$t1 = c1 + c2 + c3$$

$$t2 = c2 + c3 + c4$$

$$t3 = c3 + c4 + c5$$

$$t4 = c1 + c4 + c5$$

$$t5 = c1 + c2 + c5$$

Examples of applications of a circumplex. The area most closely identified with the circumplex model is family systems. Olson, Russell, and Sprenkle (1979; 1980; 1983) used a circumplex model to assess and intervene on families. One hypothesis that validates a circumplex model of family systems states that couples/families with balanced (two central levels) cohesion and adaptability will generally function more adequately across family life-cycle than those at the extreme of these dimensions. He also describes the Family Adaptability and Cohesion Evaluation Scale III (FACES-III) as a three dimensional circumplex model (Olson, 1991). Within the circumplex model, there are four levels of family cohesion: disengaged, separated, connected, and enmeshed. The two moderate or balanced levels of cohesion are labeled separated and connected. There are also four levels of family adaptability: rigid, structured, flexible, and chaotic. The two moderate or balanced levels of adaptability have been labeled flexible and structured. The balanced levels are hypothesized to be most viable for healthy family functioning and the extreme areas are seen generally to be more problematic for couples and families over time. See Figure 2 - 6. for the 16 types of family systems that can be identified by combining the four levels of cohesion and the four levels of adaptability. Four of the 16 are moderate on both cohesion and adaptability (balanced types). Eight types are extreme on one dimension and moderate on the other (mid-range types) and four types are extreme on both dimensions (extreme types). FACES III enables the researcher or clinician to place individual family members or groups of families within the circumplex model. FACES III is also designed so that it can assess how family members see their family (perceived) and how

they would like it to be (ideal). The perceived-ideal discrepancy for each family member assesses the level of family satisfaction.

Figure 2 - 6. Olson circumplex model of family systems.

Note: From FACES III D.H. Olson, 1985

The literature is replete with authors who have followed the lead of Olson and looked at a circumplex model in connection with family functioning. Takeda & Tatsuki (1991) looked at Japanese families. Franklin & Streeter (1993) followed 235 adolescents. Thomas and Olson (1993) worked on discriminating problem/clinical families from nonclinical families. Daley, Sowers-Hoag, and Thyer (1991) challenged the construct validity of the circumplex model of FACES-II. Mathis and Tanner (1991) looked at differences in later-life family systems. Smith (1989) used the circumplex model of marriage and family systems in training therapists. In the area of family violence, McKain (1987) has developed a treatment program for couples that is a circumplex model. Walsh and Olson (1988) demonstrated the clinical utility of the circumplex model for helping therapists to effectively assess the type of family system and to plan treatment with the dysfunctional families. Maddock and Lange (1988) have integrated Milan therapy and the circumplex model for a intervention based on the ecosystemic perspective in which a consultation team can use the circumplex model to help families improve.

Another area that uses the circumplex model extensively is personality theory. Wiggins, Trapnell, and Phillips (1988) demonstrate that the Interpersonal Adjective Scale (IAS) is constructed to conform to a circumplex and consequently must be evaluated by different structural criteria than other multivariate models. Wiggins and Broughton (1991) show that the IAS scales were constructed to provide geometrically precise semantic markers of that domain in the form of a circumplex model organized around the orthogonal coordinates of dominance and nurturance. Wiggins and Pincus

(1989) found that differing conceptions of personality disorders inherent in the Minnesota Multiphasic Personality Inventory (MMPI), Personality Disorder Scales (PDS), and the Personality Adjective Checklist (PAC) were evaluated within the context of the circumplex model of interpersonal behavior and the 5-Factor model of personality. The full 5-Factor model was required to capture and clarify the entire range of personality disorders.

Another important name in personality research that also used the circumplex was Holland. His RIASEC circumplex included six personality types: R (realistic), I (investigative), A (artistic), S (social), E (enterprising), and C (conventional). Prediger (1982) adapted Holland's model to a 3-factor (one general factor and two bipolar factors of data-ideas and things-people) (Tracey & Rounds, 1992; Rounds & Tracey, 1993).

How a circumplex is appropriate to the stage model. The stages of change could be conceived of as a circumplex because the great majority of staging has been from discrete algorithms. The notion that lies behind a discrete algorithm is that the phenomena being tested are separate groups. This separateness is not dissimilar to the separate domains of a circumplex. A second reason to explore the concept of the circumplex as a possible representation of the stages of change arises from Discriminant Function Analysis using the items of the URICA-E1 as predictors and the stages of the five question algorithm for vigorous exercise as the criterion groups. When the group centroids were plotted, the image depicted was not unlike a circle joining Maintenance back up to Precontemplation. This is also the image depicted by a circumplex. A possible way of depicting a circumplex is found in Figure 2 - 7. A

circumplex will look for separate domains that all have a similar degree of complexity. It is of note that all the examples mentioned above use the bi-polar second order factor models to describe the model e.g. Holland's ideas-data and things-people. Stability-instability and exercising-not exercising are the bi-polar second order factors for exercise and the Transtheoretical Model. See Figure 2 - 8. for a numerical representation of item composition and Figure 2 - 9. for an example of a correlation matrix for a circumplex.

Figure 2 - 7. Circumplex model for exercise.

Figure 2 - 8. Circumplex Model, Numerical Representation of Item Composition

$Y_1 = X_1 + X_2$ $Y_2 = X_1 + X_2$ $Y_3 = X_1 + X_2$ $Y_4 = X_1 + X_2$	Stability +	Exercising 0	Precontemplation Nonbeliever
$Y_5 = X_2 + X_3$ $Y_6 = X_2 + X_3$ $Y_7 = X_2 + X_3$ $Y_8 = X_2 + X_3$	0	-	Precontemplation Believer
$Y_9 = X_3 + X_4$ $Y_{10} = X_3 + X_4$ $Y_{11} = X_3 + X_4$ $Y_{12} = X_3 + X_4$	-	-	Contemplation
$Y_{13} = X_4 + X_5$ $Y_{14} = X_4 + X_5$ $Y_{15} = X_4 + X_5$ $Y_{16} = X_4 + X_5$	-	0	Preparation
$Y_{17} = X_5 + X_6$ $Y_{18} = X_5 + X_6$ $Y_{19} = X_5 + X_6$ $Y_{20} = X_5 + X_6$	0	+	Action
$Y_{21} = X_6 + X_1$ $Y_{22} = X_6 + X_1$ $Y_{23} = X_6 + X_1$ $Y_{24} = X_6 + X_1$	+	+	Maintenance

Figure 2 - 9. An example of a correlation matrix ($R_{\eta\eta}$) of a circumplex model.

	PCN	PCB	C	P	A	M
PCN	1.00	.80	.60	-.80	.60	.80
PCB		1.00	.80	.60	-.80	.60
C			1.00	.80	.60	-.80
P				1.00	.80	.60
A					1.00	.80
M						1.00

Precontemplation-Nonbelievers (PCNs) can be considered a stable state where movement is unlikely. This is represented by a plus (+) sign. It can be theorized that exercise behavior is immaterial to PCN people. It is almost outside their realm, so it has been rated as a zero (0) symbolizing neutrality. Precontemplation-Believers (PCBs) are people who potentially could move, but at this time do not intend to. This makes stability a zero because the positive and the negative cancel each other out. PCB people are not exercising, so that is represented by a minus sign (-). Contemplation (C) has minus signs for both stability and exercising because there is movement generally found in this stage, but Cs are not exercising. Preparation has a minus sign for stability, being by definition, the stage in which one stays the shortest amount of time. Preparation (P) persons can be symbolized by a zero for exercising because there is a good possibility that they are doing some exercise even if not regularly. Action (A) could be theorized as having a neutral value for stability because, although it is time limited (6 months long) and, therefore, unstable (represented by a minus sign); it is also a desirable state (represented by a positive sign) in that exercise is being participated in regularly. These cancel each other out and leave a zero rating for stability and a positive sign for exercise. Maintenance (M) has positive ratings for both stability and exercise. It should be noted that this sets up bi-polar pairs between PCN and A, PCB and P, and C and M.

Punctuated Equilibrium

Description of Punctuated Equilibrium. Punctuated equilibrium (Gersick, 1991) is defined as a system which alternates between periods of stability where change is

only incremental in nature and periods of revolution where the deep structure is abruptly and fundamentally altered.

Gersick (1991) points out that systems don't always move from lower to higher behaviors, through a series of hierarchical steps, to a pre-set end. Their histories are unique. She defines deep structure as both the network of choices a system makes in order to establish a certain configuration and organization, and as the activities it takes to maintain this configuration while exchanging resources with the outside environment. A state of equilibrium is described as the time when the deep structure paths are followed. There can be turbulence and perturbation experienced in following the deep structure paths, but no significant change in the deep structure. Three of the greatest barriers to revolution are: the system's cognitions, motivations and obligations. Revolution comes rapidly and briefly. It unmakes the deep structures and leaves the system in temporary disarray, until a new set of choices coalesces around a new deep structure. Interestingly, failure and temporal milestones have been found to be catalysts to revolution.

Examples of Applications of Punctuated Equilibrium. This model has a number of proponents in a variety of fields. The term punctuated equilibrium comes from the study of evolution. Stephen Jay Gould (1980) in the Panda's Thumb, a series of essays on natural science, and Gould and Eldredge (1993) proposed two observations that take Darwin one step further. Darwin espoused the theory of natural selection as an orderly, stately process which worked at a speed so slow as to be imperceptible by man in an ordinary lifetime. It has been said that his motto was "*Natura non facit saltum*".

(Nature does not make leaps.) When Gould and Eldredge studied the fossil record, two things were apparent. The first was stasis. Most things leave the fossil record looking just the way they did when they appeared. The second was sudden appearances. New fossils appeared in the fossil record as brand new, fully formed creatures. This is called speciation and it replenishes the earth with new species that branch off from persisting parental stock. Although the term came from the study of evolution, it has been used to describe theories that echo the type of pattern where long periods of stability are occasionally broken by a revolutionary change or punctuation. It has been applied to the thought of Thomas Kuhn (1970). Kuhn espoused the phrase paradigm and labeled changes in schools of thought as paradigm shifts. It has also been applied to the work of Prigogine and Stengers (1984) where they studied the (thermo) dynamic relationship between order and chaos and the nature of transformatory change. Tushman and Romanelli (1985) took the concept of punctuated equilibrium into the field of organization. They studied executive succession and organizational outcomes in turbulent environments. They detected radical change and reorganization around a new structure as one of the possible permutations an organization in trouble can go through. Gersick (1988) has also found punctuated equilibrium to exist in the study of groups. She studied eight naturally occurring groups in six organizations. She found that the groups alternated between periods of inertia and times of revolution in both their behavior and the themes through which the groups approached their work.

How punctuated equilibrium is appropriate to the stage model. Could punctuated equilibrium be a model of the Stages of Change? This possibility needs to be explored. As so many changers are painfully aware, progress through the stages of

change is sporadic and often cyclical. Attempts are often followed by relapse. Does this mean that the deep structure had not been sufficiently unmade that a new structure could coalesce? Perhaps unprepared change only causes perturbation and turbulence, but no significant change in deep structure. Regression to an earlier stage would result because a truly new state had not been established. The presumption would then follow that if a new deep structure had been attained, regression to a previous stage would not ensue unless another deep structure change occurred and changed a person to another stage of change. As Gersik pointed out, three of the greatest barriers to revolution are a system's cognitions, motivations and obligation. Stage theorists would look to the variables of the Transtheoretical Model to assess barriers to change. Putting a high value of importance on the onerous or difficult aspects of change, being highly tempted in many situations, and under-using the processes of change are seen as the greatest barriers to successful behavior change. Gersick points out that revolution comes rapidly. Only briefly is the system in a state of disarray. Whether this is congruent with stage of change theory needs to be explored. It could have implication for interventions. Different discontinuity points generate a family of possible models. A picture of three possible models of the stages of change as demonstrating punctuated equilibrium are seen in Figures 2 - 10., 2 - 11., and 2 - 12..

Figure 2 - 10. Punctuated Equilibrium, Single break between (Precontemplation-Non Believer) and the Simplex of (Precontemplation-Believer-Contemplation-Preparation-Action-Maintenance).

Figure 2 - 11. Punctuated Equilibrium, Single break between simplex of
(Precontemplation-Non Believer-Precontemplation-Believer-Contemplation-
Preparation) and the simplex of (Action-Maintenance).

Figure 2 - 12. Punctuated Equilibrium, Double breaks between (Precontemplation-Non Believer) and the simplex of (Precontemplation-Believer-Contemplation-Preparation) and the simplex of (Action-Maintenance).

Punctuated equilibrium searches for a theory of stage where one or more discontinuities indicates a break with the past and the forming of a new deep structure. Three versions illustrating item level relationships for different breaks in the continuity are illustrated in Figures 2 - 13., 2 - 15., and 2 - 17.. The correlations between the constructs are illustrated in Figures 2 - 14., 2 - 16., and 2 - 18.

Figure 2 - 13. Representation of item level relationships: Punctuated equilibrium, single break between PCN and PCB-C-P-A-M.

$Y_1 = X_1$ $Y_2 = X_1$ $Y_3 = X_1$ $Y_4 = X_1$	Precontemplation Nonbeliever
Precontemplation Believer	$Y_5 = X_2 + X_3$ $Y_6 = X_2 + X_3$ $Y_7 = X_2 + X_3$ $Y_8 = X_2 + X_3$
Contemplation	$Y_9 = X_2 + X_3 + X_4$ $Y_{10} = X_2 + X_3 + X_4$ $Y_{11} = X_2 + X_3 + X_4$ $Y_{12} = X_2 + X_3 + X_4$
Preparation	$Y_{13} = X_2 + X_3 + X_4 + X_5$ $Y_{14} = X_2 + X_3 + X_4 + X_5$ $Y_{15} = X_2 + X_3 + X_4 + X_5$ $Y_{16} = X_2 + X_3 + X_4 + X_5$
Action	$Y_{17} = X_2 + X_3 + X_4 + X_5 + X_6$ $Y_{18} = X_2 + X_3 + X_4 + X_5 + X_6$ $Y_{19} = X_2 + X_3 + X_4 + X_5 + X_6$ $Y_{20} = X_2 + X_3 + X_4 + X_5 + X_6$
Maintenance	$Y_{21} = X_2 + X_3 + X_4 + X_5 + X_6 + X_7$ $Y_{22} = X_2 + X_3 + X_4 + X_5 + X_6 + X_7$ $Y_{23} = X_2 + X_3 + X_4 + X_5 + X_6 + X_7$ $Y_{24} = X_2 + X_3 + X_4 + X_5 + X_6 + X_7$

Figure 2 - 14. Example of correlation matrix: Punctuated equilibrium, single break
between PCN and PCB-C-P-A-M.

	PCN	PCB	C	P	A	M
(PCN)	1.00	0	0	0	0	0
(PCB)		1.00	.80	.60	.40	.20
(C)			1.00	.80	.60	.40
(P)				1.00	.80	.60
(A)					1.00	.80
(M)						1.00

Figure 2 - 15. Representation of item level relationships: Punctuated equilibrium, single break between PCN-PCB-C-P and A-M.

$Y_1 = X_1 + X_2$ $Y_2 = X_1 + X_2$ $Y_3 = X_1 + X_2$ $Y_4 = X_1 + X_2$	Precontemplation Nonbelievers
$Y_5 = X_1 + X_2 + X_3$ $Y_6 = X_1 + X_2 + X_3$ $Y_7 = X_1 + X_2 + X_3$ $Y_8 = X_1 + X_2 + X_3$	Precontemplation Believers
$Y_9 = X_1 + X_2 + X_3 + X_4$ $Y_{10} = X_1 + X_2 + X_3 + X_4$ $Y_{11} = X_1 + X_2 + X_3 + X_4$ $Y_{12} = X_1 + X_2 + X_3 + X_4$	Contemplation
$Y_{13} = X_1 + X_2 + X_3 + X_4 + X_5$ $Y_{14} = X_1 + X_2 + X_3 + X_4 + X_5$ $Y_{15} = X_1 + X_2 + X_3 + X_4 + X_5$ $Y_{16} = X_1 + X_2 + X_3 + X_4 + X_5$	Preparation
Action	$Y_{17} = X_6 + X_7$ $Y_{18} = X_6 + X_7$ $Y_{19} = X_6 + X_7$ $Y_{20} = X_6 + X_7$
Maintenance	$Y_{21} = X_6 + X_7 + X_8$ $Y_{22} = X_6 + X_7 + X_8$ $Y_{23} = X_6 + X_7 + X_8$ $Y_{24} = X_6 + X_7 + X_8$

Figure 2 - 16. Example of correlation matrix: Punctuated equilibrium, single break between PCN-PCB-C-P and A-M.

	PCN	PCB	C	P	A	M
(PCN)	1.00	.80	.60	.40	0	0
(PCB)		1.00	.80	.60	0	0
(C)			1.00	.80	0	0
(P)				1.00	0	0
(A)					1.00	.80
(M)						1.00

Figure 2 - 17. Representations of item level relationships: Punctuated equilibrium, double break between PCN and PCB-C-P and A-M.

Figure 2 - 18. Example of correlation matrix :Punctuated equilibrium, double break between PCN and PCB-C-P and A-M.

	PCN	PCB	C	P	A	M
(PCN)	1.00	0	0	0	0	0
(PCB)		1.00	.80	.60	0	0
(C)			1.00	.80	0	0
(P)				1.00	0	0
(A)					1.00	.80
(M)						1.00

Recapitulation of Preliminary Analyses

In Study One, a continuous measure of stage of change for exercise, the URICA-E2 was developed. The URICA-E2 added a fifth stage, Preparation, to the four stages of Precontemplation, Contemplation, Action, and Maintenance, found in the URICA and URICA-E1. The URICA-E2 also attempted to clear up a confusion that appeared in URICA-E1 between Precontemplation and Maintenance and to improve the item content.

In Study One, URICA-E2 was administered to an adult sample of convenience and was then analyzed using Principal Component Analysis (PCA) in replication of the work done by McConnaughy et al. (1983) and McConnaughy et al. (1989). Upon examination it was found that not only had Preparation been added to Precontemplation, Contemplation, Action, and Maintenance, but Precontemplation had split in two giving a six component solution.

Validation of this six component model was done using Confirmatory Factor Analysis (CFA) (Bentler, 1989; Joreskog & Sorbom, 1989). Fifteen models were tested. The correlated six factor model proved to have the best fit.

To refine the instrument, PCA was then used to create a more parsimonious version. A twenty-four item version with four items per construct was chosen. To validate the parsimonious version, a CFA was done using the same items. These items were used to form standardized scale scores. The standardized scale scores of the subjects were entered in a cluster analysis to determine if discrete subtypes exist with respect to the stages of change for exercise. Seven profiles were found and named.

Each of the six profiles corresponded to a single stage of change and the seventh was a complex profile labeled Ambivalent.

Stages of Change

Stages of change are a critical integrating concept in the Transtheoretical Model. Previous research has focused on the relationship between the stages of change and either the dependent or independent variables in the model. Other studies have employed the Transtheoretical Model to guide the development of interventions which facilitate change for problem behaviors. However, no studies have attempted to evaluate which of several alternative theoretical models represents the best way to conceptualize this stage theory. In this study, we will compare three models: a simplex model (Guttman, 1954), a circumplex model (Guttman, 1954), and finally a punctuated equilibrium model (Gersick, 1991).

The URICA-E2

The instrument employed for this comparison was the URICA-E2, a continuous staging measure for exercise. This measure was based on the University of Rhode Island Change Assessment (URICA) (McConaughy, Prochaska, & Velicer, 1983; McConaughy, DiClemente, Prochaska, & Velicer, 1989) and the University of Rhode Island Change Assessment for Exercise (URICA-E1) adapted for exercise by Bess Marcus for a worksite study and analyzed by this author (Reed, Velicer, Rossi, & Marcus, August, 1993; March 1994). The URICA and the URICA-E1 both measure four Stages of Change: Precontemplation (PC), Contemplation (C), Action (A), and Maintenance (M). In early work and again in recent work the Transtheoretical Model

has been conceptualized as including five stages of change (Velicer, Prochaska, Rossi & Snow, 1992): Precontemplation (PC), a stage where no change in behavior is planned for at least the next 6 months; Contemplation (C), where change is planned within the next 6 months; Preparation (P), where change is planned in the next 30 days and some type of action has been attempted in the last year; Action (A), where change has begun and has been sustained for less than 6 months; and Maintenance (M), where change has been maintained for longer than 6 months. The URICA-E2 was analyzed using Principal Component Analysis and refined into a 24 item instrument capturing not five, but six components of change: Precontemplation-Nonbeliever (PCN), Precontemplation-Believer (PCB), Contemplation (C), Preparation (P), Action (A), and Maintenance (M).

The URICA-E2 is the only way to evaluate competing theoretical models. Because each stage is represented by four questions, one can examine the correlational relationship between the stages by setting up a structural model. In the measurement model each of the four sets of items represent a stage construct. The analysis results in overall fit indices, factor loadings which show how well each item represents its particular construct and a correlation matrix of the relationship between the stage constructs. It is this relationship that will be the focal point of Study Two.

Method

Subjects

As described in Study One, an adult sample of convenience was used. Names and addresses had been obtained from Survey Sampling, Inc., a company that has random samples for sale. Most of the sample was pulled from telephone books of the six New England states: Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine. It was drawn in proportion to state population. The balance of the sample was composed of those invited to three recent weddings, that of the researcher's son, the researcher's nephew and of a family friend. The data was collected until a sample of at least 300 was reached. The final N was 327.

Procedure

In Study One, the URICA-E2, a continuous measure of stage of change for regular exercise, was analyzed and refined into a 24 item, six stage (four items per construct) instrument using Principal Component Analysis. It was then confirmed using Confirmatory Factor Analysis (CFA), using Structural Equation Modeling (Bentler, 1989; Joreskog & Sorbom, 1989). In Study Two, the next step was to test a variety of possible models to explore a few possible relationships between the stage constructs. The procedure was to use LISREL VII (Joreskog & Sorbom, 1990) to fit the data to two simplex models, (1) a basic simplex with correlations existing between adjacent stages, (2) a more complicated simplex with relationships between alternate stages as well as between adjacent stages; three circumplex models, (1) a circumplex with relationships between each adjacent stage including M to PCN, (2) a circumplex

that adds relationships between the alternate stages to the relationships between the adjacent stages, (3) a circumplex that adds relationships between the opposite stages to the relationships between the adjacent stages, and (4) a circumplex that has relationships between the opposite, adjacent and alternate stages; and three punctuated equilibrium models (1) a punctuated equilibrium model with a single break between Precontemplation-Non Believer and Precontemplation-Believer-Contemplation-Preparation-Action-Maintenance, (2) a punctuated equilibrium model with a single break between Precontemplation-Non Believer-Precontemplation-Believer-Contemplation-Preparation and Action-Maintenance, and (3) a punctuated equilibrium model with double breaks between Precontemplation-Non Believer and Precontemplation-Believer-Contemplation-Preparation and Action-Maintenance. Model fit was ascertained by a variety of overall fit indices including: Chi-square (χ^2), Root Mean Square Residual (RMS) (Joreskog & Sorbom, 1986), Goodness of Fit Index, (GFI) (Joreskog & Sorbom, 1986), and Comparative Fit Index (CFI) (Bentler, 1990). Figure 2 - 19 displays the two types of simplex models. Figure 2 - 20 shows the four variants of circumplex models. Figure 2 - 21 lays out the three selected versions of punctuated equilibrium models.

Figure 2 - 19. Simplex Models I & II

Simplex I

Simplex II

Figure 2 - 20. Circumplex Models I, II, III, and IV

Figure 2 - 21. Punctuated Equilibrium Models I, II, & III

Results

Table 2 - 1 displays the results of testing two types of simplex, four types of circumplex and three types of punctuated equilibrium models using CFA. The first simplex model, with strong correlations posited between adjacent stages, produced a 5.1 ratio of χ^2 to degrees of freedom. The ratio improves slightly to 4.5 with the addition of strong correlations between alternate stages as well as adjacent ones. The CFI rises from .823 to .853. The most basic circumplex, that shows a high correlation of each stage to its adjoining stage including Maintenance to Precontemplation-Nonbeliever, has a ratio of 4.9 and a CFI of .834. With the addition of alternate stages to adjacent stages, the ratio of χ^2 to degrees of freedom improves to 4.4 and the CFI to .856. With the addition of opposite stages to adjacent stages, the ratio is 4.3 and the CFI .859. The final version adds all the paths: adjacent, alternate, and opposite and gets the ratio down dramatically to 3.6 and the CFI up to .892. This fourth type of circumplex model had nearly comparable results to running the data without imposing any pattern restraints. It had a ratio of 3.6 whereas the unrestrained data had a 3.5. Circumplex IV had a CFI of .892 and the unrestrained data had a .893. The first punctuated equilibrium model with a single break between PCN and PCB-C-P-A-M had a ratio of 5.5 and a CFI of .806. The second example of punctuated equilibrium with a single break between PCN-PCB-C-P and A-M showed a ratio of 5.1 and a CFI of .821. The third version of punctuate equilibrium with double breaks between PCN and PCB-C-P and A-M had a ratio as high as punctuated equilibrium one (5.5) and a CFI of .803.

Table 2 - 1

Model Comparisons using CFA (24 Items)

Model	df	χ^2	GFI	CFI	Ratio	RMS
NULL	276	6002.25				
24 Item	237	852.30	.818	.893	3.6	.093
6 Factor						
Simplex	247	1255.24	.760	.823	5.1	.248
I						
Simplex	243	1081.08	.780	.853	4.5	.126
II						
Circum	246	1194.83	.779	.834	4.9	.221
I						
Circum	240	1064.44	.784	.856	4.4	.253
II						
Circum	243	1052.82	.787	.859	4.3	.196
III						
Circum	237	852.30	.818	.892	3.6	.093
IV						
Punct Eq	248	1357.80	.739	.806	5.5	.261
I						
Punct Eq	248	1272.43	.758	.821	5.1	.235
II						
Punct Eq	249	1374.99	.738	.803	5.5	.250
III						

Table 2 - 2 contains the correlation matrices of the stage constructs for the two simplex, four circumplex and three punctuated equilibrium models. Simplex I shows the classic pattern. The main diagonal that represents the relationships between the adjacent stages shows high positive correlations between PCN and PCB (.621) medium correlations between PCB and C (.477) and between C and P (.406). The relationship between P and A is low (.267). The relationship between A and M is the highest of all (.678). When you add alternate stages paths to the basic simplex, you get a rise in all the correlations, but the exact same pattern A to M still has the highest correlation (.732) followed by PCN to PCB (.626). The lowest correlation is still P to A (.441). The difference is that the two middle relationships are switched with C to P (.576) being higher than PCB to C (.533). The correlations between alternating stages are negligible: PCN to C (.166), PCB to P (.050), C to A (-.306), and P to M (-.061).

The four circumplex models improve as paths are added. Circumplex I is not that different from simplex I along the main diagonal: PCN to PCB (.568), PCB to C (.499), C to P (.381), P to A (.252), A to M (.644) and M to PCN (-.221). The patterns start to change with circumplex II. Along the main diagonal there is found PCN to PCB (.489), PCB to C (.479), C to P (.660), P to A (.641), A to M (.715) and M to PCN (-.481). The pattern shifts again with circumplex III. The correlations along the main diagonal are: PCN to PCB (.512), PCB to C (.110), C to P (.498), P to A (.481), A to M (.513) and M to PCN (-.179). The correlation matrix for the fourth type of circumplex is nearly identical to the unrestrained model. Along the main diagonal is seen: PCN to PCB (.635), PCB to C (.500), C to P (.448), P to A (.335), A to M (.689) and M to PCN (-.514).

Table 2 - 2

Reproduced Correlation Matrices of Stage Constructs:Unrestrained Model and Simplex I & II24 ITEM 6 FACTORS No Pattern Restraints

PCN					
PCB	.635				
C	.114	.500			
P	.109	.073	.448		
A	-.386	-.575	-.240	.335	
M	-.514	-.707	-.642	-.003	.689

Simplex I

PCN					
PCB	.621				
C	.296	.477			
P	.120	.194	.406		
A	.032	.052	.108	.267	
M	.022	.035	.073	.181	.678

Simplex II

PCN					
PCB	.626				
C	.166	.533			
P	-.097	.050	.576		
A	-.229	-.400	-.306	.441	
M	-.170	-.402	-.563	-.061	.732

Table 2 - 3

Reproduced Correlation Matrices of Stage Constructs:Circumplex Models I, II, III, & IV

Circumplex I					
PCN					
PCB	.568				
C	0	.499			
P	0	0	.381		
A	0	0	0	.252	
M	-.221	0	0	0	.644
Circumplex II					
PCN					
PCB	.489				
C	-.127	.479			
P	0	.287	.660		
A	-.284	0	.369	.641	
M	-.481	-.289	0	.352	.715
Circumplex III					
PCN					
PCB	.512				
C	0	.110			
P	.199	0	.498		
A	0	-.187	0	.481	
M	-.179	0	-.572	0	.513
Circumplex IV					
PCN					
PCB	.635				
C	.114	.500			
P	.109	.073	.448		
A	-.386	-.575	-.240	.335	
M	-.514	-.707	-.642	-.003	.689

Table 2 - 4

Reproduced Correlation Matrices of Stage Constructs:Punctuated Equilibrium Models I, II, & III

Punctuated Equilibrium I

PCN					
PCB	0				
C	0	.495			
P	0	.201	.405		
A	0	.054	.108	.267	
M	0	.036	.075	.181	.678

Punctuated Equilibrium II

PCN					
PCB	.621				
C	.296	.477			
P	.126	.203	.426		
A	0	0	0	0	
M	0	0	0	0	.692

Punctuated Equilibrium III

PCN					
PCB	0				
C	0	.496			
P	0	.211	.426		
A	0	0	0	0	
M	0	0	0	0	.692

Figure 2 - 22. depicts the circumplex IV model: item numbers, item loadings and correlations between the stages.

Figure 2 - 22. Circumplex IV, CFA loadings and correlations between constructs.

Discussion

Among the models tested, it was clear that the fourth type of circumplex was by far the closest match to the unrestrained data. This reinforces two important notions about a circumplex. The first notion is the idea of reciprocity and the second is that of circularity. In this circumplex, PCN is highly correlated with ($r = .635$) PCB and PCB is correlated ($r = .500$) to C, and C is nearly as correlated ($r = .448$) to P. Strangely enough the correlation of P to A dropped ($r = .335$). As expected A was highly correlated ($r = .689$) to M and M was ($r = -.514$) negatively correlated to PCN. Interestingly, the highest negative relationship ($r = -.707$) was found between M and PCB, followed closely by M to C ($r = -.642$) and A to PCB ($r = -.575$). Two of these (M to C and A to PCB) are opposite relationships which are expected to have a strong negative correlation within the context of a circumplex (Olson, 1988a; 1988b). M to PCB is a relationship of alternate stages and was not expected, in the schema of a circumplex, to have the highest negative correlation. The other opposite relationship (PCN to P) is .109 signifying almost no correlation between the stages. The other relationships between alternate stages were all low M to P ($-.003$), PCB to P ($.073$), PCN to C ($.114$), C to A ($-.240$), and PCN to A ($-.386$).

An interesting comparison to make is to look at the main diagonals of the correlation matrices for all the models tested. This lays out the central relationships between adjacent stages. See Table 2 - 5. It can be seen that there are some generalized patterns. The lowest relationship, in a majority of the models, is from P to A. The highest is usually from A to M, followed by PCN to PCB. PCB to C, and C

to P were generally similar and in the .400s. Only circumplex IV produces the relatively high negative correlation between M and PCN that we are seeking. Most of the others had low negative correlations.

Table 2 - 5

Comparison of correlations between adjacent stages of change

	PCN to PCB	PBC to C	C to P	P to A	A to M	M to PCN
24 Item	.635	.500	.448	.335	.689	-.514
Simp I	.621	.477	.406	.267	.678	.022
Simp II	.626	.533	.576	.441	.732	-.170
Circ I	.568	.499	.381	.252	.644	-.221
Circ II	.489	.479	.660	.641	.715	-.481
Circ III	.512	.110	.498	.481	.513	-.179
Circ IV	.635	.500	.448	.335	.689	-.514
PE I	0	.495	.405	.267	.678	0
PE II	.621	.477	.426	0	.692	0
PE III	0	.496	.426	0	.692	0

Intuition and data have shown us that people recycle back to previous stages as well as move forward. This seems intuitive for exercise. Fifty percent of the people who start exercise programs quit them within the first six months. Many people start and stop regular exercise many times in the course of their lives. Even the most dedicated exercisers get injuries, go on vacations or business trips, or become ill at times. All these things can upset the most programmed routine.

Study Three

Introduction

Study Three validated the continuous measure of stages of change, the URICA-E2, against the other measures of the Transtheoretical Model of Behavior Change.

The Transtheoretical Model.

The Transtheoretical Model of Behavior Change uses a number of latent constructs: decisional balance, self-efficacy, and the processes of change, in addition to the stages of change. These constructs are derived from a variety of sources. Each is operationalized by a measure composed of a series of items unique to a problem behavior. These items have been tested and refined to develop highly reliable instruments for a number of problem behaviors, with the most extensive work involving smoking cessation.

Within the Transtheoretical Model, the dependent measures include the two scales from the Decisional Balance Measure, the Pros and Cons (Velicer, DiClemente, Prochaska, & Brandenburg, 1985). These concepts are based on Janis and Mann's (1977) concept of decisional balance. A second set of dependent measures are the three scales of the Confidence/Temptation or Self-efficacy measures (Velicer, DiClemente, Rossi, & Prochaska, 1990). This measure is based on Bandura's (1977) self-efficacy construct which involves the degree of confidence subjects have that they will not engage in a problem behavior in tempting situations. The dependent measures also

include the behaviors appropriate for a specific problem area, in this case, measures of hours of vigorous exercise engaged in over the last week.

The independent measures include the influences from the internal and external environment (including interventions) and the ten processes of change (Prochaska, Velicer, DiClemente, & Fava, 1988). The ten processes of change measured in the model are garnered from a review of psychotherapy techniques (Prochaska, 1984) and represent the behaviors, cognitions and emotions which the subjects engage in during the course of changing a behavior. In this study, the processes of change will not be used.

The core organizing concept of the Transtheoretical Model is the temporal dimension represented by the stages of change. It can be measured in two ways: by means of a short form algorithm and by a continuous measure. One single question short form staging algorithm was used in Study Three.

In Study One, a continuous measure of stage of change, the URICA-E2, was developed. In Study Two, simplex, circumplex, and punctuated equilibrium models were tested to better understand what underlies the stage of change construct for regular exercise. In Study Three, the other constructs of the Transtheoretical Model of Behavior Change, such as the Pros and Cons of regular exercise (Marcus, Rakowski, & Rossi, 1992;), The Confidence/Temptation instruments (Marcus, Selby, Niaura, & Rossi, 1992), self report measures of time spent exercising (Blair, 1984; Taylor, Coffey, Berra, Iaffaldano, Casey, & Haskell, 1984; Sallis, Haskell, Wood, Fortmann,

Rogers, Blair, & Paffenbarger, 1985), and a single question short form staging algorithm were examined for a relationship with the URICA-E2.

Dependent Measures

Decisional Balance For Regular Exercise. The Pros and Cons of regular exercise (Marcus, Rakowski, & Rossi, 1992;) were based on the decisional balance measure for smoking (Velicer et al, 1985). It assessed the perceived positive aspects (pros) and negative aspects (cons) of regular exercise. Persons in the early stages of Precontemplation and Contemplation have been found to have low scores for the Pros and high Con scores for exercising regularly. These early stage people are focused on the difficult aspects of regular exercise. Persons in the Action and Maintenance stages have been found to have high Pro scores and medium to low Con scores. These people are concentrating on the benefits of regular exercise. Subjects in the Preparation stage have balanced Pro and Con scores. When graphing the Pros and Cons across the stages, the classic pattern resembles an X. The pros rise from low to high across the continuum of stages (PC, C, P, A, and M). The cons fall from high to medium across the stage continuum.

Confidence for Regular Exercise. The confidence instrument for regular exercise (Marcus, Selby, Niaura, & Rossi, 1992), was based on the self-efficacy smoking measure (Velicer, DiClemente, Rossi, & Prochaska, 1990). Self-efficacy theory holds that confidence in one's ability to perform a behavior, in this case, regular exercise, is strongly related to one's actual ability to perform the behavior (Bandura, 1977). A linear relationship has been found for the confidence instrument across the

continuum of stages. Precontemplation has the lowest scores and they rise progressively to Maintenance which has the highest.

Hours of Regular Exercise. The measure of hours spent on vigorous exercise in the last seven days used in this study is a version of the Seven-Day Physical Activity Recall (PAR) (Blair, 1984; Taylor et al., 1984, Sallis et al., 1985),

Measures of Stage of Change

Single Question Algorithm of Vigorous Exercise. The single question algorithm for stage of change was developed for a screening instrument of the Cancer Prevention Research Center called the General Health Survey (GHS).

Continuous Measure for Stage of Change. The continuous measure for stage of change for regular exercise, URICA-E2, is based on the University of Rhode Island Change Assessment (URICA) (McConnaughy, Prochaska, & Velicer, 1983; McConnaughy, DiClemente, Prochaska, & Velicer, 1989) and the University of Rhode Island Change Assessment for Exercise (URICA-E1) adapted for exercise by Bess Marcus for a worksite study and analyzed by this author (Reed, Velicer, Rossi, & Marcus, August, 1993; March 1994).

Method

Subjects

As described in Study One, an adult sample of convenience was used. Names and addresses had been obtained from Survey Sampling, Inc., a company that has random samples for sale. Most of the sample was pulled from telephone books of the

six New England states: Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine. It was drawn in proportion to state population. The balance of the sample was composed of those invited to three recent weddings, that of the researcher's son, the researcher's nephew, and of a family friend. The data were collected until a sample of at least 300 was reached. The final N was 327.

Procedure

Study Three concentrated on the analyses which sought to externally validate the URICA-E2 against outside instruments such as the single question algorithm that measures stage of change. It also examines the URICA-E2 against decisional balance for regular exercise, confidence for regular exercise, and a question on the number of hours a participant has spent on vigorous regular exercise in the last seven days.

Instruments

URICA-E2. This is a proportionate or continuous measure of stage of change as measured by the Transtheoretical Model of Behavior Change. It is a 24 item instrument written to include the five stages of change: Precontemplation, Contemplation, Preparation, Action, and Maintenance. It was developed and refined in Study One where six components were discovered using Principal Component Analysis (PCA): Precontemplation-Nonbelievers in exercise (PCN), Precontemplation-Believers in exercise (PCB), Contemplation (C), Preparation (P), Action (A), and Maintenance (M). The scale scores from the 24 items were clustered and seven profiles were discovered and named: PCN, PCB, C, P, ABV, A, and M.

In Study Two, plausible models that underlie the stage of change construct were tested. A circumplex model that has reciprocal relationships between adjacent, alternate, and opposite stages was found to nearly duplicate the exercise data.

Single Question Algorithm for regular exercise. This instrument is preceded by a definition of regular vigorous exercise.

Regular exercise = 3 times or more per week for 20 minutes or longer. Exercise includes activities such as brisk walking, jogging, swimming, aerobic dancing, biking, rowing, etc. Activities that are primarily sedentary, such as bowling or playing golf with a golf cart, would not be considered exercise.

It is followed by a single question which offers the following five possible choices of which the participant is to pick one:

- Yes, I have been for more than 6 months.
- Yes, I have been for less than 6 months.
- No, but I am planning to start in the next 30 days.
- No, but I am planning to start in the next 6 months.
- No, and I don't plan to start in the next 6 months.

Decisional Balance for regular exercise. This is a 22 item instrument using a five point Likert scale from, not important to extremely important. The instrument presents the definition of vigorous regular exercise and asks subjects to indicate how important each of the statements is in their decision to exercise regularly. Eleven of the items are Pros of regular exercise and eleven of the items are the difficulties or Cons of regular exercise. This instrument was developed outside the scope of this project and was reduced to a 14 item instrument, with seven Pros and seven Cons.

Confidence for regular exercise. This is a seven item instrument using a five point Likert scale from not at all confident to very confident. The instrument presents the definition of vigorous regular exercise and asks subjects to indicate how confident

they are that they will exercise regularly in particular situations. The situations represent the domains of negative affective, social positive, and difficult situations. This instrument was developed outside the scope of this project and discovered to represent a single dimension rather than the three underlying concepts that it had been written to capture.

Hours of regular exercise. This instrument was used in a worksite study (Marcus, Rossi, Selby, Niaura & Abrams, 1992; Marcus, Rakowski, & Rossi, 1992; Marcus, Selby, Niaura, & Rossi, 1992). This questions seeks to arrive at a quantitative estimate of total number of hours, to the nearest half hour spent doing vigorous exercise during the last seven days.

Analysis

Stages: Discrete versus Continuous

Cross Classification: Profiles by Single Question Algorithm. Using the profiles from the cluster analysis, a classification matrix was generated to discover how well the Single Question algorithm classified subjects into the same stages as the URICA-E2 profiles. Agreement was determined by examining the percentage correct in the cross-classification matrix and looking at the off diagonal pattern for disagreement.

Discriminant Function Analysis

Scale Scores by Single Question Algorithm. The standardized scale scores formed in Study One of the URICA-E2, were validated against the single question measure of vigorous exercise. Discriminant function analysis used the scale scores of

the URICA-E2 as predictor variables and the stages of the algorithms as the criterion groups. The analysis focused on the classification tables, the canonical correlations, the percentage of variance shared, and the group centroids. This analysis permitted an examination of the precision with which the Single Question algorithm classified subjects into the same stages as the scale scores of the URICA-E2.

Twenty Four Items by Single Question Algorithm. This procedure was repeated using the 24 items as predictor variables and the stages of the algorithm as the criterion group. Again the analysis focused on the classification tables, the canonical correlations, the percentage of variance shared, and the group centroids. This permitted an examination of the precision with which the Single Question algorithm classified subjects into the same stages as the 24 Items of the URICA-E2.

Stage by Dependent Measures

Stage by Hours of Exercise

Profiles by Hours of Exercise. The profiles generated from the cluster analysis of the standardized scale scores of the URICA-E2 were used as the grouping variables in an analysis of variance of the hours spent in vigorous exercise over the last week.

Single Question by Hours of Exercise. The five stages of the Single Question algorithm was also used as the grouping variables in an analysis of variance of the hours spent in vigorous exercise over the last week.

Stage by Decisional Balance

Profiles by Decisional Balance. The profiles generated from the cluster analysis of the standardized scale scores of the URICA-E2 were used as the grouping

variables in an analysis of variance of the decisional balance construct of the Transtheoretical Model.

Single Question by Decisional Balance. The five stages of the Single Question algorithms was also used as the grouping variables in an analysis of variance of the decisional balance construct of the Transtheoretical Model.

Stages by Confidence

Profiles by Confidence. The profiles generated from the cluster analysis of the standardized scale scores of the URICA-E2 were used as the grouping variables in an analysis of variance of the confidence construct of the Transtheoretical Model.

Single Question by Confidence. The five stages of the single question algorithm was also used as the grouping variables in an analysis of variance of the confidence construct of the Transtheoretical Model.

Effect Size.

Calculation of omega squared (ω^2) for each analysis allowed a comparison of the effect size. This helped guide our decision about whether the clusters or the stages from the algorithm is a stronger variable for staging.

Results

Stage : Discrete versus Continuous

Cross Classification: Profiles by Single Question Vigorous Exercise Algorithm.

In Table 3 - 1 the highest concurrence occurred where all the people in the

Maintenance profile had staged themselves into Maintenance using the algorithm. The problem is that this only makes up 19% of all the people who staged themselves into Maintenance. Maintenance stage people were also found in the ABV profile (33%), A Profile (30%), P Profile (13%), PCN Profile (2%), and C Profile (2%).

People who staged themselves into Action using the algorithm were from the ABV Profile (42%), A Profile (24%), C Profile (21%), PCB Profile (9%), and P Profile (3%).

The most disappointing result was that only 6% of the Preparation stage people put themselves in the P Profile. The Preparation stage was made up of people from the C Profile (42%), PCB Profile (39%), PCN Profile (11%), and ABV Profile (3%).

People who staged themselves into Contemplation using the algorithm were from the PCB Profile (43%), PCN Profile (30%), C Profile (23%), ABV Profile (2%), and P Profile (2%).

Those who staged themselves into the Precontemplation stage of the algorithm were from the PCN Profile (83%), PCB Profile (10%), C Profile (3%), and P Profile (3%).

Table 3 - 1

URICA-E2 Profiles by Single Question Algorithm (Col %)

Profile	PC	C	P	A	M
PCN	83	30	11	0	2
PCB	10	43	39	9	2
C	3	23	42	21	2
P	3	2	6	3	13
ABV	0	2	3	42	33
A	0	0	0	24	29
M	0	0	0	0	19

Discriminant Function Scale Scores to Single Question Algorithm. Three significant functions were discovered when the URICA-E2 scale scores were compared to the Single Question Vigorous Exercise algorithm. The canonical correlations for Function 1, 2, and 3 were respectively 0.88, 0.60, and 0.52. The percent variance accounted for was very high (99.26%) with the first function accounting for 77.57%.

The correct hit rate was 78.23% and can be found in Table 3 - 2. Figures 3 - 1, and 3 - 2, display the group centroid plots for Function 1 by Function 2 and Function 2 by Function 3, respectively.

Table 3 - 2

Discriminant Function Analysis: Scale Scores of URICA-E2 as Predictor Variables and
Single Question Algorithm as Criterion

Actual		Predicted Stage Group Membership				
Stage	N	PC	C	P	A	M
PC	29	86.2%	13.8%	0	0	0
C	47	8.5%	51.1%	31.9%	4.3%	4.3%
P	36	5.6%	16.7%	69.4%	5.6%	2.8%
A	33	0	12.1%	15.2%	63.6%	9.1%
M	126	1.6%	1.6%	0.8%	3.2%	92.9%
Percentage Correctly Classified			78.23 %			

**Figure 3 - 1. Scale Scores of URICA-E2 by Single Question
Exercise Algorithm Group Centroids**

**Figure 3 - 2. Scale Scores of URICA-E2 by Single Question
Exercise Algorithm Group Centroids**

Discriminant Function 24 Items to Single Question Algorithm. For the Single Question algorithm for vigorous regular exercise, the 24 item URICA-E2 found three significant functions. The canonical correlations were 0.89, 0.65, and 0.60 for Functions 1, 2, and 3, respectively. The cumulative percent variance accounted for by the 3 functions equals 98.03% with the first function accounting for the lion's share (74.13%). Table 3 - 3. shows the classification table with an overall rate of 82.29% hits. Figures 3 - 3. and 3 - 4. contain the plots of Function 1 by Function 2 and Function 2 by Function 3, respectively.

Table 3 - 3.

Discriminant Function Analysis: Twenty Four Items of URICA-E2 as Predictor
Variables and Single Question Algorithm as Criterion

Actual		Predicted Stage Group Membership				
Stage	N	PC	C	P	A	M
PC	29	89.7%	6.9%	3.4%	0	0
C	47	4.3%	66.0%	21.3%	4.3%	4.3%
P	36	8.3%	25.0%	63.9%	2.8%	0
A	33	0	6.1%	12.1%	75.8%	6.1%
M	126	1.6%	1.6%	0.8%	2.4%	93.7%
Percentage Correctly Classified			82.29%			

**Figure 3 - 3. 24 Item URICA-E2 by Single Question
Exercise Algorithm Group Centroids**

**Figure 3 - 4. 24 Item URICA-E2 by Single Question
Exercise Algorithm Group Centroids**

Stage by Dependent Measures

The profiles generated from the cluster analysis of the standardized scale scores of the URICA-E2 were used as the grouping variable in a multivariate analysis of variance of decisional balance (Pros & Cons), self-efficacy (Confidence), and hours of vigorous exercise in the last seven days(VIGACT7).

The Pros and Cons for regular exercise, and the Confidence for regular exercise were factor analyzed outside the scope of this project before standardized scale scores were formed.

In order to provide a standard metric, the Pros, Cons, and Confidence were converted to T-scores ($M=50$, $SD=10$).

A MANOVA was conducted on the single question algorithm of regular exercise with the Pros, Cons, Confidence, and Hours of exercise as dependent variables. A General Linear Model (GLM) procedure was conducted on the Profiles of the URICA-E2 with the Pros, Cons, Confidence, and Hours of exercise as dependent variables.

One-way ANOVAs were performed to assess the relationship between the Single Question algorithm of exercise and the decisional balance, self efficacy and hours of exercise. One-way ANOVAs were also performed to assess the relationship between the Profiles of the URICA-E2 and the decisional balance, self efficacy, and hours of exercise.

The ANOVAs were followed up with post hoc comparisons using the Tukey procedure to determine which stages of the Single Question algorithm and which

Profiles could be differentiated. Sample sizes varied in the different analyses due to missing data.

Stage by Hours

Profiles by Hours of Exercise. The criteria for vigorous exercise is at least 20 minutes, three times a day which totals 60 minutes or one hour a week. In Table 3 - 4 there is a graph divided into shaded and clear blocks. It is expected that the early stage profiles (PCN, PCB, C, and P) would have a higher percentage of people under the one hour criteria and that the later stage people (ABV, A and M) would have a higher percentage of people over the one hour criteria. PCN (58%), PCB (67%), C (65%), and P (42%) all were below criteria. A (70%), M (72%) and ABV (74%) all were above criteria. See Table 3 - 5 for means and standard deviations of the Profiles by the Hours of vigorous exercise in which the subject participated during the last seven days (VIGACT7).

A General Linear Model procedure was conducted on the Profiles of Exercise created by the previously reported cluster analysis with the Pros, Cons, and Confidence T-Scores and the scores of the Hours of vigorous exercise in the last seven days (VIGACT7). The Pros, Cons, Confidence and Hours of vigorous exercise in the last seven days (VIGACT7) were all significant $< .0001$. Follow-up Tukeys for the VIGACT7 showed significant differences for the profile PCB with ABV, A and M profiles and PCN with the A profile.

Table 3 - 4.

URICA -E2 Profiles by Hours of vigorous exercise in the last seven days(Row % of People)

HOURS OF VIGOROUS EXERCISE IN THE LAST 7 DAYS

Profile	Under Criteria	Over Criteria	N
PCN	58.18	41.82	53
PCB	66.67	33.33	42
C	65.11	34.89	41
P	42.31	57.69	25
AMBV	26.47	73.53	66
A	30.18	69.82	50
M	28.00	72.00	24

Table 3 - 5.

Means and Standard Deviations of Hours of Exercise by Profiles

Profile	% of Subjects in Stage	VIGACT7 (SD)
PCN	18%	2.13 (3.0)
PCB	14%	1.44 (2.4)
C	14%	2.12 (3.3)
P	8%	4.00 (4.1)
ABV	22%	3.60 (3.4)
A	17%	4.36 (3.9)
M	8%	4.08 (3.9)
PCB=P < PCN=C < ABV=M=A		

Single Question by Hours. A MANOVA was conducted on the Single Question algorithm of regular exercise with the Pros, Cons, Confidence and the Hours of vigorous exercise in the last seven days (VIGACT7) and found overall significance as well as univariate significance (4, 251) $p. \leq .01$. Tukey tests for the VIGACT7 found the Maintenance stage significantly different from all the other stages at the .05 level. See Table 3 - 6 for the means and standard deviations of VIGACT7.

Means and Standard Deviations of Hours of Exercise by Stages of the Single Question.

119

Stage by Decisional Balance

Profiles by Decisional Balance. A General Linear Model procedure was conducted on the Profiles of Exercise created by the previously reported cluster analysis with the Pros, Cons, and Confidence T-scores and the scores of the Hours of vigorous exercise in the last seven days (VIGACT7). The Pros, Cons, Confidence and Hours of vigorous exercise in the last seven days (VIGACT7) were all significant $< .0001$. Follow-up Tukeys for the Pros showed significant differences for the profile PCN with all the other profiles and a difference between AMBIV and the A profiles. Follow-up Tukeys for the Cons showed a significant difference between M and PCN, PCB, C, and P, between A and PCN, PCB, C, and P, and between ABV and PCN, C, and P. See Table 3 - 7 for the means and standard deviations of Pros and Cons and Figure 3 - 5. for a graph of the Pros and Cons across the Profiles of Exercise.

Table 3 - 7.

T-Scores and Standard Deviations for Pros and Cons by the Profiles

Profile	% of Subjects in Stage	Pros T-Score (SD)	Cons T-Score (SD)
PCN	18%	39.60 (10.1)	56.00 (10.2)
PCB	14%	52.51 (7.0)	53.60 (8.4)
C	14%	50.60 (8.0)	54.05 (9.2)
P	8%	51.72 (8.3)	53.83 (11.6)
AMBIV	22%	50.58 (7.6)	48.88 (7.5)
A	17%	55.75 (5.4)	46.43 (6.9)
M	8%	51.52 (10.5)	42.32 (2.6)
PROS	PCN < ABV = C = M = P < A		
CONS	M < A = ABV < PCB = P = C = PCN		

Figure 3 - 5. URICA-E2 EXERCISE PROFILES by PROS & CONS

Single Question by Decisional Balance. A MANOVA was conducted on the Single Question algorithm of regular exercise with the Pros, Cons, Confidence, and Hours of vigorous regular exercise in the last seven days. Follow-up Tukey tests for the Pros found the Precontemplation stage significantly different from all other stages, Action significantly different from Contemplation, and Preparation different from Contemplation at the .05 level. Follow-up Tukey tests for the Cons found the Precontemplation stage significantly different from the Maintenance and Action stages, and Maintenance different from Contemplation at the .05 level. See Table 3 - 8. for T-scores and standard deviations of Single Question stages by Pros and Cons. See Figure 3 - 6. for a graph of the Pros and Cons across the stages of the Single Question algorithm.

Table 3 - 8.

T-Scores and Standard Deviations of Pros and Cons by Stages of the Single Question Algorithm.

Stage	% of Subjects	Pros T-Score (SD)	Cons T-Score (SD)
Precontemplation	10%	34.77 (7.0)	56.38 (12.2)
Contemplation	18%	48.36 (9.0)	53.02 (7.8)
Preparation	13%	53.24 (6.8)	52.24 (9.4)
Action	13%	55.27 (5.6)	49.21 (9.2)
Maintenance	46%	52.03 (8.0)	48.30 (8.0)
PROS	PC < C < M = P < A		
CONS	M = A > P = C > PC		

**Figure 3 - 6. SINGLE QUESTION (VIGOROUS) EXERCISE
ALGORITHM by PROS & CONS**

Stage by Confidence

Profiles by Confidence

A General Linear Model procedure was conducted on the Profiles of Exercise created by the previously reported cluster analysis with the Pros, Cons, and Confidence T-scores and the scores of the Hours of vigorous exercise in the last seven days (VIGACT7). The Pros, Cons, Confidence and Hours of vigorous exercise in the last seven days (VIGACT7) were all significant $< .0001$. Follow-up Tukeys for Confidence showed significant differences for PCN and all the other stages; for PCB and P, ABV, A, and M; for C and ABV, A, and M; and for ABV and A and M. See Table 3 - 9 for T-scores and standard deviations of Profiles by Confidence T-scores. See Figure 3 - 7. for a graph of Confidence across the Profiles.

Table 3 - 9.

T-Scores and Standard Deviations of Confidence by Profiles

Profile	% of Subjects in Stage	CONFIDENCE T-Score (SD)
PCN	18%	42.57 (8.8)
PCB	14%	44.04 (6.8)
C	14%	48.02 (6.5)
P	8%	52.42 (10.5)
ABV	22%	52.34 (7.3)
A	17%	57.17 (7.2)
M	8%	58.44 (7.1)

CONFIDENCE PCN < PCB < C < ABV = P < A = M

**Figure 3 - 7. URICA-E2 EXERCISE PROFILES by
CONFIDENCE**

Single Question by Confidence. A MANOVA was conducted on the Single Question algorithm of regular exercise with the Pros, Cons, Confidence, and Hours of vigorous exercise in the last seven days (VIGACT7) and found overall significance as well as univariate significance (4, 251) D.F. < .01 Follow-up Tukey tests for Confidence found the Precontemplation stage significantly different from all other stages, Action significantly different from the Contemplation and Preparation stages, and Maintenance significantly different from the Preparation and Contemplation stages at the .05 level. See Table 3 - 10. for the T-scores and standard deviations of the Confidence measure by the stages of the single question algorithm. See Figure 3 - 8 for a graph of the Confidence T-scores across the stages of change of the Single Question algorithm.

Table 3 - 10.

T-Scores and Standard Deviations of Confidence by Stages of Single Question Algorithm.

Stage	% of Subject in Stage	CONFIDENCE T-Score (SD)
Precontemplation	10%	39.15 (6.0)
Contemplation	18%	45.22 (8.2)
Preparation	13%	46.18 (7.3)
Action	13%	52.00 (7.8)
Maintenance	46%	55.14 (8.0)
CONFIDENCE		PC<C=P<A=M

**Figure 3 - 8. SINGLE QUESTION (VIGOROUS) EXERCISE
ALGORITHM by CONFIDENCE**

Effect size

An estimation of effect size was calculated for Pros, Cons, Confidence, and Hours of exercise (VIGACT7) using the Single Question Algorithm, and the Profiles.

Table 3 - 11 shows the results.

Table 3 - 11

Comparison of Effect Sizes (ω^2) of Pros, Cons, Confidence, and VIGACT7 for Single Question Algorithm and Profiles.

SINGLE QUESTION PROFILES		
ALGORITHM		
PROS	.34	.33
CONS	.07	.20
CONFIDENCE	.33	.37
VIGACT7	.12	.08

Discussion

In this project measurement tools of the Transtheoretical Model of Behavior Change were used. They included two staging instruments: a continuous measure, the URICA-E2, and a Single Question algorithm. Data were also collected on a measure of decisional balance, a measure of self-efficacy, and a measure of hours of exercise. Study Three looked at the relationships between the two measures of stage and between each of the measures of stage and decisional balance, self-efficacy, and hours of exercise in order to compare and contrast the continuous measure and the algorithm.

The two staging measures were compared by cross classifying the seven Profiles with the five stages of the Single Question algorithm. Eighty three percent of the subjects who staged themselves into Precontemplation were found in the PCN cluster. The balance of Precontemplators were in the PCB Profile (10%), C Profile (3%), and P Profile (3%). Those subjects who staged themselves into Contemplation were distributed among five profiles: PCN (30%), PCB (43%), C (23%), P (2%), and ABV (2%). This may help us understand why Cs are so slow to change. It should be noted that the PCB Profile was high on both PCB and C so it is perhaps not surprising that 66% of the Contemplation subjects are in these two profiles. What is inconsistent is the 30% of Contemplators that are in the PCN Profile. Subjects who staged themselves into Preparation were also distributed among the same five profiles: PCN (11%), PCB (39%), C (42%), P (6%), and ABV (3%). This is troubling. There was a strong component of C in the P Profile and a strong component of PCB in the C Profile.

Subjects who staged themselves into Action were distributed among five different profiles: PCB (9%), C (21%), P (3%), ABV (42%), and A (24%). This puts 66% of Action people into ABV and A Profiles. Subjects who staged themselves into the Maintenance stage were distributed across all seven of the Profiles: PCN (2%), PCB (2%), C (2%), P, (13%), ABV (33%), A (30%), and M (19%). This means 82% of the Maintenance people fell into ABV, A, and M Profiles.

To summarize the plots of the group centroids of the Discriminant Function Analysis, the first function was able to clearly discriminate all five stages (PC, C, P, A, M) using the Single Question algorithm for the 24 items and for the standardized scale scores.

The second function had a recurrent pattern using the Single Question algorithm and the reduced 24 Items and the Standardized Scale Scores. The pattern of stages deviated from the normal sequence of stages (PC, C, P, A, M) by having M cropping up in an unexpected place between PC and C. If one could ignore M, the sequence would flow normally as either A, P, C, PC or PC, C, P, A.

The only element common to both is the proximity of M to PC which is the hallmark of the idea of circumplexity. Within the Transtheoretical Model and in the area of exercise PC is seen as the earliest stage and M as the furthest along stage. They also share the concept of stability and lack of movement. Precontemplators are not planning to think about change within the next six months. Maintenance persons have been changed for at least six months and, it is hoped, will stay that way.

In order to determine the similarities and differences in the two staging techniques, hours of exercise, decisional balance, and confidence were looked at across both the Profiles and the Single Question algorithm. In Table 3 - 12 there is a comparison of the hours of exercise by both the Profiles and the Single Question algorithm. The Single Question algorithm produced the predicted linear increase in number of hours of exercise from PC (1.35), C (1.51), P (1.91), A (2.55), to M (4.31). The Profiles on the other hand deviated from the expected progression. PCB was the lowest (1.44) followed by C (2.12), PCN (2.13), ABV (3.60), P (4.00), M (4.08), and A (4.36). A comparison of the percentages in each stage to the percentages in the Profiles believed to be subsumed under the stage showed decided discrepancies. PCN and PCB Profiles totaled 32% of the people, whereas the Precontemplation stage accounted for only 10% of the people. The C Profile represented 14% of the population and the Contemplation stage accounted for 18% of the population. The P Profile accounted for 8% while the Preparation stage represented 13% of the subjects. The A Profile represented 17% of the population and the Action stage accounted for 13% of the population. The major discrepancy appeared in matching the M Profile to the Maintenance stage of the algorithm: 8% to 46%. Adding the 22% of the ABV Profile to the M Profile would increase it to 30% for the two Profiles to 46% for M by the stage algorithm. The greatest differences occur in the stable stages of PC and M. The Single Question algorithm is bottom heavy with the largest percent (46%) in Maintenance. The Profiles are top heavy with the largest percent in the early Profiles PCN and PCB (32%).

Table 3 - 12

Comparison Hours of Exercise for Profiles and Single Question Algorithm: Means and Frequency Percentages

PROFILES			SINGLE QUESTION		
	Mean	Frequency Percentage		Mean	Frequency Percentage
PCN	2.13	18%	PC	1.35	10%
PCB	1.44	14%			
C	2.12	14%	C	1.51	18%
P	4.00	8%	P	1.91	13%
ABV	3.60	22%			
A	4.36	17%	A	2.55	13%
M	4.08	8%	M	4.31	46%

In Table 3 - 13 there are comparisons of the Pros and Cons by both the Profiles and the Single Question algorithm. The Single Question algorithm produced the predicted linear decrease for the Cons from Precontemplation (56.4), Contemplation (53.0), Preparation (52.2), Action (49.2), to Maintenance (48.3). The Profiles on the other hand deviated from the expected progression. PCN was the highest (56.0) followed by C (54.1), P (53.8), PCB (53.6), ABV (48.9), A (46.4), and M (42.3).

The Pros did not follow the expected linear progression for the stages of the Single Question. Precontemplation (34.8), Contemplation (48.4), Maintenance (52.0), Preparation (53.2), Action (55.3). This echoed the plot of the group centroids for the second function by the third function for both the scale scores and the 24 items where Maintenance was found to deviate from its expected sequence. The expected sequence for the Profiles also deviated. PCN (39.6), ABV (50.6), C (50.6), M (51.5), P (51.7), PCB (52.5), A (55.8). PCN is the only Profile which falls below the standardized mean. All the other scores fall within a half standard deviation of the mean.

Table 3 - 13

Comparison of Pros and Cons by Profiles and Single Question Algorithm :Standardized Means and Frequency Percentages

PROFILES				SINGLE QUESTION			
Mean		Freq		Mean		Freq	
PROS	CONS			PROS	CONS		
PCN	39.6	56.0	18%	PC	34.8	56.4	10%
PCB	52.5	53.6	14%				
C	50.6	54.1	14%	C	48.4	53.0	18%
P	51.7	53.8	8%	P	53.2	52.2	13%
ABV	50.6	48.9	22%				
A	55.8	46.4	17%	A	55.3	49.2	13%
M	51.5	42.3	8%	M	52.0	48.3	46%

In Table 3 - 14 there is comparison of Confidence by both the Profiles and the Single Question algorithm. The Single Question algorithm produced the predicted linear increase in Confidence from PC (39.2), C (45.2), P (46.2), A (52.0), to M (55.1). The Profiles on the hand deviated slightly from the expected progression PCN was the lowest (42.6) followed by PCB (44.0), C (48.0), ABV (52.3), P (52.4), A (57.2), and M (58.4).

Table 3 - 14

Comparison of Confidence by Profiles and Single Question Algorithm:Standardized Means and Frequency Percentages

PROFILES			SINGLE QUESTION		
	Mean	Frequency Percentage		Mean	Frequency Percentage
PCN	42.57	18%	PC	39.15	10%
PCB	44.04	14%			
C	48.02	14%	C	45.22	18%
P	52.42	8%	P	46.18	13%
ABV	52.34	22%			
A	57.17	17%	A	52.00	13%
M	58.44	8%	M	55.14	46%

The comparison of effect sizes showed the Profiles to be nearly equal to the Single Question Algorithm for the Pros, and to be far better for the Cons and Confidence. The only area in which the Single Question algorithm was more effective was hours of exercise.

In summary, comparison of this Single Question algorithm to the Profiles of change produced 100% of the M profile people staging themselves into the Maintenance stage. Of the Action Profile subjects, 82.22% put themselves in the Maintenance stage. This is not surprising if you remember that the A profile also had a high Maintenance component. A PCN profile to Precontemplation stage concurrence of 53.33% seems expected. A PCB profile to Contemplation stage concurrence is not surprising as the PCB profile also had a high Contemplation component. The C profile to the Contemplation stage concurrence of 30.56% is eclipsed by the C profile to Preparation stage concurrence of 41.67% which is not totally unexpected as the C profile carried some Preparation also. The two inexplicable profiles turn out to be ABV and P. ABV was envisioned to be some sort of state of confusion, a variant of Contemplation. It has turned out to be made up of people in the Maintenance stage who were exercising over criteria. A better name needs to be found when more information is gathered about these people. The real disappointment was the behavior of the P profile. Of the subjects in the P Profile, 76% of them put themselves into the Maintenance stage. Could these people be maintainers preparing to do even more?

When the profiles were matched to measures of hours of exercise, it was found that all the profiles were correctly classified (PCN, PCB, & C as under criteria and P, ABV, A, & M as over).

The profiles, laid out as PCN, PCB, C, P, ABV, A, M, produced the classic crossover of Pros and Cons between P and ABV and a classic gradual increase across the stages for Confidence. The Single Question Algorithm also showed classic form with the Pros and Cons crossing at P and the Confidence scores rising across the stages.

Overall Discussion

The Transtheoretical Model of Behavior Change offers a proactive, interactive, individualized way of intervening on a total population. A stage based intervention can offer a tailored approach to all subjects regardless of their stage of readiness to adopt or cease a behavior. Action oriented programs have much to offer persons in Preparation and Action, but they fail miserably with early stage Precontemplators and Contemplators. From looking at the consistency of relapse rates for many behaviors, it would seem that Action oriented interventions also do not meet the needs of Maintainers. Stage based interventions are an important first step in meeting the unique needs of people in different stages of readiness. Stage is necessary, but not sufficient. This first step must be bolstered by the other variables of the Transtheoretical Model to form an effective, empirically based intervention.

The empirically based intervention of the Transtheoretical Model are all structurally similar. All subjects receive feedback on their answers to Decisional Balance, Self-efficacy, and pertinent Processes of Change questions. The key differences lie in that Stage forms a channel or unique route down which the other information flows. This makes having accurate staging tools a necessity. An in-depth study of staging instruments is the goal of this study.

Why use a continuous measure of stage of change ?

In this project, a third generation continuous staging instrument was developed. It is a researcher's tool: long, seemingly redundant, and even irritating for the subject. As a high powered microscope with which to study stage on a deeper level, it is

excellent. It is obvious that all members of a stage are not identical, but they do have some basic commonalities that unite them. Discovering both the cognitive postures and the predominant behaviors that link members of a stage gives a researcher the tools to communicate with a group of stage members in an effective manner that they can understand and appreciate.

Cognitions and behaviors can only be captured by an instrument that groups an number of items to understand each stage construct. The single item of an algorithm can not capture cognitions and behaviors.

Why use sequential instrument development?

Good instrument development is a sequential, repetitive, time consuming process (Jackson, 1970; 1971; Comery, 1988). The instrument developed in this project has a pedigree. It stands on the shoulders of its predecessors the URICA and URICA-E1. Sequential instrument development is a process that gets repeated, each subsequent version hopefully sharpening the ability of the instrument to more accurately stage subjects.

The URICA-E2 was written to clear up the confusion between Precontemplation and Maintenance discovered in URICA-E1 and to add a Preparation stage. It accomplished these two tasks. Finding that Precontemplation had split into two componenets: PCN (Nonbelievers) and PCB (Believers) was an unexpected but desirable result. Discovering that the Action stage was not as strong as anticipated proved to be a disappointing result. Both discoveries demand that a fourth generation URICA-E3 be developed.

Why use cluster analysis?

Cluster Analysis is a technique which can allow an even deeper exploration of the stage constructs than does Principal Component Analysis (PCA). A continuous measure, like the URICA-E2, gives each subject a score on each on the six components of change found using the PCA. These six scale scores can be standardized and used in the Cluster Analysis. Subjects are clustered according to the similarity of their pattern of scale scores. Similar patterns clump together forming clusters or profiles of types of changers. These patterns, somewhat like an even higher powered microscope, reveal more detail about the stages of change. Using the cubic Clustering Criterion, the dendogram, and influenced by theoretical considerations, the correct number of clusters was chosen. In this project, seven clusters were chosen and named, one for each of the six components plus a pattern named Ambivalent because tradition has named profiles having scale scores close to the mean as Ambivalent. From previous experience with Cluster Analysis using the URICA-E1, these results were unexpected. The URICA-E1 had produced three types of Precontemplation Profiles, all high on PC and named Denial, Immotive and Precontemplation. Denial was extremely high on PC and in the 20s for C, A, and M. Immotive was very high on PC and in the 30s on C, A, and M. Precontemplation was again very high on PC and in the low 40s on C, A, and M. Three types of what was thought to be Contemplation were also found and named Contemplation, Lapse, and Ambivalence. Contemplation showed a spike at C. Lapse had a double spike at C and at M. Ambivalence had all its scores hovering around the mean. A Profile that combined high scores on Contemplation and Action

was named Decision Making. Two Profiles that had high Action and Maintenance scores were named Action/Maintenance and Striving to Improve.

The fact that the Profiles matched the PCA results was a fortuitous surprise. The PCN Profile had a very definite spike on PCN. The PCB hit its peak at PCB, but also was high on C, its nearest neighbor. C hit its peak at C, but was also high on P, its nearest neighbor. P hits its peak at P, but its nearest neighbor A is the next highest value. The A profile is nearly as high on its nearest neighbor M as it is on A. M has a definite spike on M.

Comparing the Profiles and the Algorithm

This study tried to examine the strengths and weaknesses of the two different methods of determining stage of change. The algorithm has brevity and ease of administration to recommend it. Instantly it can categorize people into a stage based on no intention to change (PC), intention to change within six months (C), intention to change within 30 days (P), behavior for less than six months (A), and behavior for longer than 6 months (M). By virtue of its Omega Squared, the algorithm out performs the Profiles on the measure of hours of exercise and very slightly exceeds the Profiles on the Pros of exercise.

The Profiles require multiple questions and extensive data analytic procedures (PCA followed by Cluster Analysis) to stage people. Because the input information includes multiple questions, the assessment of stage can be based on multidimensional concepts. Cognitions and behaviors may be taken into account to describe each of the

stages. A profile is then composed of each of the stages of change in some type of pattern or relationship. By virtue of its Omega Squared statistic, the Profiles outperformed on the Cons, the Confidence measure, and nearly equaled the measure of Pros of exercise.

If a algorithm produces a single data point on a graph, a profiles is made up of a series of data points, spatially oriented above and below a standardized mean. Each of the series of data points of the profile represents the answers to a series of multi-conceptual items. The richness of information produced by the Profiles has significant rewards, but it also costs a price. A practical concern must always be how to get complete data. The instrument is best administered face to face or over the phone. The sheer number of items and the similarity of the concepts promotes a tendency for subjects to skip items. A algorithm is a much more foolproof method to stage people if all you want is to divide people into categories. Often this is exactly what is needed. Within an expert system intervention this is appropriate. Stage forms a channel down which the person goes. Normative and ipsative feedback from the other variables of the Transtheoretical Model form the substance of the individualized intervention.

The URICA was developed as a clinical tool to assess the actual stage of readiness to work on the problem for which a person is in therapy. The tool was intended to give a therapist as broad a picture as possible of the mind set of the client. It was also intended to discover which processes were most effective with which profiles. An experienced clinician would be able to administer the URICA, type the client, and pick the most effective processes of change to emphasize. The profile

would also be able to predict whether the client was likely to be successful, to quit, or to fail.

When you directly try to match the profiles to the algorithm through cross classification and Discriminant Function Analysis, there is a noticeable discrepancy. Three cross classifications were examined: the Profiles of the URICA-E2 to the algorithm, the scale scores of the URICA-E2 to the algorithm and the 24 items of the URICA-E2 to the algorithm. When the URICA-E2 is reduced to a single data point, it does a poorer job than the six data points of the scale scores or the 24 data points of the reduced instrument. The six data points of the scale produces better concurrence with the Single Question algorithm than the single data point of the Profiles. The 24 items produced even better concurrence, but only with a very large increase in data points. This leads to the assessment that one data point was not enough, and 24 are not necessary when six can produce nearly comparable results.

Why test models?

Profiles, by their makeup, hint at relationships between the stages. The different combination of stages call out to be explained. Is there an underlying pattern? The original URICA was declared to be a simplex, so versions of simplex were tested. A circumplex deserved examination if for no other reason than Precontemplation and Maintenance are both relatively stable states. From looking at URICA-E2 Profiles, it was presumed that some version of Punctuated Equilibrium (PCN) (PCB,C,P,A) (M) or (PCN) (PCB,C,P) (A,M) should be explored.

The fact that a circumplex fits the data so closely was not anticipated. Does the circumplex model with all the paths freed merely fit the data best because of the number of paths freed. The principles of parsimony expect fit to improve because of the number of paths freed. Only replication will prove or disprove whether the matching of the unrestrained data to the circumplex model was due to the sheer number of paths that were free to correlate or a true representation of the model that best fit the data.

The idea of circumplexity and exercise is intuitive. Exercise is a behavior that has to be done every day, day after day. There will always be times when regular exercise is inadvisable if not impossible. Movement back and forth among the stages is common, even expected. The most important lesson to learn may be just that fact. It is not good, nor bad. It is reality. In smoking, when you relapse, it is spoken of as a lapse (a bad thing). A lapse should be learned from in order to prevent reoccurrence. As quickly as possible you should get back on track (good thing). Acquisition of a lifelong habit like regular exercise is different from the cessation of a bad habit. An important piece of regular exercise seems to be a strong cognitive belief that regular exercise is beneficial to the particular person. If a person is mentally a regular exerciser, it is safe to assume that if they have to stop for a time, they will begin again as soon as they can. Someone without this belief in regular exercise is much more likely 1) never to start exercising, and 2) to relapse and not start again. The circumplex model implies that people start and stop exercising all the time. Our goal, with exercise, is not to move people through some type of sequence to a goal of

termination. It must be to 1) give knowledge of the benefits of exercise, 2) inspire initiation of the behavior, 3) sustain the behavior until the benefits accrue and the cognitive belief in the benefits is concretized. Once belief in the benefits takes root, behavior, when prudent, will follow. Whether I believe that regular exercise can benefit me personally is the most important thing. What I consider a benefit, may not impress another. What kind of exercise is enough for me and my lifestyle may also differ from another. Our need of exercise vary over our lifespan. As we age and our normal activity is reduced, the need for safe exercise increases proportionally.

Appendix

Please use the following definition of exercise when answering these questions.

Vigorous Exercise

Regular exercise = 3 times or more per week for 20 minutes or longer.

Exercise includes activities such as brisk walking, jogging, swimming, aerobic dancing, biking, rowing, etc. Activities that are primarily sedentary, such as bowling or playing golf with a golf cart, would not be considered exercise.

Please circle the number that indicates how strongly you agree or disagree with the following statements.

Strongly
Disagree

1

Disagree

2

Undecided

3

Agree

4

Strongly
Agree

5

1. As far as I am concerned, I don't need to exercise regularly.

1

2

3

4

5

2. I am thinking about starting to exercise regularly in the next 6 months.

1

2

3

4

5

3. I haven't been able to exercise regularly yet, but I am planning to do it within the next few weeks.

1

2

3

4

5

4. I am now exercising regularly.

1

2

3

4

5

5. I have been exercising regularly for a long time and I plan to continue.

1

2

3

4

5

6. I don't exercise and right now I don't care.

1

2

3

4

5

7. I am weighing the pros and cons of beginning an exercise program.

1 2 3 4 5

8. I have signed up to start a exercise class soon.

1 2 3 4 5

9. I am finally exercising regularly.

1 2 3 4 5

10. I have been successful at exercising regularly and I plan to continue.

1 2 3 4 5

11. I am satisfied with being a sedentary person.

1 2 3 4 5

12. I have been thinking that I might want to start exercising regularly.

1 2 3 4 5

13. I have bought some athletic shoes/clothes so I can start to exercise regularly soon.

1 2 3 4 5

14. I have started exercising regularly within the last 6 months.

1 2 3 4 5

15. I have engaged in regular active exercise for more than the past 6 months.

1 2 3 4 5

16. I could exercise regularly, but I don't plan to.

1 2 3 4 5

17. I have been trying to decide whether to begin working out regularly.

1 2 3 4 5

18. I intend to increase the regularity and intensity of my exercise very soon.

1 2 3 4 5

19. I am exercising regularly, and I hope to continue.

1 2 3 4 5

20. I have been exercising regularly for several years. 1

2 3 4 5

21. I am a person who doesn't exercise now.

1 2 3 4 5

22. I have a problem being sedentary and I think I should do something about it.

1 2 3 4 5

23. I intend to work out more often in the near future.

1 2 3 4 5

24. Recently, I have started to exercise regularly.

1 2 3 4 5

25. I may have become addicted to exercise.

1 2 3 4 5

26. I don't have the time or energy to exercise regularly now.

1 2 3 4 5

27. I am thinking that maybe I should join an exercise group in the next 6 months.

1 2 3 4 5

28. Although I am somewhat active now, I plan to begin exercising regularly within the next few weeks.

1 2 3 4 5

29. I have started to exercise regularly, and I plan to continue.

1 2 3 4 5

30. Regular exercise has been an important part of my life for quite a while now.

1 2 3 4 5

31. I should exercise but I don't right now.

1 2 3 4 5

32. I have been thinking about whether I will be able to exercise regularly.

1 2 3 4 5

33. I have set up a day and a time to start exercising regularly within the next few weeks.

1 2 3 4 5

34. Anyone can talk about exercising regularly, I am really doing it now.

1 2 3 4 5

35. I have managed to keep exercising regularly through the last 6 months.

1 2 3 4 5

36. I am a couch potato right now.

1 2 3 4 5

37. I have been thinking that I may want to begin exercising regularly.

1 2 3 4 5

38. I have lined up a friend to start exercising regularly with in the next few weeks.

1 2 3 4 5

39. I am actively exercising regularly.

1 2 3 4 5

40. I have completed 6 months of regular exercise.

1 2 3 4 5

41. I know that regular exercise is worthwhile, but I don't have time for it in the near future.

1 2 3 4 5

42. I have been calling friends to find someone to start exercising with in the next few weeks.

1 2 3 4 5

43. I have been a part of a regular vigorous exercise group for more than 6 months and I plan to continue.

1 2 3 4 5

44. I think regular exercise is good, but I can't fit it into my schedule right now.

1 2 3 4 5

45. I have joined a health club and plan to start exercising soon.

1 2 3 4 5

46. I joined a team so that I would never get bored with exercising regularly.

1 2 3 4 5

47. I really think I should work on getting started with a regular exercise program in the next 6 months.

1 2 3 4 5

48. I am preparing to start a regular exercise group in the next few weeks.

1 2 3 4 5

49. I have been competing regularly in a vigorous sport for more than 6 months.

1 2 3 4 5

50. I am aware of the importance of regular exercise but I can't do it right now.

1 2 3 4 5

51. In my busy life, regular exercise isn't my first priority right now, but maybe in 6 months it will be.

1 2 3 4 5

Vigorous Exercise

Regular exercise = 3 times or more per week for 20 minutes or longer.

Exercise includes activities such as brisk walking, jogging, swimming, aerobic dancing, biking, rowing, etc. Activities that are primarily sedentary, such as bowling or playing golf with a golf cart, would not be considered exercise.

*The following statements represent different opinions about regular exercise. Please rate **HOW IMPORTANT** each statement is to your decision to exercise regularly according to the above definition. Please answer using the 5 point scale below:*

Not Important	Slightly Important	Important	Very Important	Extremely Important
1	2	3	4	5

1. I would sleep better if I exercised regularly.
1 2 3 4 5
2. To exercise regularly takes too much time.
1 2 3 4 5
3. I would feel better about myself if I exercised regularly.
1 2 3 4 5
4. To exercise regularly takes money away from my family.
1 2 3 4 5
5. Others would think that I looked better if I exercised regularly.
1 2 3 4 5
6. I dislike getting sweaty.
1 2 3 4 5
7. I would be healthier if I exercised regularly
1 2 3 4 5
8. I feel uncomfortable in exercise clothes.
1 2 3 4 5

9. I would have more energy for my family and friends if I exercised regularly.

1 2 3 4 5

10. My family would not approve of me spending time exercising.

1 2 3 4 5

11. Regular exercise would help me relieve tension.

1 2 3 4 5

12. I would probably be sore and uncomfortable if I exercised regularly.

1 2 3 4 5

13. I would feel more confident if I exercised regularly.

1 2 3 4 5

14. I would feel that I was wasting my time if I exercised regularly.

1 2 3 4 5

15. I would feel good about myself if I kept my commitment to exercise regularly.

1 2 3 4 5

16. I would be too tired to do my daily work after exercising.

1 2 3 4 5

17. I would be easier for me to perform routine physical tasks if I exercised regularly.

1 2 3 4 5

18. I feel uncomfortable when I exercise because I get out of breathe and my heart beats very fast.

1 2 3 4 5

19. I would feel more comfortable with my body if I exercised regularly.

1 2 3 4 5

20. I would have less time for my family and friends if I exercised regularly.

1 2 3 4 5

21. Regular exercise would help me have a more positive outlook on life.

1 2 3 4 5

22. At the end of the day, I am too exhausted to exercise.

1 2 3 4 5

Vigorous Exercise

Regular exercise = 3 times or more per week for 20 minutes or longer.

Exercise includes activities such as brisk walking, jogging, swimming, aerobic dancing, biking, rowing, etc. Activities that are primarily sedentary, such as bowling or playing golf with a golf cart, would not be considered exercise.

Circle the number to indicate how confident you are that you would exercise in each of the following situations.

Not at All Confident	Slightly Confident	Somewhat Confident	Quite Confident	Very Confident
1	2	3	4	5

1. When a friend is waiting to exercise with you.

1 2 3 4 5

2. When you are under a lot of stress.

1 2 3 4 5

3. When you are tired.

1 2 3 4 5

4. When you are depressed.

1 2 3 4 5

5. When you are away from home on a trip.

1 2 3 4 5

6. When the weather is bad.

1 2 3 4 5

7. When you are under a lot of time pressure.

1 2 3 4 5

Vigorous Exercise

Regular exercise = 3 times or more per week for 20 minutes or longer. Exercise includes activities such as brisk walking, jogging, swimming, aerobic dancing, biking, rowing, etc. Activities that are primarily sedentary, such as bowling or playing golf with a golf cart, would not be considered exercise.

The following experiences can affect the exercise habits of some people. Think of any similar experience you may be currently having or have had in the last month. *Then rate the frequency of each event on a 5 point scale with 1 = Never to 5 = Repeatedly.*

1. I am willing to watch TV shows that promote the benefits of exercise.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

2. Instead of taking the elevator, I take the stairs.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

3. I am moved when I hear about people like Scott Hamilton, the world champion skater, whose life was transformed by exercise.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

4. When I exercise regularly, I feel I'm being a good role model.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

5. I have someone to exercise with.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

6. I have noticed that one of the rewards to doing regular aerobic exercise is that it lifts depression.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

7. I have made a commitment to exercise regularly.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

8. I try to act like a regular exerciser by stretching, warming up and cooling down.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

9. I have noticed that important people often advertise the fact that they exercise every day.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

10. I keep a set of exercise clothes in my car so I can exercise when ever I get the time.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

11. I'll read information in magazines about how good exercise is for you.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

12. Instead of just watching TV to relax at night, I take a walk first.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

13. I get upset when I realize that people I loved would be alive if they had changed their habits and had exercised regularly.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

14. If I tell people to exercise but don't do it myself, I am giving mixed messages.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

15. I have people around who encourage me to exercise regularly.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

16. I find, if I engage in a regular sport, I am rewarded by having fun and getting exercise.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

17. I have made a commitment to work out.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

18. I try to wear clothes that are appropriate for the exercise activity that I am doing.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

19. I have noticed that more and more worksites are encouraging their employees to exercise regularly.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

20. I wear my athletic shoes to work so I will remember to take a ~~walk~~ at lunch time.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

21. I'll look at articles that present research on exercise and its benefits.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

22. Instead of sitting through TV commercials, I stand up and exercise.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

23. I get angry when I see elderly people not being encouraged to keep active.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

24. I realize that if I don't exercise regularly, I may get ill and be a burden on others.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

25. I belong to a group that exercises together regularly.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

26. If I engage in regular exercise, I find I get the benefit of having more energy.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

27. I have joined a health club (fitness center, or some such group) to exercise regularly.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

28. I believe that I am the type person who will make time in their life for regular exercise.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

29. It seems every town has exercise programs for adults.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

30. I set up times in advance with people so that I will remember to exercise regularly.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

31. I'll read advertisements that sell products that help you to exercise.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

32. Instead of parking the car in the closest spot to the door, I pick the furthest away spot and walk.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

33. I get annoyed when people say they don't have time to exercise.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

34. I realize that it is my responsibility to society to be as healthy as I can be and that means exercising regularly.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

35. I have family members that will exercise with me.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

36. I am aware that when I exercise regularly, I get the benefit of looking better.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

37. I am on a team or in some way participate in a sport regularly.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

38. I want to be the type person who stays looking young and has a lot of energy.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

39. I am always seeing families jogging together with the babies in strollers.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

40. Commercials on TV are a cue to me to get up, stretch and exercise.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

41. I look for information about exercising.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

42. I try to think of exercise as a time to clear my mind rather than a workout for my body.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

43. I have someone who calls me on my reasons for not exercising.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

44. I tell myself that if I try hard enough, I can keep exercising regularly.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

45. I remind myself that I am the only one who is responsible for my health and well-being and can make the decision to exercise regularly.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

46. I believe that regular exercise will make me a healthier, happier person.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

47. I am aware of more and more people encouraging me to exercise.

Never	Seldom	Occasionally	Often	Repeatedly
1	2	3	4	5

Past Exercise History

1. During the **LAST 7 DAYS**, how much total time did you spend doing vigorous physical activity and moderate physical activity?. *Record only time actually engaged in the activity i.e. subtract out breaks and rest periods.*

VIGOROUS ACTIVITY such as:

- jogging
- running
- swimming
- strenuous sports such as singles tennis or racquetball
- digging in the garden
- chopping wood
- etc.

Total hours for the last 7 days to the nearest 1/2 hour _____

MODERATE ACTIVITY such as

- brisk walking
- golf
- doubles tennis
- yard work
- heavy housecleaning
- bicycling on level ground
- etc.

Total hours for the last 7 days to the nearest 1/2 hour _____

Please think about Last Week. Pick a typical weekday and a weekend day. How many hours did you spend doing different kinds of activity.

BE SURE THAT YOUR TOTAL EQUALS 24 HOURS.

LAST WEEK Pick a typical weekday

LAST WEEK Pick a typical weekend
day

Weekday	Very Hard activity (makes you huff and puff or sweat a lot, makes your heart beat fast) for example running hard, competition/hard swimming, squash competition soccer, running upstairs, bicycling hard, mountain climbing, carrying a load upstairs, carrying a heavy load like bricks, chopping wood, competition network, fast aerobics	Weekend
Hrs		Hrs
	Hard activity (makes you huff and puff or sweat a little) For example: roller skating, fast disco dancing, basketball, walking fast uphill, cross country hiking, jogging, swimming laps, tennis, climbing stairs or a ladder, aerobics, touch football, softball, baseball, moving heavy furniture.	
Hrs		Hrs
	Moderate activity (not tiring) For example: walking, easy bicycling, catching & throwing a ball, slow dancing, sweeping, mopping or vacuuming, raking the yard, cleaning up your room, 10-pin bowling, surfing, volleyball.	
Hrs		Hrs
	Light activity (little effort) For example: playing a musical instrument, sewing, typing, driving a car, eating a meal, taking a bath, talking on the phone, traveling by bus/train, homework/studying.	
Hrs		Hrs
	Inactivity (no effort) For example: sleeping, resting, quietly lying down while talking, watching TV, reading.	
Hrs		Hrs

_____ Total hours
must equal
24 hours

_____ Total Hours
must equal
24 hours

1. Age: _____ in years

2. Sex: _____ Male _____ Female *check one*

3. Ht.: _____ Feet _____ Inches

4. Wt.: _____ lbs.

(Please check one)

5. Marital Status _____ Married _____ Divorced _____ Separated

_____ Never Married _____ Widowed

6. Nationality _____ White _____ Hispanic _____ African-American

_____ Native American _____ Asian _____ Other

7. Highest Education *(Please circle the highest grade completed)*

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21...

High School C o l l e g e Graduate School

8. Family Income per year *(Please circle one)*

a. Less than \$10,000

f. \$50,000 to \$59,999

b. \$10,000 to \$19,999

g. \$60,000 to \$69,999

c. \$20,000 to \$29,999

h. \$70,000 to \$79,999

d. \$30,000 to \$39,999

i. \$80,000 to \$89,999

e. \$40,000 to \$49,999

j. \$90,000 to \$99,999

k. \$100,000 and over

Regular exercise = 3 times or more per week for 20 minutes or longer.
Exercise includes activities such as brisk walking, jogging, swimming, aerobic dancing, biking, rowing, etc. Activities that are primarily sedentary, such as bowling or playing golf with a golf cart, would not be considered exercise.

Do you exercise three times a week for at least 20 minutes each time?

- ☐ Yes, I have been for MORE than 6 months.
☐ Yes, I have been, but for LESS than 6 months.
☐ No, but I intend to in the next 30 days.
☐ No, but I intend to in the next 6 months.
☐ No, and I do NOT intend to in the next 6 months

For each question below please mark YES or NO. Physical activity or exercise means walking briskly, vacuuming, jogging, digging in the garden, climbing stairs or any other physical activity where exertion is similar to these.

Regular physical activity or exercise means accumulating 30 minutes or more in the above activities most days of the week.

For example, you could take one 30 minute walk, jog, bike or swim or three 10 minute walks, or 5 minutes of vacuuming, 10 minutes of digging in the garden, and 5 minutes of climbing stairs.

1. I am currently physically active	1. <u>Yes</u>	2. No
2. I intend to become more physically active
in the next 6 months	1. Yes	2. No
3. I currently engage in regular physical activity	1. Yes	2. No
4. I have been physically active regularly
for the past 6 months.	1. Yes	2. No
5. I have been physically active regularly in the past
for a period of at least 3 months.	1. Yes	2. No

Some of these questions may seem very similar, they are. I am comparing different ways of asking questions. I will learn a great deal from this, so, please, don't ignore any of the questions.

Which of the two definitions of regular exercise or activity do you consider to be right for your life at this time? : (Please check one of the boxes)

1. ☐ Regular exercise = 3 times or more per week for 20 minutes or longer. Exercise includes activities such as brisk walking, jogging, swimming, aerobic dancing, biking, rowing, etc. Activities that are primarily sedentary, such as bowling or playing golf with a golf cart, would not be considered exercise.

or

2. ☐ Physical activity or exercise means walking briskly, vacuuming, jogging, digging in the garden, climbing stairs or any other physical activity where exertion is similar to these.

Regular physical activity or exercise means accumulating 30 minutes or more in the above activities most days of the week.

For example, you could take one 30 minute walk, jog, bike or swim or three 10 minute walks, or

5 minutes of vacuuming, 10 minutes of digging in the garden, and 5 minutes of climbing stairs.

Regular exercise = 3 times or more per week for 20 minutes or longer.

Exercise includes activities such as brisk walking, jogging, swimming, aerobic dancing, biking, rowing, etc. Activities that are primarily sedentary, such as bowling or playing golf with a golf cart, would not be considered exercise.

1. I currently exercise	1. True	2. False
2. I intend to exercise in the next 6 months	1. True	2. False
3. I currently exercise regularly	1. True	2. False
4. I have exercised regularly for the the past 6 months	1. True	2. False
5. I have exercised regularly in the past for a period of at least 3 months.	1. True	2. False

Bibliography

Aldenderfer, M. S. and Blashfield, R. K. (1984). Cluster Analysis.: A Sage University Paper. (p.59). Newbury Park, NJ: Sage Publications.

Aloia, J.F., Cohn, S.H., Babu, T., Abesamis, C., Kalici, N., & Ellis, K. (1978). Skeletal mass and body composition in marathon runners. Metabolism, 27, 1793-1796.

American College of Sports Medicine. (1989). American College of Sports Medicine position stand: The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness in healthy adults. Medicine and Science in Sports and Exercise, 22, 265-274.

Anderson, T. W., & Rubin, H. (1956). Statistical inference in Factor Analysis. Proceedings of the Third Berkeley Symposium on Mathematical Statistics and Probability, 5, 111-150.

Bandura, A. (1977). Self-Efficacy: Toward unifying theory of behavioral change. Psychological Review, 84, 191-215.

Barnard, R. J., Ugianskis, E. J., Martin, D. A., & Inkeles, S. B. (1992). Role of diet and exercise in the management of hyperinsulinemia and associated atherosclerotic risk factors. American Journal of Cardiology, 69, 440-444.

Belman, M.J., Botnick, W. C., Nathan, S. D., & Chon, K. H. (1994). Ventilatory load characteristics during ventilatory muscle training. American Journal of Respiratory Critical Care and Medicine, 149, 925-929.

Bentler, P.M. (1989). EQS: Structural equations program manual. Los Angeles: CA: BMDP Statistical Software.

Bentler, P.M. (1990). Comparative fit indexes in structural models. Psychological Bulletin, 107, 238-246.

Blair, S. N. (1984). How to assess exercise habits and physical fitness. In J. Matarazzo, S. Weiss, J. Herd, & N. Miller (Eds.) Behavioral health: A handbook of

health enhancement and disease prevention (pp. 424-447). New York: John Wiley & Sons.

Blashfield, R. K. (1980). The growth of cluster analysis: Tryon, Ward, and Johnson. Multivariate Behavioral Research, 15, 439-458.

Boom, J., & Molenaar, P. C. (1989). A developmental model of hierarchical stage structure in objective moral judgements. Developmental Review, 9, 133-145.

Boomsma, D. I., & Molenaar, P. C. (1987). The genetic analysis of repeated measures: I. Simplex models. Behavior Genetics, 17, 111-123.

Buskirk, E. R. (1986). Introduction to the symposium: Exercise in the treatment of obesity. Medicine and Science in Sports and Exercise, 18, 1-2.

Calabrese, L. H. (1990). Exercise, immunity, cancer, and infection. In C. J. Bouchard, R. J. Shepard, T. Stephens, J. R. Sutton, & B.D. McPherson (Eds.), Exercise, fitness, and health: A consensus of current knowledge, (pp.455-466). Champaign, IL: Human Kinetics.

Comrey, A. L. (1988). Methodological Contributions to Clinical Research. Factor analytic methods of scale development in personality and clinical psychology. Journal of Consulting and Clinical Psychology, 56, 754-761.

Congdon, K. (1993). Handbook for Cardiac Rehabilitation Center, Exerlife Program, University of Rhode Island.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. Psychometrika, 16, 297-334.

Dalen, N., & Olsson, K. E. (1974). Bone mineral content and physical activity. ACTA Orthopaedica Scandinavica, 45, 170-174.

Daley, J. G., Sowers-Hoag, K. M., & Thyer, B. A. (1991). Construct validity of the circumplex model of family functioning. Journal of Social Service Research, 15, 131-147.

Danner, R., & Edwards, D. (1992). Life is movement: Exercise for the older adult. Activities, Adaptation and Aging, 17, 15-26.

DiClemente, C. C., Prochaska, J. O., Fairhurst, S. K., Velicer, W. F., Velasquez, M. M., & Rossi, J. S. (1991). The process of smoking cessation: An analysis of precontemplation, contemplation, and preparation stages of change. Journal of Consulting and Clinical Psychology, 59, 295-304.

Dienstbier, R. A., LaGuardia, R. L., Barnes, M., Tharp, G. (1987). Catecholamine training effects from exercise programs: A bridge to exercise temperament relationships. Motivation and Emotion, 11, 297-318.

Dishman, R. K. (Ed.). (1988). Exercise adherence: Its impact on public health. (p2). Champaign, IL: Human Kinetics Books

Dolan, C. V., Molenaar, P. C., & Boomsma, D.I. (1991). Simultaneous genetic analysis of longitudinal means and covariances structure in the simplex model using twin data. Behavior Genetics, 21, 49-65.

Doshi, N. J., Hurley, R. S., Garrison, M. E., Stombaugh, I. (1994). Effectiveness of a nutrition education and physical fitness training program in lowering lipid levels in the Black elderly. Journal of Nutrition for the Elderly, 13, 23-33.

Drinkwater, B. L., Nilson, K., & Chestnut, C. M. (1989). Bone mineral density of amenorrheic and eumenorrheic athletes. New England Journal of Medicine, 311, 277-281.

Droste, C., Greenlee, M. W., Schreck, M., & Roskamm, H. (1991). Experimental pain thresholds and plasma beta-endorphin levels during exercise. Medicine and Science in Sports and Exercise, 23, 334-342.

Franklin, C., & Streeter, C. L. (1993). Validity of the 3-D circumplex model for family assessment. Special Issue: Empirical advances in social work assessment. Research on Social Work Practice, 3, 258-275.

Froelicher, V. (1987). The effect of exercise on myocardial perfusion and function in patients with coronary heart disease. European Heart Journal, 98, Supp G 1-8.

Gersick, C. J. G. (1991). Revolutionary change theories: A multilevel exploration of the punctuated equilibrium paradigm. Academy of Management Review, 16, 10-36.

Gersick, C. J. G. (1988). Time and transition in work teams: Toward a new model in group development. Academy of Management Journal, 31, 9-41.

Gould, S. J. (1980). The Pandas Thumb. New York: Norton.

Gould, S. J. & Eldredge, N. (1993). Punctuated Equilibrium comes of age. Nature, 366, 223-227.

Guttman, L. (1954). A new approach to factor analysis: The radex. In P.F. Lazarsfeld (Ed.), Mathematical thinking in the social sciences. (pp 258-348). New York: Columbia University Press.

Hagberg, J. M. (1990). Exercise, fitness, and hypertension. In C. J. Bouchard, R. J. Shepard, T. Stephens, J. R. Sutton, & B. D. McPherson (Eds.), Exercise, fitness, and health: A consensus of current knowledge. (pp.455-466). Champaign, IL: Human Kinetics.

Hamachek, D. E. (1986). Enhancing the self's psychology by improving fitness physiology. Journal of Human Behavior and Learning, 3, 2-12.

Harris and Associates, Inc. (1989). The Prevention Index, '89: Summary Report. Emmaus, PA: Rodale.

Haskell, W. L. (1984). Exercise induced changes in plasma lipids and lipoproteins. Preventive Medicine, 13, 23-36.

Haskell, W. L., Leon, A. S., Caspersen, C. J., Froelicher, V. F., Hagberg, J. M., Harlan, W., Holloszy, J. O., Regensteiner, J. G., Thompson, P. D., Washburn,

R. A. (1992). Cardiovascular benefits and assessment of physical activity and physical fitness in adults. Medicine, Science, Sports and Exercise, 24, s201-s220.

Hayduk, L. A. (1987). Structural equation modeling with LISREL: Essentials and advances. Baltimore: Johns Hopkins University Press.

Hays, R. D., Widaman, K. F., DiMatteo, M. R., & Stacy, A. W. (1987). Structural-equation models of current drug use: Are appropriate models so simple(x)? Journal of Personality and Social Psychology, 52, 134-144.

Helm, M., & Ellson, J. (1988). Cardiac rehabilitation: Occupational therapy enhancement of an existing cardiac outpatient rehabilitation programme. British Journal of Occupational Therapy, 51, 385-389.

Helmrich, S. P., Ragland, D. R., Paffenbarger, R. S. (1994). Prevention on non-insulin-dependent diabetes mellitus with physical activity. Medicine, Science, Sports and Exercise, 26 824-830.

Holland, J. L. (1973).

Jackson, D. N. (1970). A sequential system for personality scale development Current Topics in Clinical and Community Psychology. (pp. 61-96). New York: Academic Press.

Jackson, D. N. (1971). The dynamics of structured personality tests: 1971. Psychological Review, 78, 229-248.

Janis, I. L. & Mann, L. (1977). Decision Making: A psychological analysis of conflict, choice and commitment. New York: Collier Macmillan.

Jennings, G., Nelson, L. Nestel, P. (1986). The effect of changes in physical activity on major cardiovascular risk factors, hemodynamics, sympathetic function, and glucose utilization in man: a controlled study of four levels of activity. Circulation, 73, 30-40.

Joreskog, K. G., & Sorbom, D. (1979). Advances in factor analysis and structural equation models. Cambridge, MA.: Abt Books.

Joreskog, K. G., & Sorbom, D. (1986). PRELIS A program for multivariate data screening and data summarization: A preprocessor for LISREL. Mooresville, IN: Scientific Software, Inc.

Joreskog, K. G., & Sorbom, D. (1989). LISREL VI user's guide. Mooresville, IN: Scientific Software.

Joreskog, K. G., & Sorbom, D. (1990). LISREL VII: Analysis of linear structural relationships by the method of maximum likelihood (User's Guide). Mooresville, IN: Scientific Software, Inc.

Kligman, E. W., & Pepin, E. (1992). Prescribing physical activity for older patients. Geriatrics, 47, 33-45.

Kohlberg, L. (1976). Moral stage and moralization: The cognitive developmental approach. In T. Lickona (Ed.), Moral development and behavior: Theory, research and social issues. New York: Holt, Rinehart & Winston.

Krolner, B., & Taft, B. (1983). Vertebral bone loss: An unheeded side effect of therapeutic bedrest. Clinical Science, 64, 537-540.

Kubitz, K. A., & Landers, D. M. (1993). The effects of aerobic training on cardiovascular responses to mental stress: An examination of underlying mechanisms. Journal of Sports and Exercise Psychology, 15, 326-337.

Kubler-Ross, E. (1969). On death and dying. New York: Macmillan.

Kuhn, T. S. (1970). The structure of scientific revolution. 2nd Edition. Chicago: University of Chicago Press.

Lee, I. M. & Paffenbarger, R. S. (1994). Physical activity and its relation to cancer risk: A prospective study of college alumni. Medicine, Science, Sports and Exercise, 26, 831-837.

Maddock, J. W., & Lange, C. G. (1988). Integrating Milan therapy and the Circumplex Model: Ecosystemic consultation with families and their helpers. Special

Issue: Circumplex model: Systemic assessment and treatment of families. Journal of Psychotherapy and the Family, 4, 141-174.

Marcus, B. H., Emmons, K. M., Abrams, D. B., Marshall, R., Kane, M., Etzel, R. A., & Novotony, T. (1992). Biological feedback as part of a worksite smoking cessation program: Impact on smokers and non-smokers. Manuscript in preparation.

Marcus, B. H., Rakowski, W., & Rossi, J. S. (1992). Assessing motivational readiness and decision making for exercise. Health Psychology, 11, 257-261.

Marcus, B. H., Rossi, J. S., Selby, V. C., Niaura, R. S., & Abrams, D. B. (1992). The stages and processes of exercise adoption and maintenance in a worksite sample. Health Psychology, 11, 386-395.

Marcus, B. H., Selby, V. C., Niaura, R. S., & Rossi, J. S. (1992). Self-efficacy and the stages of exercise behavior. Research Quarterly For Exercise and Sport, 63, 60-66.

Marsh, H.W. (1993). Stability of individual differences in multiwave panel studies: Comparison of simplex models and one-factor models. Journal of Educational Measurement, 30, 157-183.

Mathis, R. D., & Tanner, Z. (1991). Cohesion, adaptability, and satisfaction of family systems in later life. Family Therapy, 18, 47-60.

McAuley, E., & Courneya, K. S. (1992). Self-efficacy relationships with affective and exertion responses to exercise. Journal of Applied Social Psychology 22, 312-326.

McConaughy, E. A., DiClemente, C. C., Prochaska, J. O., & Velicer, W. F. (1989). Stages of change in psychotherapy: A follow up report. Psychotherapy, 26, 494-503.

McConaughy, E. A., Prochaska, J. O., & Velicer, W. F. (1983). Stages of change in psychotherapy: measurement and sample profiles. Psychotherapy: Theory, Research, and Practice, 20, 368-375.

- McKain, J. L. (1987). Family violence: A treatment program for couples. Journal of Independent Social Work, 1, 71-83.
- McMurdo, M. E., & Burnett, L. (1992). Randomised controlled trial of exercise in the elderly. Gerontology, 38, 292-298.
- Morgan, W. P., & O'Connor, P. J. (1988). Exercise and mental health. In R. K. Dishman (Ed.), Exercise Adherence (p.101). Champaign IL: Human Kinetic Books
- Morris, J. N., Everitt, M. G., Pollard, R., Chave, S. P. W. (1980). Vigorous exercise in leisure time: protection against coronary heart disease. Lancet, 2, 1207-1210.
- Nediger, W. G., & Chelladurai, P. (1989). Life Styles Inventory: Its applicability in the Canadian context. Educational and Psychological Measurement, 49, 901-909.
- Nelson, T. M., McIntyre, J. W., LaBrie, I. G., & Csiky, A. (1991). Self Perception of the ability to work in the cold. Behavioral Medicine, 17, 15-23.
- Olson, D. H. (1988a). Circumplex model of family systems: VIII Family assessment and intervention. Special Issue: Circumplex Model: Systematic assessment and treatment of families. Journal of Psychotherapy and the Family, 4, 7-49.
- Olson, D. H. (1988b). Family assessment and intervention: The Circumplex Model of family systems. Child and Youth Services, 11, 9-48.
- Olson, D. H. (1991). Commentary: Three-dimensional (3-D) circumplex model and revised scoring of FACES-III. Family Process, 30, 74-79.
- Olson, D. H., Russell, C. S., & Sprenkle, D. H. (1979). Circumplex model of marital and family systems II: Empirical studies and clinical intervention. In John Vincent (Ed.), Advances in family intervention, assessment and theory (pp. 128-176). Greenwich, CT: JAI Press.

Olson, D. H., Russell, C. S., & Sprenkle, D. H. (1980). Marital and family therapy: A decade review. Journal of Marriage and the Family, 42, 973-993.

Olson, D. H., Russell, C. S., & Sprenkle, D. H. (1983). Circumplex model IV: Theoretical update. Family Process, 22, 69-83.

Paffenbarger, R. S., Hyde, R. T., Wing, A. L., Hsieh, C. C. (1986). Physical activity, all-cause mortality, and longevity of college alumni. New England Journal of Medicine, 314, 605-613.

Pandolf, K. B. (1991). Aging and heat tolerance at rest or during work. Special Issue: Ergonomics and the older worker. Experimental Aging Research, 17, 189-204.

Piaget, J. (1960). The child's conception of the world. Totowa, NJ: Littlefield Adams.

Piaget, J. (1972). Intellectual evolution from adolescence to adulthood. Human Development, 15, 1-12.

Prigogine, I., & Stengers, I. (1984). Order out of chaos: Man's new dialogue with nature. New York: Bantam.

Prochaska, J. O. (1984). Systems of Psychotherapy: A transtheoretical analyses (2nd edition). Homewood, IL: The Dorsey Press.

Prochaska, J. O. & DiClemente, C. C. (1983). Stages and processes of self change of smoking: Toward an integrative model of change. Journal of Consulting and Clinical Psychology, 51, 390-395.

Prochaska, J. O., Velicer, W. F., DiClemente, C. C., & Fava, J. (1988). Measuring processes of change: Application to the cessation of smoking. Journal of Consulting and Clinical Psychology, 56, 520-528.

Reed, G. R., (1993). The Transtheoretical model and exercise behavior: A comparison of five staging methods . Unpublished thesis. University of Rhode Island.

Reed, G. R., Velicer, W. F., Rossi, J. S., & Marcus, B. H. (1993, August). Profiles from the URICA-E: A continuous measure of the stages of change for

exercise. Paper Presented at Annual Meeting of the American Psychological Association, Washington, DC.

Reed, G. R., Velicer, W. F., Rossi, J. S., & Marcus, B. H. (1994, March). Stages of change for exercise: A comparison of an algorithm and a continuous measure. Paper presented at the annual meeting of the Society For Behavioral Medicine, Boston, MA.

Romney, D. M., Bynner, J. M. (1992). A simplex model of five DSM-III personality disorders. Journal of Personality Disorders, 6, 34-39.

Rounds, J., & Tracey, T. J. (1993). Prediger's dimensional representations of Holland's RIASEC circumplex. Journal of Applied Psychology, 78, 875-890.

Sallis, J. F., Haskell, W. L., Wood, P. D., Fortmann, S. P., Rogers, T., Blair, S. N., & Paffenbarger, R. S. (1985). Physical activity assessment methodology in the five-city project. American Journal of Epidemiology, 121, 91-106

SAS Manual. (1985). Cary NC: SAS Institute.

Shephard, R. (1992). A critical analysis of worksite fitness programs and their postulated economic benefits. Medicine and Science in Sports and Exercise, 24, 354-370.

Siscovick, D. S., Laporte, R. E., & Newman, J. M. (1985). The disease specific benefits and risks of physical activity and exercise. Public Health Reports, 100, 18-188.

Sigal, R. J., Purdon, C., Bilinski, D., Vranic, M., Halter, J. B., Marliss, E. B. (1994). Glucoregulation during and after intense exercise: Effects of beta-blockade. Journal of Clinical Endocrinology and Metabolism 78, 359-366.

Smith, C. W. (1989). Use of the circumplex model of marriage and family systems in training therapists. Clinical Supervisor, 7, 9-19,

Sonstroem, R. J. (1987, August). Stage model of exercise adoption. Paper presented at the National Convention, American Psychological Association, New York.

Sonstroem, R. J., Harlow, L., Gemma, L. M., & Osborne, S. (1991). Test of structural relationships within a proposed exercise and self-esteem model. Journal of Personality Assessment, *56*, 348-364.

Sonstroem, R. J., Harlow, L., & Josephs, L. (1994). Exercise and self esteem: Validity of model expansion and exercise associations. Journal of Sport and Exercise Psychology, *16*, 29-42.

Sonstroem, R. J., Speliotis, E. D., & Fava, J. L. (1992). Perceived physical competence in adults: An examination of the physical self-perception profile. Journal of Sport and Exercise Psychology, *14*, 207-221.

Stern, R. A., Prochaska, J. O., Velicer, W. F., & Elder, J. P. (1987). Stages of adolescent cigarette smoking acquisition: Measurement and sample profiles. Addictive Behaviors, *12*, 319-329.

Sternfeld, B. (1992). Cancer and the protective effects of physical activity: the epidemiological evidence. Medicine and Science in Sports and Exercise, *24*, 1195-1209.

Szabo, A., Peronnet, F., Boudreau, G., Cote, L. (1993). Psychophysiological profiles in response to various challengers during recovery from acute aerobic exercise. International Journal of Psychophysiology, *14*, 285-292.

Takeda, J., & Tatsuki, S. (1991). Construct validity of the circumplex model of marital and family systems: Results of a preliminary study and some methodological suggestions. Japanese Journal of Family Psychology, *5*, 33-51.

Taylor, C. B., Coffey, T., Berra, K., Iaffaldano, R., Casey, K., & Haskell, W. L. (1984). Seven-day activity and self report compared to direct measure of physical activity. Journal of Epidemiology, *120*, 818-824.

Taylor, C. B., Sallis, J. F., & Needle, R. (1985). The relation of physical activity and exercise to mental health. Public Health Reports, 100, 195-202.

Thomas, V., & Olson, D. H. (1993). Problem families and the circumplex model: Observational assessment using the Clinical Rating Scale (CRS). Journal of Marital and Family Therapy, 19, 159-175.

Tracey, T. J., & Rounds, J. B. (1992). Evaluating the RIASEC circumplex using high-point codes. Special Issue: Career decision making and career indecision. Journal of Vocational Behavior, 41, 295-311.

Tushman, M., & Romanelli, E. (1985). Organizational evolution: A metamorphosis model of convergence and reorientation. In L.L. Cummings and B.M. Staw (Eds.). Research in organizational behavior, 7, (pp171-222). Greenwich, CT.: JAI Press.

Velicer, W. F. (1976). Determining the number of components from the matrix of partial correlations. Psychometrika, 41,, 321- 337.

Velicer, W. F., DiClemente, C. C., Prochaska, J. O., & Brandenburg, N. (1985). A decisional balance measure for assessing and predicting smoking status. Journal of Personality and Social Psychology, 48, 1279-1289.

Velicer, W. F., DiClemente, C. C., Rossi, J. S., & Prochaska, J. O. (1990). Relapse situations and self-efficacy: An integrative model. Addictive Behaviors, 15, 271-283.

Velicer, W. F., Fava, J. L., Harrop, J. W., & Zwick, W. R. (1991). Component Analysis Extended (CAX) computer program. Unpublished computer program, University of Rhode Island.

Velicer, W. F., Hughes, S., Fava, J., Prochaska, J. O., & DiClemente, C. (1995). An empirical typology of subjects within stage in a smoking cessation study. Addictive Behaviors, 20, 000-000.

Velicer, W. F., Prochaska, J. O., Rossi, J. S., & Snow, M. (1992). Assessing outcome in smoking cessation studies. Psychological Bulletin, *111*, 23-41.

Velicer, W. F., Rossi, J. S., Prochaska, J. O., & DiClemente, C. C., (1992). A criterion measurement model for addictive behavior. Psychological Review submitted for review.

Walsh, F., & Olson, D. H. (1988). Utility of the circumplex model with severely dysfunctional family systems. Special Issue: Circumplex model: Systematic assessment and treatment of families. Journal of Psychotherapy and the Family, *4*, 51-78.

Ward, J. (1963). Hierarchical grouping to optimize an objective function. Journal of the American Statistical Association, *58*, 236-244.

Wiggins, J.S, & Broughton, R. (1991). A geometric taxonomy of personality scales. European Journal of Personality, *5*, 343-365.

Wiggins, J. S., & Pincus, A. L. (1989). Conceptions of personality disorders and dimensions of personality. Psychological Assessment, *1*, 305-316.

Wiggins, J. S., Trapnell, P., & Phillips, N. (1988). Psychometric and geometric characteristics of the Revised Interpersonal Adjective Scales (IAS-R). Multivariate Behavioral Research, *23*, 517-530.

Windle, M., Barnes, G. M., & Welte, J. (1989). Causal models of adolescent substance use: An examination of gender differences using distribution-free estimators. Journal of Personality and Social Psychology, *56*, 1232-142.

Wood, P. D. (1994). Physical activity, diet, and health: independent, and interactive effects. Medical Science, Sports and Exercise, *26*, 838-843.