Medication Adherence in Older Adults:
The Contributions of Cognitive Functions and Health Beliefs

by

Rhonda Ann Feldman
B.Sc., Queen's University, 1993
M.A., University of Western Ontario, 1995

A Dissertation Submitted in Partial Fulfillment of the
Requirements for the Degree of

DOCTOR OF PHILOSOPHY

In the Department of Psychology

We accept this dissertation as conforming
to the required standard

Dr. H. Tuokko, Co-Supervisor (Department of Psychology)

Dr. C. Mateer, Co-Supervisor (Department of Psychology)

Dr. D. Hultsch, Departmental Member (Department of Psychology)

Dr. E. Gallagher, Outside Member (Department of Nursing)

Dr. G. Gutman, External Examiner (Simon Fraser University)

Medication Adherence in Older Adults:
The Contributions of Cognitive Functions and Health Beliefs

Rhonda A. Feldman, M.A.

University of Victoria, BC

Medication adherence in older adults involves multiple factors. Cognitive factors for successful medication adherence may include executive functioning (i.e., comprehension, self-monitoring, problem solving, and planning), memory (retrospective and prospective), and processing speed. Facilitating health beliefs may be involved, such as locus of control, self-efficacy, and risk-benefits analysis. Medication adherence was investigated in older individuals with a wide variety of illnesses. Cognitive and health belief variables were expected to significantly contribute to the prediction of medication adherence, measured by self-report questionnaires. Executive functioning was expected to be a better predictor of adherence than memory or processing speed. Ninety-five volunteers aged 65 and over individually completed a battery of tests on two occasions about one week apart. Demographic variables, including age, education, number of medications, and living status were recorded. Multiple neuropsychological measures of memory, executive functioning and processing speed were administered. Questionnaires of locus of control, general self-efficacy, and medication benefit-risk analysis were also completed. Two self-report questionnaires measured medication adherence. After removal of outliers from the data set, multiple regression analyses were run separately on the two adherence measures. Better adherence was associated with fewer medications taken, and poorer scores on measures of executive functioning. Health beliefs were not predictive of adherence. The relationship of better adherence with fewer medications has

been seen previously in the literature. For those results that were counter to expectations, several possible explanations are considered. The absence of a health belief effect may have been due to poorly understood or psychometrically problematic measures. Proposed explanations for the surprising association of poorer executive functioning and better adherence include (1) cognitive rigidity is beneficial to consistent medication adherence, (2) those with good executive functioning may over-rely on internal organizational strategies rather than using external cues, resulting in more errors, or (3) poor self-monitoring produces both poor executive function scores and reduced adherence self-reporting.

Dr. H. Tuokko, Co-Supervisor (Department of Psychology)

Dr. C. Mateer, Co-Supervisor (Department of Psychology)

Dr. D. Hultsch, Departmental Member (Department of Psychology)

Dr. E. Gallagher, Outside Member (Department of Nursing)

Dr. G. Gutman, External Examiner (Simon Fraser University)

Table of Contents

List of Tables

List of Tables (Continued)

List of Tables (Continued)

List of Figures

Acknowledgments

I must first acknowledge my supervisors, Dr. Catherine Mateer, who brought me to beautiful Victoria, BC, and Dr. Holly Tuokko, who taught me how to make ravioli with data, among many other things. Thank you both for your extraordinary patience, skill, and knowledge.

Next, let me express my gratitude to my committee members. I appreciate your taking the time to participate in this process with me.

I would like to give many thanks to all the wonderful people who contributed their time and effort as participants in this project. My appreciation also goes out to all the staff and resources made available to me at the Centre on Aging at the University of Victoria. In addition, thank you to everyone at the Baycrest Centre for Geriatric Care in Toronto for their contributions and insight.

My most profound gratitude goes to my parents, whose support, both financial and emotional, was above and beyond the call of duty. There is no question in my mind that I could not have done this without you. Plus, you make pretty good research assistants if you ever need alternative careers.

I would like to give many, many thanks to my siblings, their spouses, and their children. You have grown in number (and height) since I began this process, and you always made me want to finish so I could come home to be with you.

Finally, I want to thank all of my wonderful friends from the bottom of my heart for their unending encouragement and humour.

Dedication

To my parents, Fred and Toba Feldman.

Medication Adherence in Older Adults:

The Contributions of Cognitive Functions and Health Beliefs

Introduction

As life expectancy increases in North America, the overall population of seniors concomitantly grows (McGinnis, 1997). Seniors represented about 13 percent of the Canadian population in 2000, and by the year 2021 this section of the population is expected to rise to almost 19 percent (Statistics Canada, 08 December 2002). For our society to adapt to the changing needs of its members, it is becoming increasingly important to understand those factors influencing the quality of life, autonomy, and self-care performance of this large group of older adults.

One important component of self-care that has received much attention is the proper self-management of medications. Although seniors are only about 12 percent of the population, they use 28-40 percent of prescribed medications (Tamblyn and Perreault, 10 July, 2000). In 1997, 84% of seniors reported taking some kind of medication over a two day period, with 56% taking more than two medications (Health Canada, Division of Aging and Seniors, 20 August 2002). Older adults are also more likely than younger adults to be taking multiple medications at once (Statistics Canada for the Division of Aging and Seniors, 10 July, 2000). Difficulties in proper drug use can have serious consequences, as an estimated 5-23 percent of all admissions to hospital are due to drug-related illnesses, the majority of which appear to be related to poor adherence (Tamblyn and Perreault, 10 July, 2000). There are also many circumstances in which failure to follow the prescribed medication regimen can lead to life-threatening conditions (e.g.,

diabetes), or fail to prevent the development of serious illness (e.g., hypertension and glaucoma). Thus, the capacity to manage one's medications independently can make a difference in an older individual's ability to live in the community with only minimal support care.

Traditionally, a failure in the self-management of medications has been referred to as non-compliance. However, this term implies that the individual has failed or refused to follow instructions as indicated by his or her doctor. Such a description suggests negative attributes of incompetence or opposition. The literature is trying now to indicate the growing role of the individual in a collaborative process involved in medical decisions and drug regimens (Donovan and Blake, 1992). Although the term currently used, non-adherence, still has some negative connotations, it is more consistent with the idea of a person choosing to follow or not follow the regimen they helped to create.

In the area of health care, it can be very difficult to ensure a client's adherence to a treatment plan, whether in medication self-management, keeping appointments, or following health-promoting lifestyle routines. Promoting drug-use regimen adherence, in particular, is a complex, multi-factorial issue. When one considers the complexity of the task of medication usage, it becomes clear that an apparent lack of adherence to the regimen can occur at any of a number of stages in the process, and for any number of reasons. For example, once a prescription is given by the doctor, the person must choose to, and remember to, have it filled at the pharmacy, then remember and understand the instructions given for how the drug was to be taken, and then do problem solving to identify how those instructions can be best translated into behaviour in his or her everyday life. Actually taking the medication in the manner, dosage, frequency and

duration that was prescribed requires physical capacity, successful planning, self-monitoring, and memory abilities.

In addition, an individual will be likely to consistently follow this regimen only if he or she believes, among other things, that his or her illness is serious enough to treat, that it will be effectively treated with the drugs as prescribed, and that any side effects are worth the possible benefit. As described in the Health Belief Model (as reviewed in e.g., Feuerstein, Labbé, and Kuczmierczyk, 1986; Taylor, 1999; Rutter, Quine, and Chesham, 1993; and Poole, Matheson, and Cox, 2001), an individual's behaviour with regard to his or her health will be influenced by his or her perceived vulnerability to a particular illness, the perceived severity of the illness, and any perceived barriers and benefits to the healthy behaviour.

A related theory regarding the influence of attitudes on behaviour is that of the Theory of Planned Behaviour (as reviewed in Ajzen and Madden, 1986). According to this theory, health behaviour results from behavioural intentions, which in turn are subject to attitudes about the outcomes of an action, what others believe is the appropriate action to take, and whether or not the individual feels capable of performing the action (as reviewed in Taylor, 1999). The Theory of Planned Behaviour, by addressing both intentions to perform an action and perceived behavioural control, is applicable to a wide range of behaviours, even beyond those involved in the area of health.

In summary, then, following a medication regimen requires the cognitive abilities of attention, comprehension, problem solving, self-monitoring, planning, and memory for information learned in the past (retrospective memory) and for activities to be done in the future (prospective memory). However, adequate cognitive functioning is not sufficient;

the actual behaviour will only occur with the right combination of physical ability and complementary health beliefs.

Clearly, the successful completion of adherence to a prescribed medication regimen requires the synchronization of multiple skills and abilities. Some of these abilities can be categorized as being dependent on elements outside of one's control, while others are within one's control. For example, physical ability and level of cognitive functioning are not influenced by one's choice or desire, rather they represent limitations with which one must learn to cope through whatever means necessary. So, if an older individual is unable to open a bottle of pills, he or she is not taking his or her medication as prescribed, but his or her nonadherence is unintentional and circumstantial. Memory lapses can be viewed similarly, as representing an imposed limitation on an individual's ability to carry out his or her wishes for adherence. On the other hand, there are also factors contributing to successful adherence that are influenced by choice and control. As addressed in the Theory of Planned Behaviour (Fishbein and Ajzen, 1975), intention to take one's medications plays an important role in actual adherence. That is, one may intentionally decide not to follow the medication regimen recommended by a health care professional because taking the medication is somehow counter to one's beliefs.

There is evidence to support the distinction between intentional and unintentional nonadherence. A study by Cooper, Love and Raffoul (1982) surveyed community-dwelling older individuals about their medication usage and specifically addressed this issue. Their investigation indicated that 70 percent of reported nonadherence was due to intentional reasons, while only 30 percent of reported nonadherence was unintentional.

Among the reasons given for non-adherence, the most frequent was the patient's perception that the drug was not needed at the dosage prescribed. Similarly, Col, Fanale, and Kronholm (1990) surveyed older individuals admitted to hospital for reasons related to adverse drug effects or nonadherence. Of the reported nonadherence in this sample, 54 percent was intentional and 45 percent was unintentional. These findings, while less extreme than those of Cooper, et al., also suggest that a large part of nonadherence is due to an individual's choice and decision-making process.

Despite the evidence that an individual's intention will influence their adherence, much of the research and many of the products aimed at improving medication adherence have been focused on memory-enhancing strategies and devices. For example, pill boxes and alarm reminder systems are intended to increase adherence by reducing the memory and organizational demands of a medication regimen. If the greatest degree of nonadherence is actually due to intentional factors (i.e., decision making), it would seem that such interventions would be ineffective in producing increased treatment adherence. Thus, it is important to investigate the roles of intentional factors, such as health beliefs, and unintentional factors, such as elements of cognition, to overall medication adherence. Some research has been conducted previously into the relationship between cognition and medication adherence (e.g., Isaac, Tamblyn and the McGill-Calgary Drug Research Team, 1993; Park, et al. 1999). However, Isaac, et al. did not include measures of health beliefs in their study, and Park et al. used non-clinical measures of cognition and limited measures of health beliefs. Neither of these studies included any measure of the intentionality of nonadherence.

Cognitive Factors

It has been well documented that changes in cognitive functioning are normal with increasing age (e.g., see reviews by Tuokko and Hadjistavropoulos, 1998; Glisky and Glisky, 1999; and Lezak, 1995). Sharp losses in cognitive ability have been observed in cross-sectional studies of different age groups, whereas longitudinal studies tend to show gradual decline in some areas of cognitive functioning and gains in others (e.g., as reviewed by Lezak, 1995). The more rapid decline observed in cross-sectional studies may be due, in part, to cohort differences such as education or physical health, while the gains in functioning seen in longitudinal studies may be related to selective representation of healthier, more prosperous individuals among those who reach greater age (e.g., as reviewed by Hoyer, Rybash and Roodin, 1999). In general, however, over-learned, well-practiced and familiar skills and abilities (i.e., "crystallized" intelligence) tend to remain intact well into the 70s and 80s, whereas reasoning and problem solving (i.e., "fluid" intelligence) are more likely to show decline after the early 60s (Lezak, 1995). So, the pattern of cognitive decline with age depends on the functional ability of interest and the method in which it is studied.

A particularly robust change in processing speed has been observed with increasing age. Salthouse (e.g., 1996) has hypothesized that a major factor associated with age related differences in cognitive abilities is a decrease in the speed at which cognitive operations can be carried out, although he suggests these effects may be direct or indirect. Salthouse's theory suggests speed produces age related differences through two mechanisms. The first of these mechanisms is that of limited time, in which cognitive operations occur too slowly to complete a task within the given time. Salthouse

likens this process to an assembly line, in that if the basic processing operations are not completed within the given time, the final product is likely to be delayed or left incomplete. The second mechanism contributing to age related differences in cognitive functioning is that of simultaneity. Here, slowed processing reduces the amount of available information necessary for higher level processing. In other words, the products of earlier processing may be degraded or less relevant for later processing if they take too long to complete. This process differs from the limited time mechanism in that it involves the quality of the information available for later processing, rather than the quantity, even if there are no external time constraints. When the rate of processing is slow, the relevant information may be impoverished or degraded by the time the preceding operations have been completed. In this way, even complex problem solving may be affected indirectly by processing speed.

There are other areas of cognitive functioning that show systematic changes with increasing age. Although simple attention span (e.g., Digit Span Forward) remains stable with increasing age, declining performance is associated with increased age when mental manipulation of items held in working memory is required (e.g., Digit Span Backward). Age-related deficits have also been noted in tasks of divided attention, selective attention and distractibility. Declines associated with aging have been shown in measures of naming and verbal fluency, though other language skills such as vocabulary and verbal reasoning generally remain intact. Significant reduction of memory performance commonly occurs in the free recall of information, especially over a longer retention interval. However, information is retained well for short intervals over the lifespan, and recognition memory seems largely unaffected by aging. Declining performance

associated with aging has also been noted in tasks of visuospatial ability (e.g., Block Design) and drawing performance (e.g., clock drawing). Increasing age appears to affect reasoning for novel and complex problems, though reasoning is less affected by age if the tasks are familiar (e.g., arithmetic). Concept formation and ability to abstract also tend to decline with age (Tranel, Anderson and Benton, 1994).

Research on the relationship between aging and remembering an activity to be done in the future, or prospective memory, has been equivocal. McDaniel and Einstein (1992) reported evidence that older adults are less accurate than younger adults in remembering to do time-based tasks but not event-based tasks. These researchers also found older adults are relatively poorer at prospective memory tasks involving multiple tasks to be remembered concurrently.

Thus, it could be expected that older individuals would have more difficulty than younger individuals on tasks related to medication management when divided attention, naming, long term free recall, visuospatial ability, prospective memory for time-based tasks, and problem solving are required. Practically, these abilities might be called upon in remembering the name of a medication, how and when the drugs are supposed to be taken, how pills should be organized physically for easy use, in what way lifestyle routines must be changed to accommodate for the medication, remembering that the medication must be taken at a specific time in the future, and being able to interrupt one's current activity to take the medications at the right time.

Many of these cognitive variables have been investigated for their relative importance in medication adherence. Studies using measures of general cognitive status (e.g., Mini Mental State Exam or MMSE) have generally shown poor association

between these measures and adherence. Multiple investigations (e.g., Isaac, et al. 1993; Day, Moore and Hodgins, 1998; Patrick and Howell, 1998) have found no significant relationship between the MMSE and measures of adherence. Graveley and Oseasohn (1991) have found, however, that MMSE scores greater than 27 correlated with adherence behaviour.

The importance of memory to adherence has also received significant attention from researchers, and has been investigated in a variety of ways. Isaac, et al. (1993) found that, of the measures they used, visual recall had the strongest relationship to adherence, as measured by pill count and self-report, and verbal memory correlated moderately with adherence. Morrell, Park, Kidder and Martin (1997) found some limited support for the association of working memory with adherence, although it was not found to be a significant predictive factor in their study. Park, et al. (1999) found support for the relationship between adherence and the cognitive factors of speed of processing, working memory, episodic memory, and reasoning when they were grouped into a single construct. However, the measures of cognitive functioning used in this study were highly intercorrelated, and therefore the direct relationship of each individual element was not calculated.

Other cognitive factors that have been found to correlate with adherence include vocabulary (Leirer, Morrow, Tanke, and Pariante, 1991; Morrow, Leirer, Andrassy, Tanke, and Stine-Morrow, 1996), and knowledge about one's medications (Day, et al. 1998; Lorenc and Branthwaite, 1993) or one's illness (Morrell, et al.1997). Some cognitive factors that have been considered in research but have not been found related to adherence include attention/concentration, motor ability (Isaac, et al. 1993), object

rotation (Leirer, et al. 1991), and paired associate learning (Graveley and Oseasohn, 1991). Demographic and psychosocial factors found to be predictive of adherence include ethnicity, marital status (Graveley and Oseasohn, 1991), busyness (Park, et al. 1999) and not living alone (Lorenc and Branthwaite, 1993). Physical factors predictive of adherence include age (e.g., Park, et al. 1999; Graveley and Oseasohn, 1991), blood pressure (Morrell, et al. 1997), and number of pills taken (Graveley and Oseasohn, 1991).

Significant age-related declines have been noted in abstract reasoning and problem solving. However, only one study has investigated the potential relationship of these executive functions to adherence in older adults (Park, et al. 1999). As mentioned above, this study used only one measure of reasoning as a part of a composite score of cognitive functions. Reviewed by Tranel, et al. (1994), executive functions encompass a large variety of skills and attributes, and are considered higher-order cognitive abilities, such as judgement, decision making, planning and social conduct. In addition, Lezak (1995) explains the executive functions as involving volition, planning, purposive action, and effective performance. Lezak describes volition as the capacity for intentional behaviour, or being able to identify what one needs and how one might go about achieving that goal in the future. Planning refers to the recognition of the steps involved in achieving future goals. Initiation and the appropriate behavioural sequence programming are required for purposive action. Finally, effective performance refers to the necessity of monitoring and changing behaviour in response to on-going feedback in order to achieve the goal. Tranel, et al. describe decision making much like Lezak's purposive action, and their self-perception term is like her effective performance term. In addition, Tranel, et al. indicate that judgement is the ability to weigh different options and

decide on their relative worth.

A related line of research conducted by Willis and Diehl, and described by Park, Willis, Morrow, Diehl and Gaines (1994), is concerned with older adults' comprehension of medical information (e.g., instructions on pill bottles). Their findings in normal and demented older adults suggest that the comprehension of prescription information is more difficult when inferences must be made, and even more difficult if other cognitive deficits are present. Thus, inferential reasoning and the consolidation of information for judgement and purposive action can be compromised in this population.

Given the clear relationship of such factors as planning, initiation and programming of behaviour, self-monitoring, and judgement to the ability to independently manage a medication regimen, it is surprising how little research has been conducted on the potential relationship between adherence behaviours and other measures of executive functions. Patrick and Howell (1998) included a measure of verbal fluency to assess executive functioning as part of a battery investigating the relationship between cognitive measures and the outcome of self-medication training. They found that the executive measure did not accurately predict progression through the training course to improve autonomy in medication use, although a measure of visuospatial ability (the Hooper Visual Organization Test) was a good predictor of successful training. It is highly possible that the measure of executive functioning used in this study was not sufficiently sensitive to reveal a relationship to success in the training course. A study by Willis, et al. (1998) demonstrated that both global measures of cognitive functioning and additional measures of executive functioning contributed unique variance to the performance on a test of everyday problem solving abilities (e.g.,

managing finances, medications and transportation). The measure of everyday functioning used in this study collapsed information across six instrumental activities of daily living, and so did not allow specific conclusions to be drawn about medication management on its own. However, the findings indicate a relationship between executive functions and common problem solving tasks, such as medication management.

Mann et al. (1999) examined the role executive functions may play in the adherence to health-care of individuals with HIV (human immunodeficiency virus). They used the Executive Interview (EXIT), (developed by Royall, Mahurin, and Gray, 1992) to measure abstraction, judgement and reasoning. High scores on this measure indicate greater executive dyscontrol. Adherence to medication regimens and health-care behaviours (e.g., sexual abstinence) was measured by self-report. The findings revealed that adherence to medication was negatively correlated with EXIT total scores. That is, poorer adherence was related to poorer executive functioning. As Mann, et al.'s study had few participants and used a non-validated self-report measure of adherence, generalizations must be made cautiously. However, this study suggests a possible relationship between adherence and executive functions.

Health Beliefs

There have been many approaches to investigate the relationship between adherence behaviour and health beliefs. Of these, three perspectives were investigated in detail: self-efficacy, locus of control, and Horne and Weinman's (1999) model of the balance between concerns about, and necessity of, medication use. There has been some evidence that those with good health show a particular pattern of health beliefs. A study by Waller and Bates (1992) indicated a population of healthy older individuals had an

internal locus of control and high generalized self-efficacy. In other words, these healthy older adults believed their own behaviours influenced their health, and they also believed themselves capable of the behaviours necessary to maintain good health.

Self-Efficacy.

Bandura's (e.g., 1977, 1982) social learning theory is concerned with those cognitive processes contributing to the ability to exercise control over one's actions. He proposed that a situation's outcome is mediated first by beliefs concerning one's capability to perform a given behaviour (efficacy expectations) and then by beliefs about whether or not that behaviour will lead to a given outcome (outcome expectations). Thus, self-efficacy refers to "judgments of how well one can execute courses of action required to deal with prospective situations," (Bandura, 1982, p. 122). From these judgements, people choose to engage in behaviours they believe themselves capable of executing (high self-efficacy) and tend to avoid behaviours they believe they will execute poorly (low self-efficacy). Bandura also proposed that self-efficacy expectations will influence the amount of effort and degree of persistence people will be willing to exert in the face of obstacles to achieve the desired goal, where higher self-efficacy leads to greater persistence.

Efficacy expectations can differ in strength, magnitude and generality. The strength of self-efficacy beliefs refers to how strongly held the belief is, or in other words, how easily extinguished the belief may be in light of disconfirming evidence (Bandura, 1977). Magnitude reflects efficacy judgements based on the difficulty of the task, where high efficacy expectations may be limited to easy tasks and diminish with more difficult tasks. While Bandura also proposed that self-efficacy judgements have the

quality of generality, such that some experiences can influence efficacy beliefs broadly and others are more situation-specific, he also stressed that perceived coping abilities are evaluated for each type of behavioural domain, rather than one having a global personality trait of efficacy (1977).

Others have argued that if an individual experiences success in multiple areas, these experiences can lead to positive self-efficacy expectations in a wider variety of situations (e.g., Sherer, et al.1982). Consistent with these conceptualisations of domain-specific versus generalized self-efficacy different measures have been developed. For example, Sherer, et al. developed the General Self-Efficacy Scale, which they found to be valid and reliable in measuring expectations based on past experiences and the tendency "to attribute success to skill as opposed to chance" (pp. 671). The items making up the General Self-Efficacy Scale (GSES) consist of general self-efficacy items and social self-efficacy items. These items can be found in Appendix A. Research by Woodruff and Cashman (1993) demonstrated the value of the scale's psychometric properties at the level of general self-efficacy, and with regard to a specific domain (in this case, academics). Bosscher and Smit (1998) modified the GSES for use with older individuals by excluding five items that had low correlations and ambiguous wording. The modified twelve-item scale was found to appropriately measure general self-efficacy in older persons (Bosscher and Smit, 1998).

Previous research (e.g., as reviewed by Maibach and Murphy, 1995; and Horne and Weinman, 1998) has shown a significant relationship between self-efficacy and several types of health behaviours, such as smoking cessation, weight control and exercise. Work by Brus, van de Laar, Taal, Rasker, and Wiegman (1999) has indicated

that in a population of patients with rheumatoid arthritis, a question concerning self-efficacy expectations was the only significant predictor of medication adherence, as measured by pill-count. In the Brus, et al. study, adherence was not related to outcome expectations, or perceived attitudes. Although the measure of self-efficacy used by Brus, et al. has questionable reliability and validity, these results do suggest a role of efficacy expectations in adherence behaviour.

De Geest, Abraham, Gemoets, and Evers (1994) qualitatively investigated which elements of self-efficacy may contribute to medication taking behaviours among transplant patients in Belgium. They conducted in-depth interviews with a small number of individuals whose chronic conditions (e.g., transplant recipients) required lifelong medication use. From these interviews, the researchers identified multiple themes that were reported to influence medication adherence among transplant recipients, including personal attributes, such as emotional distress and the desire for "normalcy", environmental factors, such as disruption to their routine, and drug-related factors, such as side effects. In a personal communication (Aug. 9, 2000), De Geest indicated the resulting scale (the Long-Term Medication Behaviour Self-Efficacy Scale) has demonstrated adequate reliability in two studies of transplant recipients, but that research on the validity of the instrument is still in progress.

Locus of Control.

A related health-belief construct is that of health locus of control. Described by Wallston, Wallston, Kaplan and Maides (1976), health locus of control refers to Rotter's (1954) internal-external locus of control theory applied to the area of health. Similar to Bandura's self-efficacy theory, health locus of control proposes that experiences in a

given domain of behaviour will lead to expectancies about future behaviours in that domain, in this case, health behaviours. The Health Locus of Control scale developed by Wallston, et al. (1976) was intended as a unidimensional measure of the degree to which people believe their health is determined by their own behaviour (internal control), or by others (external control) (Wallston, Wallston, & DeVellis, 1978).

The construct of assigning internal or external responsibility for one's health was expanded in the Multidimensional Health Locus of Control (MHLC) scale (Wallston, et al. 1978), to identify separately the beliefs that one's health is influenced externally by powerful others (e.g., doctors, family, or friends) and by chance, fate or luck. The MHLC scale has been constructed with alternate forms of the general construct (forms A and B are in Appendix B, from Wallston, et al. 1978) and a form that is condition-specific (form C, from Wallston, Stein and Smith, 1994). Reliability for these scales is optimal when forms A and B are combined together (Wallston, et al. 1978; Wall, Hinrichsen and Pollack, 1989). Although data have been collected that casts doubt on the factor structure of this measure (Cooper and Fraboni, 1988) and on the comparability of forms A and B (Cooper and Fraboni, 1990), there has also been evidence to support the factor structure of the MHLC (Marshall, Collins, and Crooks, 1990; Robinson-Whelen and Storandt, 1992; Wall, et al.1989).

Robinson-Whelen and Storandt (1992) verified the factor structure of the MHLC form B in a study among older adults. They found that the internal, powerful others and chance external locus of control factors were maintained in this older group, but that internal consistency suffered. Through factor analyses, they identified four items that loaded on more than one factor, and found removing these items from the analysis

improved all indices of fit to the proposed three-factor model. They concluded from their statistical findings that this shorter, modified version of the scale might be more appropriate for use with an older population.

Wallston, et al. (1978) predicted that in the face of negative side effects, adherence behaviour would likely differ as a function of locus of control. That is, they suggested that a person with strong beliefs in powerful others, especially a doctor, would be likely to continue to take medications as prescribed despite side effects, whereas a person with a strong belief in chance may decide to stop taking the medications entirely. Lastly, Wallston, et al. (1978) predicted that those with an internal locus of control may perform "self-study" (p. 168) to see whether they felt better taking their drugs as prescribed or in a different way.

Consistent with Wallston, et al.'s (1978) prediction, the research on the relationship of locus of control and adherence behaviour has produced differing results. Myers and Myers (1999) used MHLC-C to investigate adherence to treatment in a group of adults with cystic fibrosis. They found that overall adherence to treatment was significantly related to individual's beliefs that powerful others, especially doctors, were responsible for their health; that is, good adherence was associated with a belief in external control. Similarly, Raiz, Kilty, Henry and Ferguson (1999) also found that individuals who believed health outcomes were controlled by powerful others were more likely to be adherent to their medication regimens. These findings suggest that individuals who believe strongly in the role powerful others, such as doctors, play in their health are more likely to carefully follow the instructions they are given for taking their medications. In contrast, using the full length MHLC, McDonald-Miszczak, Maki, and

Gould (2000) found that individuals who believe powerful others have an important role in their health rate themselves as less adherent to their prescribed medication regimens than those who do not hold this belief.

Raiz, et al. (1999) and McDonald-Miszczak, et al. (2000) sampled significantly different populations, and this may explain the discrepancy in their findings. Raiz, et al. sampled only successful renal transplant recipients, whereas McDonald-Miszczak, et al. sampled volunteers from the general community. Although it is speculation, the transplant experience itself may change the way these patients see their behaviour as linked to the advice of powerful others (e.g., doctors). That is, transplant recipients may adhere more closely to the advice of their doctors to take their medications because they attribute their good health to the suggestions of these powerful others. On the other hand, in the general population, a strong belief in the role powerful others play in one's health may mean a release of personal responsibility for good health, such that the more an individual attributes good health to others, the less he or she will do to maintain their own health. Although it is clear from these studies that external locus of control has a relationship to adherence behaviour, it is unclear in what way it will reveal its influence in the present study, that is, by encouraging or discouraging adherence.

Necessity versus Concerns about Medication.

Incorporating aspects from several different medication adherence models, Horne and Weinman (1998) conceptualised the influence of health beliefs on medication adherence as involving an individual's expectations of the proposed treatment and its value, as well as emotional reactions to his or her disease. Horne, Weinman, and Hankins (1999) wanted to further explore how beliefs about chronic illness and treatment

would affect medication-taking behaviour. They developed the Beliefs About Medicines Questionnaire (BMQ) to identify beliefs on how treatment affected people's perception of their illnesses, and the items of this measure can be found in Appendix C. From this large study, different themes emerged regarding people's beliefs about their own specific prescribed medication, and about medication in general. The two specific themes were concerned with the necessity of prescribed medication, and about the possible negative consequences of taking these same medications (e.g., dependence or side effects). Horne, Weinman, and Hankins (1999) consider these elements part of a cost-benefit analysis inherent to the medication-taking process. Themes identified in the BMQ about general medication prescriptions included beliefs about the nature of taking potentially harmful substances as medicine, and the perception of doctors over-prescribing medicine.

Horne and Weinman (1999) examined the psychometric properties of the BMQ scale, and also investigated to what degree these beliefs could be useful in predicting medication adherence. Using a four-item self-report scale of adherence (the Reported Adherence to Medication scale or RAM), they found that higher scores on the necessity construct correlated with higher reported adherence, while higher scores on the concerns construct were associated with lower adherence. Those who attained higher concerns scores than necessity scores reported significantly reduced adherence. Through multiple regression analysis it was determined that the difference between the necessity-concerns scores was the strongest predictor of the variance in reported adherence. Other predictive factors in this analysis were the individual's age and the type of illness they had.

Multifactorial Models

The greatest proponents of a multifactorial model of medication adherence are

Denise Park and her colleagues. The model of adherence proposed by these researchers emphasizes the contribution of cognitive functioning (e.g., memory), illness representation (e.g., perceived outcome), and external cues or strategies (e.g., reminder devices) to medication adherence. As described in Park and Jones (1997), this model suggests individual differences indirectly influence adherence by their impact on illness representation and cognitive function (see Figure 1). Age is proposed to act only as a mediating factor for cognitive functions, that is, risk for nonadherence is not greater in older people unless they also experience cognitive decline.

In fact, Park and Kidder (1996) review studies from their laboratory that reveal young-old adults (ages 60-70) have the best adherence of any age group, including middle-aged adults. The oldest-old (71 years and up) demonstrated the poorest adherence, but benefited most from the use of organizational devices (Park, Morrell, Frieske, and Kincaid 1992), which Park and Kidder suggest shows that nonadherence in this oldest group may stem from cognitive problems. These researchers proposed that the young-old demonstrated "the appropriate cognitive skills, life style, and illness representation that would result in a high level of adherence" (Park and Kidder, 1996, p. 382). That is, they perceive their physical vulnerability to illness, have the cognitive resources necessary to monitor the use of medications, and possibly have more time (e.g., if they are retired) to spend on medication regimens.

As described in Park and Jones, (1997), the model has a number of cognitive subcomponents that are required to accurately engage in medication adherence. These are: (1) comprehension of medication instructions, (2) integration of instructions from individual prescriptions, and organization into a temporal plan, (3) retention of this

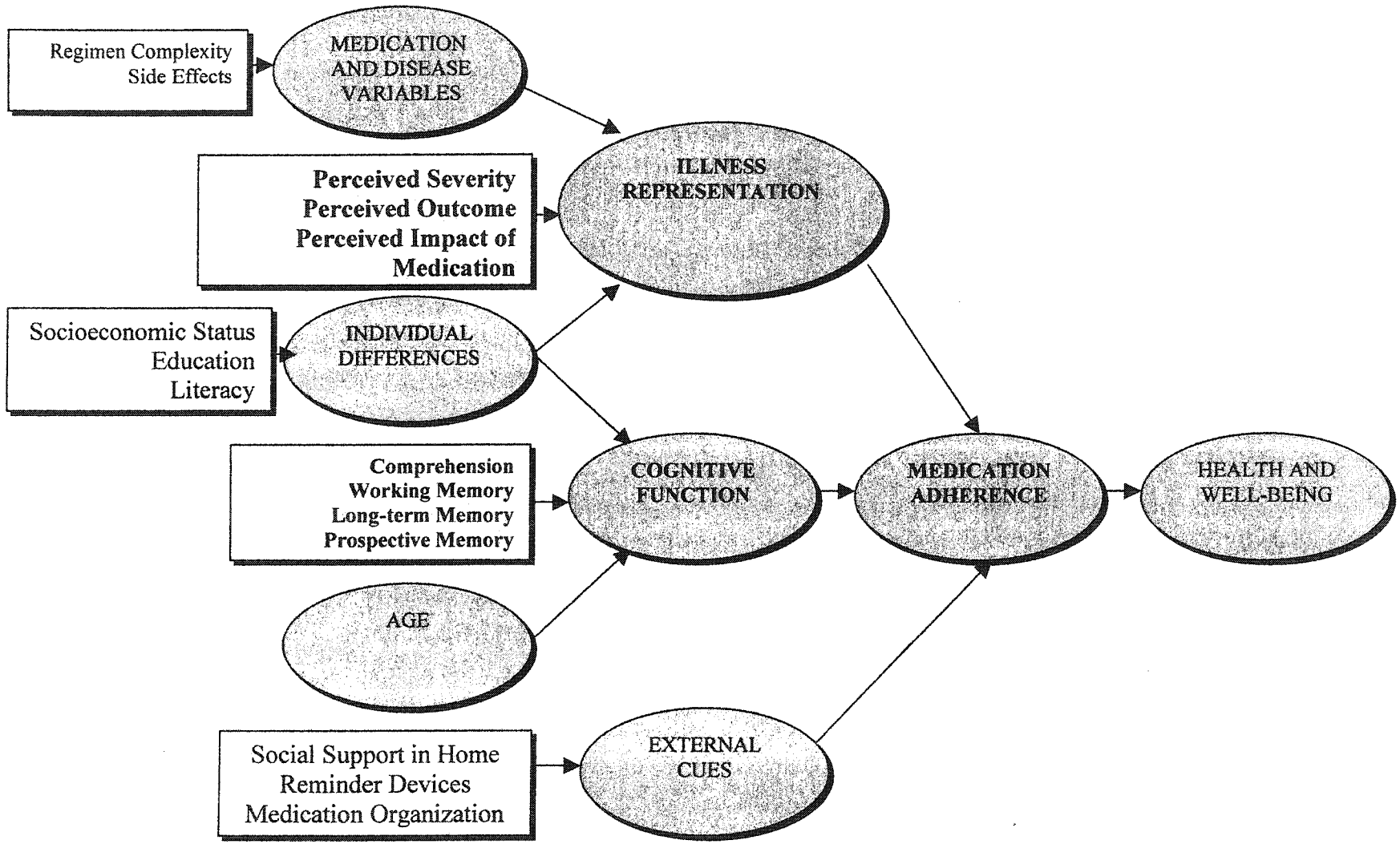


Figure 1: From Park and Jones (1997) Conceptual model of medication adherence

medication plan, and (4) remembering to take the medication at the appointed time. Park (1999) emphasized that the second step involves integration, organization, and planning.

A recent study by Park, et al. (1999) used structural equation modeling to assess the relative contributions of age, cognitive function, beliefs about illness, and other psychosocial factors to medication adherence in a group of individuals aged 34 to 84, diagnosed with rheumatoid arthritis. As in most of the work done by this group, adherence was measured with the Medication Event Monitoring System (MEMS), a sensitive electronic device placed in a pill bottle cap to register each time the container is opened. Health beliefs, with a focus on self-efficacy traits, were measured by questionnaire, as were other psychosocial variables (e.g., busyness of lifestyle, negative affect, and objective health status). The self-efficacy scales were developed for the study. Cognition was assessed with a battery of laboratory tests to measure speed of information processing, working memory, text comprehension, long-term memory, reasoning, and vocabulary.

The results from this study showed that 38% of the sample made no adherence errors at all over the monitored time period (four weeks), and that perfect adherence was actually more common among older adults than younger adults. Given this high adherence rate, Park, et al. (1999) thought the group sampled might have unusually high cognitive abilities. However, when they compared their data to another sample of individuals without arthritis, they found the arthritis group actually had age-related decline on several cognitive measures. The data indicated that excellent medication adherence can occur despite coexisting age-related cognitive decline. All cognitive measures were entered into the analysis as a single construct of general cognition. The

findings from the structural equation modelling indicated that age, cognitive function, and ability to control illness-related negative moods (i.e., affect self-efficacy) all had direct influence on medication adherence. Increasing age was associated with greater adherence. Once the direct relationship of age to cognitive function was statistically controlled, individuals with low cognitive functioning demonstrated poorer adherence than those with higher cognitive functioning. The most significant predictor of adherence was the degree of busyness of an individual's lifestyle, such that people with very busy lives were less adherent.

Rationale for the Present Study

Medication adherence in older adults is a complex task, involving multiple factors. As can be seen in Figure 2, the present study was built on the multifactorial concept of medication adherence put forth by Park and Jones, but differs slightly in the elements thought to be contributing to this complex behaviour. By presenting such factors as age, cognitive functioning, and health beliefs in this model format, it is not intended to imply which factors mediate for others, or the relative importance of each element. Instead, the model as presented is simply intended to demonstrate the complexity of the multiple variables thought to be contributing in some way to medication adherence, as were investigated in the present study.

Cognitive factors required for successful adherence behaviour include comprehension, problem solving, self-monitoring, planning, retrospective memory and prospective memory. According to Salthouse (1996), processing speed may also play a role via its general influence on cognitive functioning. In addition, facilitating health beliefs are also required, such as the belief in the ability to affect one's health by one's

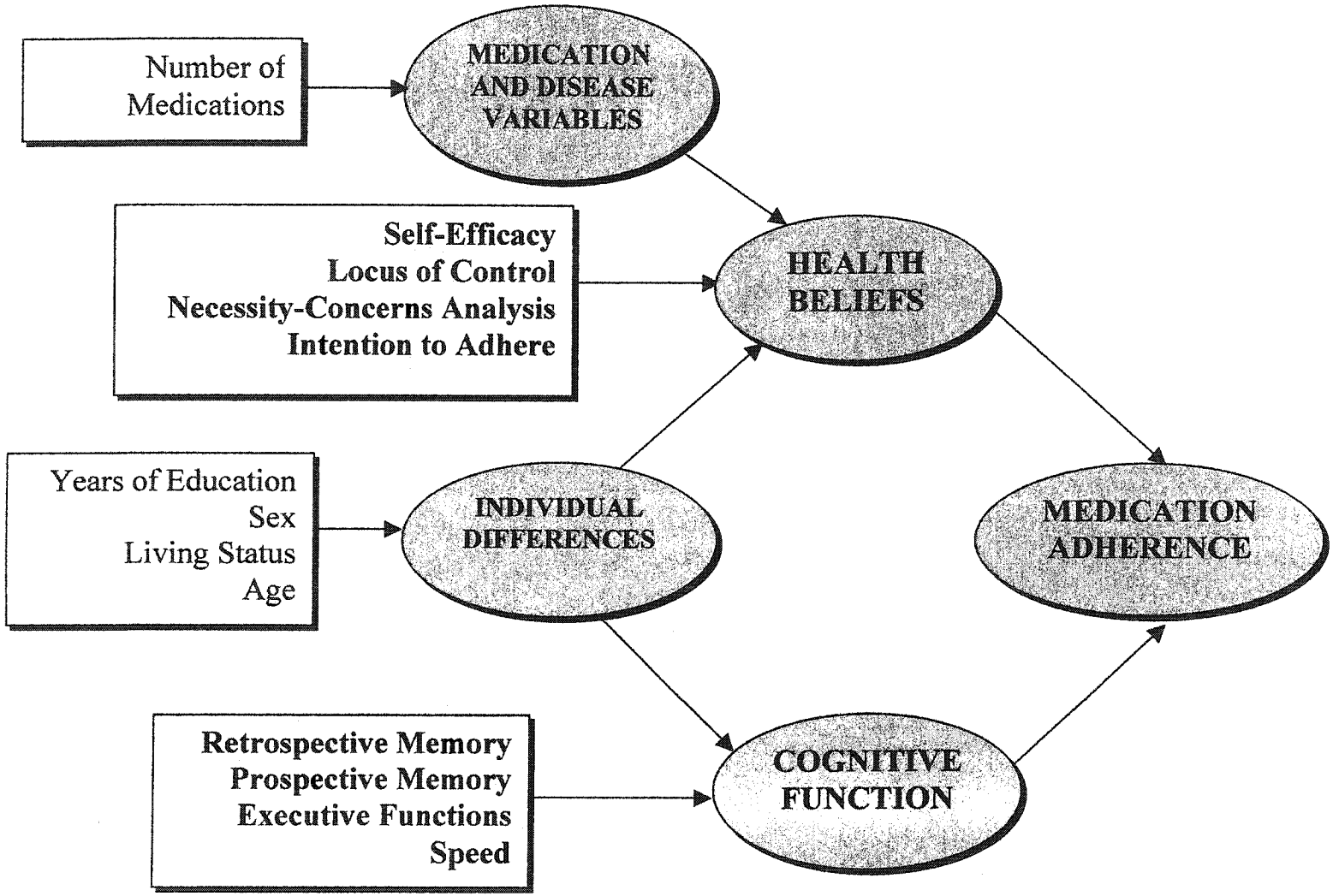


Figure 2: Present study depiction of medication adherence variables

actions (locus of control), the belief that one is capable of the actions necessary to affect health (self-efficacy), and the belief that the benefits of these actions outweigh the risks or negative consequences (necessity versus concern). As identified by Cooper, et al. (1982) nonadherence may be due to intentional or unintentional factors. That is, nonadherence may occur unintentionally because of impaired cognition, or it may occur intentionally because of a reasoned decision based on health beliefs. The intention behind the nonadherent behaviour has implications for intervention strategies.

The present study was designed to build upon the previous research that had examined the roles of cognitive factors and health beliefs to adherence behaviours. Previous studies of the influence of cognition on adherence (e.g., Isaac, et al. 1993; Park, et al. 1999) have demonstrated associations between adherence and the cognitive factors of visual and verbal recall (Isaac, et al. 1993), working memory (Morrell, et al. 1997), and, in a grouped cognitive construct, speed of processing, working memory, episodic memory and reasoning (Park, et al. 1999). Executive functions, such as judgement, decision-making, planning, and volition, have not previously been studied in relation to adherence in an older population, although Mann, et al. (1999) did demonstrate the association of executive functions and adherence in a younger group. As executive functioning may play an important role in adherence behaviour, the present study investigated this relationship in greater depth than had been done in prior research, in addition to evaluation of memory and speed of processing. With regard to health beliefs, the present study was designed to include several different measures previously shown to be related to medication adherence (e.g., in Brus, et al. 1999, Myers and Myers 1999, and Horne and Weinman 1999). By including these measures together in the present study, it

was hoped that the relative importance of these different health belief constructs to adherence might be evaluated.

Therefore, the present investigation attempted to examine how the factors of health beliefs and cognitive functioning differentially related to medication nonadherence in a volunteer sample of older individuals with a range of health issues. Clinically relevant tests of cognition were administered individually to participants, with a special emphasis on those factors likely to be affected by increasing age (i.e., types of memory, executive functions, and processing speed). In addition, the importance of different health beliefs to adherence was assessed in this same population. Medication adherence was assessed with two questionnaires, and questionnaire format was also used to collect data on health beliefs, specifically self-efficacy, locus of control, intentionality, and the analysis of necessity versus concerns about medications. Health beliefs and cognitive functioning were expected to contribute to the variability in reported nonadherence for all participants.

The primary hypothesis of this study was that:

> Composite scores for health beliefs and cognitive factors would contribute significantly to the variability of scores on self-reported nonadherence measures.

Secondary hypotheses pertaining to the differential importance of types of cognitive factors and health beliefs to adherence were:

A. Measures of executive functioning were expected to be better predictors of nonadherence than memory measures (retrospective and prospective) or processing speed measures.

B. Individual measures of health beliefs, i.e., self-efficacy, health locus of control, and necessity-concern analysis, were all expected to contribute to the prediction of nonadherence. Specifically, it was anticipated that individuals demonstrating high self-efficacy, and greater beliefs in the necessity of medication than concerns about it, would tend to show higher adherence to medication regimens. In addition, external locus of control was expected to be associated with the measure of adherence. However, the equivocal findings in the literature did not allow a prediction as to whether external locus of control would be associated with greater or lesser nonadherence.

Study Design

Participants for this study were recruited through advertisements in local newspapers, and posters at local geriatric community centres and retirement homes in Victoria, British Columbia, Canada (see Appendix D). Individuals who were interested in volunteering for the study were invited to call the principal investigator, and were contacted by telephone at a later time. All volunteers were asked a series of questions regarding their appropriateness for inclusion in the study, and these questions are presented in the description of the participants. If all inclusion requirements were met, a brief description of the time and task requirements of the study were outlined to ensure fully informed consent to participate. Two separate appointments were then set at the individual's convenience, each to take place in the same location of their choosing, most frequently in the participant's home. Each testing session took approximately one hour.

During the first session, participants were asked to provide demographic information about themselves, and full details of the prescription medications they were taking at the time of testing. Medication information was recorded directly from the medication containers, or from detailed lists provided to the examiner by the participant. Information recorded included the name of the medication, the strength, and the dosage (i.e., the number of times per day the medication was taken). All types of medication administration were included: pills/tablets/capsules, eye drops, needle injection, and topical creams/ointments. Information on non-prescribed medicines, for example, vitamins, were recorded but were not used in the assessment of adherence in this study. During this first session, the Modified Mini Mental State Examination (3MS) was

administered, as were the health belief questionnaires and three cognitive tests (Similarities, Verbal Fluency, and Digit Span). Detailed descriptions of all measures used are provided below. Approximately one week later a second visit was made to the participant for the completion of the cognitive testing. In addition to the cognitive testing during this second session, participants also completed the questionnaires measuring adherence. For those adherence questionnaire items that required reporting of the names and dosages of medications, participants were required to provide this information from memory. These responses from the second session were compared to those from the first session. Either the brand names or the generic names for the medications were accepted, and were verified in Hovsepian (2001) and Repchinsky (2001).

Participants

Individuals age 65 years and older were asked to participate in this investigation. To be included in the study, they had to meet the following inclusion criteria: (1) be taking at least one prescription medication on a regular basis, (2) be able to read, understand and speak English. Due to the oral presentation of some of the cognitive tests, one individual who wished to participate was excluded because of profound hearing impairment. Individuals were only included in the study if their answer to the following question was negative: "Does someone else help you with your medications?" Demographic information was collected on all participants, and included their age, number of years of formal education, gender, whether or not they lived alone, how many prescription drugs they took at the time of the study and for what reasons. A total of 105 individuals began the study and 95 were able to complete all testing. Of these 95 participants, 65 were female and 30 were male, and 61% of the group lived alone. The

age range was from 65 to 97 years (M age = 76.96 years, SD = 6.8). The mean number of years of education for the group was 14.6 (SD = 3.9). The number of prescription medications reported taken by the group ranged from 1 to 13 (M = 4.74, SD = 2.6).

Ten participants met all criteria for inclusion, but were not included in the data analyses because they did not complete all components of the study. Reasons given by the ten participants for not completing the testing included fatigue or illness, family circumstances, lack of time, and lack of interest. Seven of the ten participants completed the first half of the test battery, and can be compared to the larger group of included participants on demographic variables. Three non-completers were female and 4 were male. They ranged in age from 72 to 92 (M = 80.57, SD = 6.05), and had a mean of 11.7 years of education (SD = 2.2). The number of prescription medications reported taken by the non-completing group ranged from 1 to 20 (M = 6.57, SD = 6.16). The non-completers did not differ significantly from the completers on an ANOVA including these variables (age, $F(1, 100) = 1.880$, $p = .17$; years of education, $F(1, 100) = 3.642$, $p = .059$; number of medications, $F(1, 100) = 2.612$, $p = .109$). However, the non-completers' mean score on the Modified Mini Mental State Examination (3MS) (M = 88.57, SD = 7.57) was significantly lower than that of the completers (M = 93.72, SD = 4.36; $F(1, 100) = 8.112$, $p = .005$).

The participants in this study were screened using the Modified Mini-Mental Status Exam (3MS) to ensure that participants had no more than mild cognitive deficits, on the assumption that they would be likely to have sufficient self-awareness into their abilities for accurate self-report of adherence behaviour (Zanetti, et al. 1999). Of the individuals who completed testing, none were excluded on this basis. Participants were

given a choice as to whether they would like to complete the questionnaires and the cognitive tests at home or elsewhere. One participant chose to be tested at his place of work, and one was tested in the community hall of his retirement complex. All other participants were tested in their own homes.

Materials

Figure 3 identifies all measures administered in the present study. Measurement of medication adherence is notoriously difficult, and there is no "gold standard" method of measurement (Donovan, 1995). All approaches to the measurement of adherence to treatment regimens have pros and cons. Direct observations of adherence behaviour have been improving as technology develops, but all methods remain problematic in some way. Pill counts are problematic because they can be misleading as pills can be thrown away before they are counted, but also because they restrict observations to medications taken in pill form. Measurement of drug levels in blood or urine are dependent on the half-life of the drug taken, meaning an individual may be judged as adherent if they took their medications the day of measurement, despite a pattern of nonadherence on the days preceding the test. In addition, these are very intrusive measures that may significantly alter an individual's normal drug-taking behaviours. The most recent development in the measurement of adherence involves electronic methods, that monitor when and how often the medication container is opened (e.g., Medication Event Monitoring System (MEMS) and bar-code readers). These measures have been shown to have a high degree of accuracy measuring these occurrences without the same degree of intrusiveness as other frequency measures, but these devices are expensive and can therefore only be used in limited numbers. In addition, the opening of the container

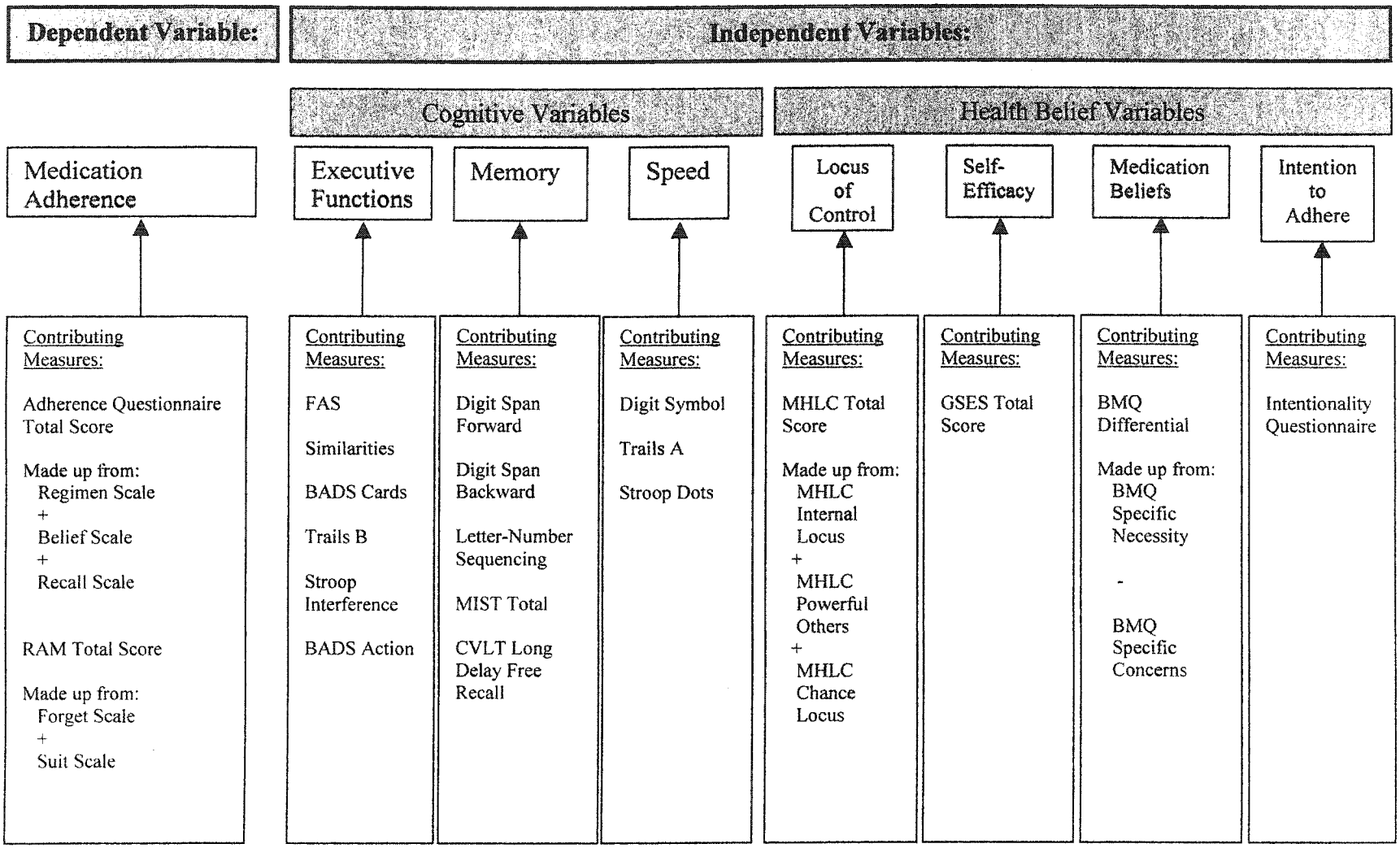


Figure 3: All measures contributing to dependent and independent variables

or the sweeping of the bar-code does not ensure that the drugs have been taken. Similar to pill counting, electronic containers also restrict the type of medication monitored. Tasks simulating medication management (e.g., Gurland, et al. 1994) can assess some of the skills assumed necessary for successful treatment adherence, but these simulations do not take into account uncontrolled factors, and are not necessarily ecologically valid.

Self-report has been used often as a measure of adherence in the literature, as it is simple, inexpensive and unobtrusive. However, data collected through self-report may be subject to individual's reluctance to indicate that they have not been behaving as suggested by their doctor, or he or she may not remember or be aware of errors they have made in taking their medications. Self-report also requires a certain level of cognitive functioning for reliable results. Investigation of the relationship of the degree of insight into one's own cognitive deficits and cognitive status (Zanetti, et al. 1999) has revealed that insight was uniformly high when MMSE (Mini-Mental Status Exam) scores were above 24 (roughly equivalent to about 76 to 77 on the 3MS), showed a linear decrease between MMSE scores of 23 and 13, and was uniformly low for MMSE scores below 12.

There are also valid arguments for the use of self-report as a measure of adherence. As articulately argued by Gould, McDonald-Miszczak, and King (1997) and McDonald-Miszczak, et al. (2000), self-report is the primary manner in which doctors and pharmacists gauge their patient's adherence, and health professionals often make changes to medication regimens on this basis. Individuals are also going to regulate their own use of medications based on their subjective perceptions of their adherence. Finally, self-report methods can be used to monitor any kind of prescribed medication, regardless

of its form. As such, a measure of self-reported adherence contributes valuable information about the understanding of adherence behaviour.

Measures of Self-Reported Adherence to Medication Use

Adherence Questionnaire (BMQ, Svarstad, Chewning, Sleath, and Claesson 1999).

Svarstad, et al. (1999) created the Brief-Medication Questionnaire (BMQ). For clarity, the BMQ created by Svarstad, et al. will be referred to as the Adherence Questionnaire. The Adherence Questionnaire was created as a self-report tool for screening adherence behaviours, to which Svarstad, et al. applied established survey methodology in an attempt to improve the sensitivity of their measure over self-report measures previously developed. For this reason, they asked participants to only comment on medication adherence for the past week. To have an accurate objective measure of adherence, they used the MEMS (Medication Event Monitoring System) for comparison data against which they could evaluate the sensitivity of their tool. The measure was developed to measure adherence to one known target medication for cardiac conditions, and all responses to the questionnaire were compared to known prescription details for each participant.

Svarstad, et al. (1999) found the scores on the Adherence Questionnaire were highly correlated with true rates of omission (as measured by the MEMS) in the past week and the past month. Of the three sets of questions in the Adherence Questionnaire, they found two sets (Regimen and Belief screens) had good sensitivity, specificity, positive predictive value and overall accuracy for repeat nonadherence behaviours, but were not sensitive to sporadic nonadherence; the third set of questions (Recall screen)

showed the opposite pattern. Svarstad, et al. suggested that repeated nonadherence may reflect intentional changes to the medication routine, whereas sporadic nonadherence may reflect unintentional forgetting, and so would be tapped by different sets of questions in their measure. (The Adherence Questionnaire can be found in Appendix E.) As described above, scoring for the Adherence Questionnaire required knowledge of participants' prescribed medication independent of the responses given on the questionnaire. Since independent medication records were not available in the present study, the actual scoring of the Adherence Questionnaire compared the initial medication information provided by the participants (i.e., from their medication containers) to the information that they recalled later, and was not specific to one target medication. Thus, the method of scoring for the Adherence Questionnaire differed slightly in the present study from that described by Svarstad, et al. All of the other original scoring procedures were followed. Even with this modification to the scoring procedure, the Svarstad, et al. questionnaire was judged to be the most complete and appropriate self-report medication adherence questionnaire available.

Reported Adherence to Medication scale (RAM, Horne, Weinman, and Hankins 1999).

To supplement the Adherence Questionnaire with a simpler self-report measure of adherence, the RAM was also administered to the participants in this study. In the development of their measure of health beliefs (the Beliefs about Medications Questionnaire, described in detail below), Horne, et al. created a 4-item self-report measure of medication adherence, specifically addressing the "tendency to forget to take medication and to deliberately adjust or alter the dose from that recommended by the

physician," (p.13). These items can be found in Appendix F. Each item was rated on a 5-point Likert-type score, and responses were summed over the four items, producing scores ranging from 4 to 20, with higher scores indicating greater reported adherence. From the study conducted by Horne, et al. the RAM scale had Cronbach's alpha coefficients ranging from 0.6 - 0.83.

Intentional / Unintentional Nonadherence Questionnaire.

In addition to the questions posed in the published adherence measures, participants were also asked to answer questions regarding the degree of intentionality in their reported nonadherence, on a measure devised for this study. In the survey by Cooper, et al. (1982), the most frequent reasons given by participants for intentional nonadherence were that the medications were not needed, they produced negative side effects, or more drugs were needed than were prescribed. In Cooper, et al.'s study, participants indicated that their unintentional reasons for nonadherence were forgetting, misunderstanding, or the drug was unavailable or too expensive. Derived from these findings from Cooper, et al. questions were created for the present study to collect information about the frequency of occurrence of intentional and unintentional reasons for nonadherence in the sample population. Four items were created to address each of intentional and unintentional nonadherence. Each item was scored on a 5 point Likert-type scale. (These questions can be found in Appendix G.) The Cronbach's alpha for these eight items was .7145 in the present study.

Measures of Health Beliefs

General Self Efficacy Scale (GSES; Sherer, et al. 1982).

As mentioned in the introduction, De Geest, et al. (1994) investigated which

elements of self-efficacy may contribute to medication taking behaviours among transplant patients in Belgium, and they consequently developed the Long-Term Medication Behaviour Self-Efficacy Scale. Although questions specific to self-efficacy in medication adherence would be ideal for the present study, unfortunately, the questions on the De Geest scale are very specific to transplant recipients. Thus, the more broadly applicable General Self-Efficacy Scale was chosen as the more appropriate measure for the present study. Similarly, Bosscher and Smit's (1998) shortened scale for use with an older population was based on the responses of a sample of older individuals in Amsterdam, and it is unclear whether the same changes would be appropriate in a Canadian sample.

Based on Bandura's (1977) self-efficacy theory, Sherer et al. developed a 23-item scale to assess self-efficacy expectancies based on past success and failure. Seventeen items made up the General Self-efficacy subscale, and accounted for 26.5% of the total variance in the original sample of university students. The remaining six items made up the Social Self-Efficacy subscale, which accounted for 8.5% of the total variance. For the purposes of the present study, only the General subscale was administered, a procedure used by Waller and Bates (1992). (These items can be found in Appendix A.) Each item on the scale was rated on a 14-point Likert-type scale ranging from "strongly agree" to "strongly disagree". Ten items on the General subscale required reversed scoring, so that a higher total score indicated higher self-efficacy expectations. Cronbach's alpha for the General subscale was .86 in the original sample. Sherer, et al. found the GSES had adequate construct and criterion validity.

Multidimensional Health Locus of Control Scale (MHLC, Forms A and B; Wallston, et al. 1978).

Although Robinson-Whelen and Storandt (1992) developed a shortened version of the MHLC Form B for use with an older population, to maximize reliability of the measure of locus of control used in the present study, both the original forms A and B were administered. The MHLC was developed by Wallston, et al. (1978) to measure the degree to which individuals attributed their health to internal factors, external factors in the form of powerful others, or external factors in the form of chance. The items were written for an eighth grade reading level, and were scored on a 6-point Likert-type scale, ranging from "strongly disagree" scored as one, to "strongly agree" scored as six. Thirty-six items were identified by Wallston, et al. (1978) for inclusion in the final scale, consisting of two comparable forms, with six items for each of the internal, external (powerful others) and external (chance) subscales. (These items can be found in Appendix B.) With the original sample (persons over sixteen years of age waiting in an airport), Wallston et al. found the combined forms had Cronbachs alpha levels of .859 (internal subscale), .830 (powerful others subscale) and .841 (chance subscale).

Beliefs About Medicines Questionnaire (BMQ; Horne, et al. 1999).

The Beliefs about Medicines Questionnaire (BMQ) developed by Horne, et al. consisted of items collected from the literature to reflect general health beliefs and beliefs about specific medications an individual may be taking. The BMQ had eighteen items in total, which represented four factors derived from principal component analysis. The BMQ-Specific scale had five items regarding beliefs about the necessity of prescribed medication (*Specific-Necessity*) and five items regarding beliefs about the possibility of

dependence and toxicity of medications (*Specificity-Concerns*). The BMQ-General scale consisted of four items about the beliefs that medicines can be addictive or harmful (*General-Harm*) and four items regarding possible over-prescription of drugs by physicians (*General-Overuse*). With an original sample of chronically ill persons from six types of illness, Horne, et al. demonstrated appropriate criterion and discriminant validity for the BMQ. Internal consistency was acceptable for three subscales in all sampled groups, but was low for the *General-Harm* subscale in three of the six sampled illness groups. Horne, et al. suggest this may reflect that individual experiences with illness differentially influence beliefs about medications. (The items from the BMQ can be found in Appendix C.) Horne and Weinman (1999) found that the best predictor of adherence was the difference between the specific necessity and specific concerns scores on the BMQ, and so only this score was used in the analyses of the present study.

Measures of Cognitive Functioning

A cognitive screening measure (3MS) was given to indicate appropriate inclusion of participants in this study. As previously mentioned, multiple types of memory abilities are required for successful adherence to a medication regimen. The California Verbal Learning Test (CVLT) is specifically intended to measure retrospective memory. As prospective memory is another component for the accurate self-management of medication, the Memory for Intensions Screening Test (MIST) was administered. Attention and immediate verbal memory were measured with the Forward Digit Span subtest from the WAIS-III, while the Backward Digit Span and the Letter-Number Sequencing subtests were used to assess working memory (Lezak, 1995). Another subtest from the WAIS-III, Digit Symbol, was administered in order to assess speed of

processing, as were components of other measures (Stroop Dot Naming and Trail Making Test Part A).

Executive functions are processes including planning abilities, flexibility, problem solving, inhibition, and abstract thinking (Lezak, 1995; Tranel, et al. 1994). In order to assess the multiple components of executive functioning, it was necessary to administer tasks geared towards each of these specific qualities, yet without surpassing the abilities of the participants. The following neuropsychological tests were chosen for this purpose. To assess abstract thinking, the Similarities subtest from the WAIS-III was given. Planning was tested with the Trail Making Test, and the Stroop test (Victoria version) was given to evaluate freedom from inhibition. Cognitive flexibility was assessed with the Controlled Oral Word Association Test (FAS), and one of the subtests from the Behavioural Assessment of Dysexecutive Syndrome (BADS), the Rule Shift Cards Test. A second subtest from the BADS, the Action Program Test, was used to evaluate novel problem solving and abstract thinking. Detailed descriptions of these measures follow below.

Modified Mini-Mental State Examination (3MS; Teng and Chui, 1987).

The 3MS is an extension of the Mini-Mental State Examination (MMSE, Folstein, et al. 1975). The MMSE was designed as a quick and easy bedside measure of cognitive impairment in elderly persons (Tuokko and Hadjistavropoulos, 1998). The first section required oral responses to assess orientation, memory, and attention, while the second section assessed naming, ability to follow instructions, write a sentence and copy a design. The maximum score on the MMSE is 30, and traditionally scores of 23 or lower are considered in the impaired range (Tuokko and Hadjistavropoulos, 1998). The 3MS

differs from the MMSE in that it has four more items, and other modifications to increase the range of cognitive functioning covered by the measure and improve psychometric properties of the scale (Teng and Chui, 1987). Scoring on the 3MS ranges from 0 to 100 and normative data is available up to age 89, stratified by years of education (Tombaugh, McDowell, Kristjansson, and Hubley 1996).

It was important that none of the participants exhibited a degree of cognitive decline that would interfere with their ability to accurately identify and describe their own medication taking behaviour. It was necessary, therefore, to identify and exclude those individuals who were showing significant signs of impairment. Tombaugh, et al. identified the sensitivity, specificity, positive predictive power and negative predictive power of 3MS scores in a large group of elderly persons. From their work, a cutoff score of 77 on the 3MS was deemed sufficient to appropriately identify elderly persons with dementia without mistakenly identifying normal individuals as having dementia. This cutoff score has optimal sensitivity and specificity for identifying demented persons from normal (McDowell, Kristjansson, Hill, and Hébert 1997). None of the participants who completed all components of the study scored below this cutoff score.

California Verbal Learning Test (CVLT; Delis, Kramer, Kaplan and Ober, 1987).

The CVLT consists of a "shopping list" of sixteen items from four semantic categories. The list was read out loud and then followed immediately by a free recall trial. The learning of the list was repeated for a total of five free recall trials. A second list of items was then read, followed by a free recall trial. Then another free recall of the first list was requested, followed by a cued recall trial, in which recall of the items was

prompted with a category cue. A delay period of 20 minutes was filled with non-memory tasks, following which free and cued recall trials were requested. Finally, recognition memory was tested with a list of items consisting of novel items in addition to those from the original list. Normative information is available to age 80 by gender (Tuokko and Hadjistavropoulos, 1998). Only the long delay free recall scores contributed to the analyses in the present study, although information on cued recall (immediate and delayed) and a recognition score were also recorded.

Memory for Intensions Screening Test (MIST; Raskin and Buckheit, 2001).

The MIST was developed by Raskin and Buckheit (2001) and measures the ability to remember to perform a behaviour at some point in the future. Prospective memory tasks can either be set to occur at a specific future time, or after a specified event has taken place (e.g., a buzzer going off) at which time the behaviour is performed. The MIST assessed ability to perform both time-based and event-based behaviours. All of the tasks were simple commands (e.g., "When I give you a red pen, sign your name."), and examinees were asked to keep track of a maximum of four prospective memory tasks at one time. Time-based tasks were scheduled to be completed 2 or 15 minutes after the initial instructions were given, and the participants were provided with a large-faced digital clock for this purpose. In the original version of the scale, a final task was to be done 24 hours after the instruction had been given, but this item was excluded from the present study. While they were keeping track of the prospective tasks to be done, participants were required to work on a distractor task, consisting of an engaging word-finding puzzle. Both accuracy and recognition scores were calculated, as were descriptions of the types of errors made. Only the total accuracy score was included in

the analyses. Split half reliability for this measure was calculated as .82, and with the Spearman-Brown formula, the total score reliability was estimated as .91 (S. Raskin, personal communication, 22 July 2002).

Wechsler Adult Intelligence Scale – Third Edition (WAIS-III; Wechsler, 1997a).

As described in the test's manual (Wechsler, 1997a) the WAIS-III is an individually administered clinical instrument used to assess the intellectual skills of adults ages 16 to 89. It is comprised of a number of subtests, which assess different aspects of intellectual functioning.

Forward and Backward Digit Span Subtest

The Forward Digit Span subtest was used to measure immediate verbal recall and attention (Lezak, 1995). This subtest required the immediate recall of orally read lists of digits of increasing length. When the number sequence was repeated correctly, the examiner read the next longer number sequence until two consecutive lists of the same length were repeated incorrectly. The test was not timed. Backward Digit Span required individuals to repeat orally presented lists of numbers, but in the reversed order to that in which they were presented. To successfully perform this task, the numbers must have been concurrently held in mind and manipulated, a working memory task (Lezak, 1995). As in Forward Digit Span, the task was discontinued if two consecutive trials of the same number of digits were repeated incorrectly, and the test was not timed. Normative data are available for the Digit Span subtest up to age 89. Although the reliability coefficients of these tests appears to be reduced in older adults (.84) relative to the average across age groups (.90), it is still quite acceptable (Wechsler, 1997b).

Letter-Number Sequencing Subtest

Another WAIS-III subtest was used to assess working memory. The Letter-Number Sequencing task consisted of increasing strings of letters and numbers read orally to the participants. For each letter-number string, the participant was required to correctly repeat back the numbers, in order, followed by the letters, in alphabetical order. As in the Digit Span tests, correct responses resulted in the presentation of longer strings to be mentally manipulated and recalled.

Digit Symbol Subtest

This subtest consisted of a printed key pairing nonsense symbols with numbers from one to nine. Beneath the key were four lines of numbers with blank boxes beneath them. The task was to fill in as many symbols as possible to match the numbers within 90 seconds. The score was the number of squares filled in correctly. Digit Symbol is a task of psychomotor performance, including motor persistence, sustained attention, response speed, and visuomotor coordination (Lezak, 1995). This test is particularly sensitive to dementia, and may show deficits while other tests are still performed well (Lezak, 1995). The reliability of this subtest in the 85-89 age group (the oldest group normed) is .87, compared to the average across age groups of .84 (Wechsler, 1997b).

Similarities Subtest

This subtest assessed verbal concept formation (Lezak, 1995). Pairs of words were read to the individual and he or she had to explain what the two words had in common. The word pairs ranged in difficulty, requiring the identification of increasingly more abstract concepts. Responses to items were given the maximum of two points for a high level of abstract generalization, and one point for more concrete relationships

(Wechsler, 1997a). The test was not timed. Age related declines appear to be related to level of education (Lezak, 1995). The reliability coefficient of this subtest in the oldest age group is .89, compared to the average across ages of .86 (Wechsler, 1997b).

Trail Making Test; (Reitan, 1986).

Consisting of Parts A and B, the Trail Making Test assessed speeded attention, sequencing, mental flexibility, visual search and motor function (Spreen and Strauss, 1998). Part A required the connection of 25 randomly spaced numbered circles, by drawing a pencil line as quickly as possible connecting the numbers in sequential order. Part B similarly required lines drawn to connect 25 circles randomly spaced on a page, but these consisted of letters and numbers, and had to be connected in alternating fashion (i.e., 1, A, 2, B, and so on). For both forms, the test score was the number of seconds required to complete the task. The examiner corrected errors, but timing did not stop. As Part B requires the switching between letters and numbers, this test measures mental flexibility and planning (Lezak, 1995). Tuokko and Hadjistavropoulos (1998) review research that indicated performance on this task also reflected a person's ability to follow a sequence mentally and to deal with more than one stimulus at a time.

Stroop, Victoria version; (Regard, 1981b).

According to the manual (Regard, 1981b) the Stroop task measured the ease with which a person can shift his or her perceptual set to conform to changing demands. The speed with which an individual could name the colour of dots on a page was compared to how quickly he or she could name the colour of ink in which a conflicting colour name was printed. For example, the word "red" could be printed in green ink, to which the required response would be green. The test was administered in three parts. The first

task required the naming of coloured dots in rows from left to right across a page. In the Victoria version of this task, the second part consisted of naming the colour of ink in which short, common words were printed. The final task demonstrated a marked slowing of responses when the ink colour to be named was different than the printed colour name, thus requiring the disregard of the verbal information (Lezak, 1995). This task measures cognitive flexibility, one aspect of executive functioning (Tuokko and Hadjistavropoulos, 1998), as well as the ability to suppress the over-learned skill of reading in favour of the less familiar task of colour naming (Regard, 1981a). Performance on this task slows with advancing age (Tuokko and Hadjistavropoulos, 1998), but the effects of age related slowing may be lessened when a ratio index of interference is calculated (i.e., time on card 3/time on card 1) (Spreen and Strauss, 1998). The Stroop interference score has also been shown to reflect planning and organization of behaviour (Spreen and Strauss, 1998), and is sensitive to severity of dementia. Visual competence and intact colour vision are required for this task. Norms are available for individuals over 80 years old (Regard, 1981a).

Controlled Oral Word Association Test (FAS); (Benton, 1974).

This task consisted of three timed word-naming trials, in which as many words as possible beginning with a given letter (e.g., F, A, and S) were to be generated within 60 seconds. Words beginning with a given letter could not be proper nouns, numbers or the same word with a different suffix (Lezak, 1995). In addition, this task required the rapid shifting of mental set both between and within trials of generation of words starting with a particular letter (Lezak, 1995). Thus, this task assesses verbal abilities and mental

flexibility. The total number of appropriate words generated across all three trials was entered in the analyses.

Behavioural Assessment of Dysexecutive Syndrome (BADS; Wilson, Alderman, Burgess, Emslie, & Evans, 1996).

Two subtests from the BADS were administered in this study. The Rule Shift Cards Test requires a specific response to twenty-one spiral-bound non-picture playing cards. The task required the ability to follow a given rule and the flexibility to change mental set to a new rule, even though the stimuli were the same. In this study, a stimulus booklet was created with forty-two cards to increase the strength of the initial trial's mental set effect. In the first trial of this subtest, responses had to be "yes" to a red card and "no" to a black card. In the second trial, responses were based on the colour of the preceding card (i.e., "yes" if the present card was the same colour as the preceding card, and "no" if it was not). Time taken and numbers of errors were scored. The rules remained in front of the individual on a printed card so that memory requirements were reduced.

The second subtest from the BADS to be used in this study was the Action Program Test. This task required novel problem solving in order to manipulate the given materials to reach a set goal (Wilson, et al.1996). The examinee was presented with a large beaker of water with a lid on it, an empty tube with a small cork at the bottom of it, and several other transitional objects with which they could manipulate the beaker and the tube. Their task was to remove the cork from the tube without touching the beaker or the tube, and using only these intermediate objects. To solve the problem involved five separate steps with the materials, and the conceptual understanding that water must be

transferred from the beaker to float the cork to the top of the tube. The task was not timed, but prompts were permitted from the examiner after two minutes of unsuccessful problem solving.

Results

Data Set

All analyses and data management were completed using SPSS for Windows Standard Version 10.0.5 (1999). For each measure, standardized scores (z-scores) were computed within the sample to provide a common metric for the analyses. All scores were set so that a higher positive score represented better performance on that measure (e.g., a high score on a speeded measure indicated fast performance), as did a high score on an error measure. These scores were then used in the subsequent analyses. When multiple scores were generated by a single measure, only one score was used in the analyses. The single scores were chosen to be the most representative of the cognitive attribute they were intended to measure. For example, although the CVLT provided multiple recall and recognition scores, only the free delayed recall scores were included in the analyses to provide a measure of retrospective memory. (A list of the scores used in the analyses are listed in Appendix H).

As mentioned above, 95 participants completed all components of the study. A single examiner administered all testing materials individually. Missing data only occurred due to random equipment errors (e.g., malfunctioning stopwatch) or human error (e.g., missing test forms). The most conservative method of dealing with missing data is to exclude any participant from the analyses if there are missing data for any of the variables to be included (Tabachnick and Fidell, 1989). Called listwise deletion, this was the method used to manage missing data in all of the present analyses. As a consequence, not all analyses included all 95 participants. The fewest number of participants included in the a priori analyses due to missing data was 92.

Influential Data Points (Outliers)

Careful review of the distributions of the different measures revealed that some participants had generated scores that were quite disparate from the rest of the scores on that measure. These 5 outlying points, as generated by three different participants, appeared to be very influential on the regression analyses. One participant had scores more than 5 standard deviations below the group mean on the Stroop Dots measure and the Trails B measure. Another participant had scores more than 3 standard deviations below the group mean on the BADS Action Errors measure and the WAIS Similarities measure. A third participant was more than 4 standard deviations below the group mean on the BADS Cards Trial 2 Errors measure. Careful review of the characteristics of these three participants did not reveal any systematic difference from the rest of the sample, or even any similarities among them, except that they were all female. The greatest likelihood is that these discrepant scores are the result of distraction during testing, lapses of attention, or misunderstanding the task requirements. As such, they are not representative of the abilities being examined, and rather are random error. The analyses were therefore run without these three participants, as a conservative method of working with the discrepant data. Thus, the maximum number of participants in any analysis was 92, and some analyses were run with only 89 participants, if all missing data was accounted for with listwise deletion. All subsequent analyses refer only to this filtered data set. The descriptive statistics for the measures used in the following analyses can be found in Appendix K. Frequency distribution histograms for all measures are presented in Appendix L.

The demographic data of this new sample is shown in Table 1. The participants were 62 females and 30 males. Of the total group, 60.9% lived alone. Significantly more

Table 1: Demographic data of filtered data set (N = 92)

	Minimum	Maximum	Mean	Standard Deviation
Age	65	92	76.82	6.46
Years of Education	8	26	14.79	3.84
Number of Medications	1	13	4.75	2.59
3MS	81	100	93.93	4.15

women lived alone than men (χ^2 (1, N = 92) = 14.171, p <.001). There was no significant difference between males and females on any of the other demographic variables (i.e., age, years of education, number of medications, or 3MS). However, there was a significant difference between those participants who lived alone and those who lived with someone else on the demographic variables of age and years of education. Those participants who lived alone were significantly older (lived alone age M = 78.70, SD = 5.96; did not live alone age M = 73.89, SD = 6.17) and had less education (lived alone education M = 14.12, SD = 3.77; did not live alone education M = 15.82, SD = 3.78) than those living with someone else (age: F(1, 90) = 13.857, p<.001; education: F(1, 90) = 4.420, p<.05).

Each of the standardized measures were combined into composite variables, one for each of the a priori hypotheses to be examined (i.e., memory, executive functions,

speed, and health beliefs). Before these composites were created, the contributing measures were examined to determine if the hypothesis-driven groupings of the measures were consistent with the observed groupings of the data. To this end, correlations of the component measures were calculated.

To address the a priori hypotheses, regardless of the correlation scores, composite scores were calculated from the standardized scores to condense the data for use in the hypothesized multiple regression analyses. To test the primary a priori hypotheses, composite scores were created by averaging the standardized scores from all measures within a given category to represent that category. For example, all of the standardized scores obtained for a participant on measures of executive functioning were averaged to compute the executive function composite score for that participant. To address the first a priori hypothesis that cognitive measures and health belief measures would predict adherence scores, one composite score was calculated including all of the cognitive measures together, and a second composite score was calculated with the three types of health belief measures together. For other analyses separate composites were calculated for the executive functioning measures, the memory measures, and the processing speed measures. (The contributing components of these composites are listed in Appendix I). These composite scores were then entered into multiple regression analyses as the independent variables.

However, when the correlation data indicated different groupings of the measures than had been originally hypothesized (i.e., for memory and executive functioning), factor analyses were run to identify which measures were grouping together as different factors within the cognitive constructs. This investigation into the actual groupings of the

data was performed to identify any common characteristics of those measures that were grouping together. Additional multiple regression analyses were then run with these factor composites as the independent variables, instead of the a priori hypothesized composites.

Demographic Information

In addition to the data generated by the cognitive and health belief measures, demographic information was collected about each participant. The collected demographic information included: age, sex, years of education, number of medications taken, and whether or not the participant lived alone. Regression analyses that included all of this demographic information together revealed that only the number of medications was related to the scores on the adherence measures. In fact, it was found that the number of medications was the most significant predictive factor entered into the analyses (to be discussed below). Both dependent measures of adherence correlated significantly with the number of medications, but in different directions (Adherence Questionnaire $r = -.515$, $p<.001$; and RAM Total $r = .231$, $p<.05$). Of note, the number of medications did not correlate significantly with any of the cognitive variables (see Appendix M), and so did not reflect general cognitive ability. As the number of medications was such an important variable, all of the analyses will be discussed both in terms of the results with and without accounting for number of medications.

Correlations

As mentioned above, correlations were calculated for all of the a priori hypothesized composite groupings, to identify whether or not the hypothesis-driven groupings of the measures were the same as the data-driven groupings of the measures.

Tables of the correlations between the variables can be found in Appendix N. The original groupings were to combine the adherence, executive function, memory, speed, and health belief measures each into a single composite variable. Review of the originally hypothesized composites and the correlations between their contributing measures revealed non-significant correlations for some of the measures. For example, the correlation between the two measures of adherence (the RAM total and the Adherence Questionnaire total) was not significant ($r = .118$, $p > .05$). Similarly, the health belief measures, consisting of the MHLC total score, the BMQ necessity-concerns differential, and the GSES total score, all failed to correlate with each other significantly.

In contrast, among the processing speed measures, all three variables (Digit Symbol, Trail Making Test Part A, and Stroop Dots) were significantly correlated at the $p<0.01$ level. Positive correlations were found among most of the scores contributing to the memory composite, but not every memory measure significantly correlated with every other memory measure. Similarly, the correlation analyses of the executive function scores showed that some of the measures were highly related to other measures (e.g., Trails B) whereas other measures did not correlate strongly (e.g., Stroop Interference). The BADS Action Error score did not correlate significantly with any of the other executive function measures.

Composite variables

The a priori composite groupings were not completely supported by the data, and so modifications were made to the proposed regression analyses. That is, because the two measures of adherence did not correlate significantly with each other, they could not be combined to form a single composite measure of adherence. Consequently, all

analyses were conducted separately on the total scores of the Adherence Questionnaire and the RAM. It is of note, however, that the Adherence Questionnaire total and the RAM total did correlate significantly with each other when number of medications was controlled for in a partial correlation ($r = .284$, $p < .01$).

The health belief measures also failed to correlate significantly with each other, and so the three independent health belief variables were also entered separately in all subsequent analyses. The speed measures all significantly correlated with each other so were maintained together in all subsequent analyses. As the a priori hypothesized executive function and memory composites were not supported by the actual data, regression analyses were run twice. The first set of analyses was hypothesis-driven, and used the originally hypothesized groupings of the measures for the composite variables. A second set of exploratory analyses instead used the data-driven groupings of the measures for the composite variables, as indicated by the correlation analyses and factor analyses, to be discussed in more detail later.

As expected, the hypothesized composite variables for the cognitive measures correlated significantly with each other. The hypothesized executive function composite significantly correlated with the speed composite ($r = .347$, $p < .01$) and the hypothesized memory composite ($r = .460$, $p < .001$) whether or not number of medications was removed first. Similarly, the speed and memory composites also correlated significantly ($r = .233$, $p < .05$) under these different conditions. In contrast, the cognitive variables failed to correlate significantly with the composite health belief variable, as expected. With each health belief measure considered separately, the hypothesized memory composite variable only significantly correlated with the MHLC total score ($r = -.315$,

$p<.01$). The negative correlation of the memory composite with the locus of control total is due to significant negative correlations with the internal locus of control subscale ($r = -.223$, $p<.05$) and chance ($r = -.238$, $p<.05$) locus of control subscale. In other words, as memory scores increase, belief in the importance of internal and chance loci of control decreases.

Correlations were performed on the cognitive composite variables, the health belief composite variable, and the two dependent measures of adherence (Adherence Questionnaire Total and RAM total). The executive function composite measure was significantly negatively correlated with both the Adherence Questionnaire ($r = -.223$, $p<.05$) total and the RAM total ($r = -.299$, $p<.01$).

A Priori Regression Analyses

To review the a priori hypotheses of the study, the primary hypothesis was that:

> Composite scores for health beliefs and cognitive factors would contribute significantly to the variability of scores on a self-reported nonadherence measure.

Secondary hypotheses pertaining to the differential importance of types of cognitive factors and health beliefs to adherence were:

C. Measures of executive functioning were expected to be better predictors of nonadherence than memory measures (retrospective and prospective) or processing speed measures.

D. It was anticipated that the individual measures of health beliefs, i.e., self-efficacy, health locus of control, and necessity-concern differential, would all contribute to the prediction of nonadherence. Specifically, it was

anticipated that individuals demonstrating high self-efficacy, and greater beliefs in the necessity of medication than concerns about it, would tend to show higher adherence to medication regimens. In addition, external locus of control was expected to be associated with the measure of adherence. However, the equivocal findings in the literature did not allow a prediction as to whether external locus of control would be associated with greater or lesser nonadherence.

As a result of the poor correlations between measures originally expected to be condensed into composite measures, more analyses were run than were originally proposed. To investigate the a priori hypotheses, each of the following elements were entered as independent variables in separate analyses (as can be seen in Table 2):

1. The cognitive composite variable calculated as the average of all the cognitive measures, and the health belief composite variable calculated as the average of the health belief measures.
2. The executive function composite variable calculated as the average of all the executive function measures, the memory composite variable calculated as the average of all the memory measures, and the speed composite variable calculated as the average of all the processing speed measures.
3. Each of the total self-efficacy score, the total locus of control score, and the calculated difference between the belief in the necessity of medications and concerns about them.
4. Each of the internal locus of control, powerful others locus of control, and chance locus of control.

These four basic multiple regression analyses were run with the Adherence Questionnaire total and the RAM total as the dependent variable in separate analyses, with and without the number of medications included as an independent variable.

Table 2: Independent variables used in each regression type for the different dependent variables.

Analyses	Dependent Variable	Independent Variable
Type 1	(i) Adherence Questionnaire Total	Cognitive Composite + Health Belief Composite
	(ii) RAM Total	Cognitive Composite + Health Belief Composite
Type 2	(i) Adherence Questionnaire Total	Executive Function Composite + Memory Composite + Speed Composite
	(ii) RAM Total	Executive Function Composite + Memory Composite + Speed Composite
Type 3	(i) Adherence Questionnaire Total	MHCL Total + GSES Total + BMQ differential
	(ii) RAM Total	MHCL Total + GSES Total + BMQ differential
Type 4	(i) Adherence Questionnaire Total	Internal HLC + Powerful Others HLC + Chance HLC
	(ii) RAM Total	Internal HLC + Powerful Others HLC + Chance HLC

A Priori Analysis Type #1.

The first hypothesis of this study involved composite variables for all the cognitive measures grouped together and all the health belief variables grouped together. Hierarchical linear regression analyses were run first on the Adherence Questionnaire

total score as the dependent measure. As can be seen in Table 3, the inclusion of the cognitive composite score and the health belief composite score did not significantly predict the scores on the Adherence Questionnaire.

Table 3: Type #1 Regression analysis with the Adherence Questionnaire.

Model Summary					Change Statistics	
Model	**Variables Entered**	**R**	**R Square**	**Adjusted R Square**	**R Square Change**	**Significance of F Change**
1	Cognitive Composite	.05	.00	-.01	.00	.64
2	Health Belief Composite	.11	.01	-.01	.01	.36

	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Significance of t**
	B	**Standard Error**	**Beta**		
Model 1					
Cognitive Composite	-.12	.25	-.05	-.47	.64
Model 2					
Cognitive Composite	-.14	.25	-.06	-.57	.57
Health Belief Composite	-.17	.19	-.10	-.92	.36

Similarly, as can be seen in Table 4, when demographic information was added to the regression analyses along with the cognitive composite score and the health belief composite score, only the number of medications significantly predicted scores on the Adherence Questionnaire ($\underline{B} = -.188$, $\underline{p} < .001$).

Hierarchical regression analyses were then run on the RAM total score as the dependent measure. As seen in Table 5, the results indicated that the cognitive composite

Table 4: Type #1 Regression analysis with the Adherence Questionnaire and the inclusion of demographic variables

Model Summary					Change Statistics	
Model	**Variables Entered**	**R**	**R Square**	**Adjusted R Square**	**R Square Change**	**Significance of F Change**
1	Age	.06	.00	-.01	.00	.60
2	Years of Education	.07	.00	-.02	.00	.69
3	Number of Medications	.51	.26	.23	.25	.00
4	3MS	.52	.27	.23	.00	.45
5	Cognitive Composite	.52	.27	.22	.00	.93
6	Health Belief Composite	.52	.27	.21	.00	.61

	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Significance of t**
	B	**Standard Error**	**Beta**		
Model 1					
Age	.01	.02	.06	.52	.60
Model 2					
Age	.01	.02	.05	.40	.69
Years of Education	-.01	.03	-.05	-.41	.68
Model 3					
Age	.00	.02	.00	-.00	1.00
Years of Education	-.03	.03	-.11	-1.08	.28
Number of Medications	-.02	.04	-.51	-5.39	.00
Model 4					
Age	.00	.02	-.02	-.22	.83
Years of Education	-.02	.03	-.09	-.89	.37
Number of Medications	-.19	.04	-.50	-5.14	.00
3MS Score	-.08	.11	-.08	-.77	.45

Table 4: Type #1 Regression analysis with the Adherence Questionnaire and the inclusion of demographic variables (continued)

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 5					
Age	.00	.02	-.03	-.23	.82
Years of Education	-.02	.03	-.09	-.88	.38
Number of Medications	-.19	.04	-.50	-5.06	.00
3MS Score	-.08	.13	-.07	-.62	.54
Cognitive Composite	-.03	.29	-.01	-.09	.93
Model 6					
Age	.00	.02	-.02	-.20	.85
Years of Education	-.03	.03	-.10	-.98	.33
Number of Medications	-.19	.04	-.49	-4.91	.00
3MS Score	-.08	.13	-.08	-.63	.53
Cognitive Composite	-.02	.29	-.01	-.08	.93
Health Belief Composite	-.09	.17	-.05	-.51	.61

Table 5: Type #1 Regression analysis with the RAM Total Score.

Model Summary					Change Statistics	
Model	Variables Entered	R	R Square	Adjusted R Square	R Square Change	Significance of F Change
1	Cognitive Composite	.21	.04	.03	.04	.05
2	Health Belief Composite	.32	.10	.08	.06	.02

Table 5: Type #1 Regression analysis with the RAM Total Score (continued)

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 1					
Cognitive Composite	-.48	.24	-.21	-2.00	.05
Model 2					
Cognitive Composite	-.42	.23	-.18	-1.79	.08
Health Belief Composite	.40	.17	.24	2.32	.02

score did not significantly predict the RAM total score, but the health belief composite score was a significant predictor of the RAM total ($\underline{B}$ = .405, $\underline{p}$<.05). Interestingly, when demographic information was added to the regression analyses along with the cognitive composite score and the health belief composite score, the number of medications contributed to the prediction of the RAM total, but was not significantly predictive when the other variables were included in the equation. The health beliefs composite remained a significant predictor with the addition of demographic variables ($\underline{B}$ = .366, $\underline{p}$ = .05), as seen in Table 6. Further analysis with the health belief measures (to be discussed below) revealed that the BMQ differential score was significantly predicting the RAM total score.

A Priori Analysis Type #2.

The second hypothesis addressed the separate contributions to the adherence measures of the cognitive composite variables, i.e., memory, executive functions, and speed. The Adherence Questionnaire total score was entered first into the regression analyses as the dependent variable. As seen in Table 7, only the executive function

composite was a significant predictor of the Adherence Questionnaire (B = -.712, p < .01). A different pattern resulted from inclusion of the demographic variables, as can be seen in Table 8. The results of this analysis showed that the number of medications

Table 6: Type #1 Regression analysis with the RAM Total Score and the inclusion of demographic variables.

Model Summary					Change Statistics	
Model	**Variables Entered**	**R**	**R Square**	**Adjusted R Square**	**R Square Change**	**Significance of F Change**
1	Age	.13	.02	.00	.02	.24
2	Years of Education	.15	.02	.00	.01	.43
3	Number of Medications	.26	.07	.04	.05	.04
4	3MS	.27	.07	.03	.00	.74
5	Cognitive Composite	.33	.11	.05	.04	.07
6	Health Belief Composite	.39	.15	.09	.04	.05

	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Significance of t**
	B	**Standard Error**	**Beta**		
Model 1					
Age	.02	.02	.13	1.19	.24
Model 2					
Age	.02	.02	.10	.94	.35
Years of Education	-.02	.03	-.09	-.80	.43
Model 3					
Age	.02	.02	.12	1.13	.26
Years of Education	-.02	.03	-.06	-.57	.57
Number of Medications	.08	.04	.22	2.05	.04

Table 6: Type #1 Regression analysis with the RAM Total Score and the inclusion of demographic variables (continued).

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 4					
Age	.02	.02	.13	1.17	.24
Years of Education	-.02	.03	-.07	-.63	.53
Number of Medications	.08	.04	.21	1.94	.06
3MS Score	.04	.12	.04	.33	.74
Model 5					
Age	.00	.02	.06	.52	.61
Years of Education	-.01	.03	-.06	-.52	.60
Number of Medications	07	.04	.18	1.67	.10
3MS Score	.16	.14	.16	1.20	.23
Cognitive Composite	-.57	.31	-.25	-1.85	.07
Model 6					
Age	.01	.02	.05	.39	.69
Years of Education	-.00	.03	-.00	-.01	1.00
Number of Medications	.06	.04	.15	1.39	.17
3MS Score	.17	.13	.16	1.27	.21
Cognitive Composite	-.58	.30	-.26	-1.90	.06
Health Belief Composite	.37	.18	.22	2.00	.05

Table 7: Type #2 Regression analysis with the Adherence Questionnaire.

Model Summary					Change Statistics	
Model	**Variables Entered**	**R**	**R Square**	**Adjusted R Square**	**R Square Change**	**Significance of F Change**
1	Executive Function Composite	.23	.05	.04	.05	.03
2	Speed Composite	.30	.09	.07	.03	.07
3	Memory Composite	.31	.10	.07	.01	.33

	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Significance of t**
	B	**Standard Error**	**Beta**		
Model 1					
Executive Function Composite	-.47	.21	-.23	-2.20	.03
Model 2					
Executive Function Composite	-.61	.22	-.30	-2.71	.01
Speed Composite	.27	.15	.20	1.81	.07
Model 3					
Executive Function Composite	-.71	.25	-.35	-2.87	.01
Speed Composite	.26	.15	.19	1.71	.09
Memory Composite	.19	.19	.11	.98	.33

Table 8: Type #2 Regression analysis with the Adherence Questionnaire and the inclusion of demographic variables.

Model Summary					Change Statistics	
Model	**Variables Entered**	**R**	**R Square**	**Adjusted R Square**	**R Square Change**	**Significance of F Change**
1	Age	.06	.00	-.01	.00	.61
2	Years of Education	.08	.01	-.02	.00	.59
3	Number of Medications	.52	.27	.24	.26	.00
4	3MS	.52	.27	.24	.01	.41
5	Executive Function Composite	.55	.31	.27	.03	.05
6	Speed Composite	.57	.32	.27	.01	.23
7	Memory Composite	.59	.35	.29	.03	.06

	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Significance of t**
	B	**Standard Error**	**Beta**		
Model 1					
Age	.01	.02	.06	.51	.61
Model 2					
Age	.01	.02	.04	.36	.72
Years of Education	-.01	.03	-.06	-.54	.59
Model 3					
Age	.00	.02	.00	-.03	.98
Years of Education	-.03	.03	-.11	-1.16	.25
Number of Medications	-.02	.04	-.51	-5.51	.00

Table 8: Type #2 Regression analysis with the Adherence Questionnaire and the inclusion of demographic variables (continued).

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 4					
Age	.00	.02	-.02	-.24	.81
Years of Education	-.02	.03	-.09	-.93	.36
Number of Medications	-.19	.04	-.50	-5.21	.00
3MS Score	-.09	.11	-.09	-.83	.41
Model 5					
Age	-.01	.02	-.06	-.62	.54
Years of Education	-.02	.03	-.08	-.77	.44
Number of Medications	-.19	.04	-.51	-5.37	.00
3MS Score	-.01	.11	-.01	-.12	.90
Executive Function Composite	-.43	.21	-.21	-2.01	.05
Model 6					
Age	.00	.02	-.03	-.30	.77
Years of Education	-.02	.03	-.09	-.88	.38
Number of Medications	-.18	.04	-.47	-4.85	.00
3MS Score	-.06	.12	-.06	-.53	.60
Executive Function Composite	-.46	.21	-.22	-2.15	.04
Speed Composite	.19	.15	.14	1.21	.23
Model 7					
Age	.00	.02	.00	-.01	.99
Years of Education	-.02	.03	-.08	-.83	.41
Number of Medications	-.18	.04	-.47	-4.89	.00
3MS Score	-.13	.12	-.13	-1.08	.28
Executive Function Composite	-.59	.22	-.29	-2.65	.01
Speed Composite	.20	.15	.15	1.35	.18
Memory Composite	.33	.18	.20	1.88	.06

significantly predicted the Adherence Questionnaire total ($\underline{B}$ = -.180, $\underline{p}$ < .001), and the executive function composite also significantly predicted the Adherence Questionnaire total ($\underline{B}$ = -.587, $\underline{p}$ = .01).

As shown in Table 9, when the RAM total was used as the dependent variable in the regression equation, the executive function composite significantly predicted the RAM total ($\underline{B}$ = -.662, $\underline{p}$ < .01). The inclusion of the demographic variables changed this pattern of results, as seen in Table 10. In this analysis, the RAM total was significantly predicted by the number of medications ($\underline{B}$ = .097, $\underline{p}$ < .05), the speed composite ($\underline{B}$ = .347, $\underline{p}$ < .05), and the executive function composite ($\underline{B}$ = -.677, $\underline{p}$ < .01).

A Priori Analysis Type #3.

The third hypothesis examined the ability of the health belief measures to predict adherence. The first set of regression analyses with the separate health beliefs measures were run with the Adherence Questionnaire total as the dependent measure. None of the locus of control total score, the self-efficacy total score, or the necessity-concerns differential was significantly predictive (see Table 11). Shown in Table 12, the addition of demographic variables revealed again only that the number of medications significantly predicted the Adherence Questionnaire total ($\underline{B}$ = -.192, $\underline{p}$ < .001).

The health belief measures were then entered as independent variables into the regression analyses with the RAM total score as the dependent variable. As shown in Table 13 the BMQ necessity-concerns differential significantly predicted the RAM total score ($\underline{B}$ = .231, $\underline{p}$ < .05). However, with the addition of demographic information to the regression equation, nothing significantly predicted the RAM total (see Table 14).

Table 9: Type #2 Regression analysis with the RAM Total Score.

Model Summary					Change Statistics	
Model	**Variables Entered**	**R**	**R Square**	**Adjusted R Square**	**R Square Change**	**Significance of F Change**
1	Executive Function Composite	.30	.09	.08	.09	.00
2	Speed Composite	.34	.11	.09	.03	.10
3	Memory Composite	.34	.12	.09	.00	.59

	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Significance of t**
	B	**Standard Error**	**Beta**		
Model 1					
Executive Function Composite	-.60	.21	-.30	-2.89	.00
Model 2					
Executive Function Composite	-.72	.22	-.36	-3.30	.00
Speed Composite	.24	.14	.18	1.64	.10
Model 3					
Executive Function Composite	-.66	.24	-.33	-2.76	.01
Speed Composite	.24	.14	.18	1.68	.10
Memory Composite	-.10	.18	-.06	-.55	.59

Table 10: Type #2 Regression analysis with the RAM Total Score and the inclusion of demographic variables.

Model Summary					Change Statistics	
Model	**Variables Entered**	**R**	**R Square**	**Adjusted R Square**	**R Square Change**	**Significance of F Change**
1	Age	.13	.02	.00	.02	.23
2	Years of Education	.15	.02	.00	.01	.43
3	Number of Medications	.26	.07	.04	.05	.04
4	3MS	.27	.07	.03	.00	.76
5	Executive Function Composite	.40	.16	.11	.09	.00
6	Speed Composite	.45	.20	.15	.05	.31
7	Memory Composite	.50	.21	.14	.01	.44

	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Significance of t**
	B	**Standard Error**	**Beta**		
Model 1					
Age	.02	.02	.13	1.20	.23
Model 2					
Age	.02	.02	.10	.96	.34
Years of Education	-.02	.03	-.09	-.79	.43
Model 3					
Age	.02	.02	.12	1.13	.26
Years of Education	-.02	.03	-.07	-.60	.55
Number of Medications	.08	.04	.22	2.06	.04

Table 10: Type #2 Regression analysis with the RAM Total Score and the inclusion of demographic variables (continued).

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 4					
Age	.02	.02	.13	1.17	.25
Years of Education	-.02	.03	-.07	-.65	.51
Number of Medications	.08	.04	.21	1.94	.06
3MS Score	.03	.12	.03	.30	.76
Model 5					
Age	.01	.02	.07	.65	.52
Years of Education	-.01	.03	-.05	-.44	.66
Number of Medications	.07	.04	.20	1.92	.06
3MS Score	.15	.12	.15	1.28	.20
Executive Function Composite	-.67	.23	-.33	-2.93	.00
Model 6					
Age	.02	.02	.13	1.19	.24
Years of Education	-.02	.03	-.07	-.65	.52
Number of Medications	.10	.04	.26	2.49	.01
3MS Score	.06	.12	.06	.49	.63
Executive Function Composite	-.73	.23	-.36	-3.24	.00
Speed Composite	.36	.16	.27	2.19	.03
Model 7					
Age	.02	.02	.12	1.06	.29
Years of Education	-.02	.03	-.07	-.67	.50
Number of Medications	.10	.04	.26	2.47	.02
3MS Score	.10	.13	.09	.70	.48
Executive Function Composite	-.68	.24	-.34	-2.84	.01
Speed Composite	.35	.16	.26	2.13	.04
Memory Composite	-.15	.19	-.09	-.77	.44

Table 11: Type #3 Regression analysis with the Adherence Questionnaire.

Model Summary					Change Statistics	
Model	**Variables Entered**	**R**	**R Square**	**Adjusted R Square**	**R Square Change**	**Significance of F Change**
1	MHLC Total Score	.09	.01	-.00	.01	.42
2	GSES Total Score	.14	.02	-.00	.01	.31
3	BMQ Differential Score	.18	.03	-.00	.01	.27

	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Significance of t**
	B	**Standard Error**	**Beta**		
Model 1					
MHLC Total Score	.08	.10	.09	.82	.42
Model 2					
MHLC Total Score	.08	.10	.08	.74	.46
GSES Total Score	-.11	.10	-.11	-1.01	.31
Model 3					
MHLC Total Score	.08	.10	.08	.78	.44
GSES Total Score	-.10	.10	-.10	-.93	.35
BMQ Differential Score	-.11	.10	-.12	-.1.11	.27

Table 12: Type #3 Regression analysis with the Adherence Questionnaire and the inclusion of demographic variables.

Model Summary					Change Statistics	
Model	**Variables Entered**	**R**	**R Square**	**Adjusted R Square**	**R Square Change**	**Significance of F Change**
1	Age	.07	.01	-.01	.01	.52
2	Years of Education	.09	.01	-.02	.00	.60
3	Number of Medications	.52	.27	.24	.26	.00
4	3MS	.52	.28	.24	.01	.43
5	MHLC Total Score	.53	.28	.23	.00	.74
6	GSES Total Score	.53	.28	.23	.00	.51
7	BMQ Differential Score	.53	.28	.22	.00	.89

	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Significance of t**
	B	**Standard Error**	**Beta**		
Model 1					
Age	.01	.02	.07	.64	.52
Model 2					
Age	.01	.02	.05	.48	.63
Years of Education	-.01	.03	-.06	-.52	.60
Model 3					
Age	.00	.02	.01	.06	.95
Years of Education	-.03	.03	-.10	-1.06	.29
Number of Medications	-.20	.04	-.52	-5.59	.00

Table 12: Type #3 Regression analysis with the Adherence Questionnaire and the inclusion of demographic variables (continued).

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 4					
Age	.00	.02	-.02	-.16	.87
Years of Education	-.02	.03	-.08	-.87	.39
Number of Medications	-.19	.04	-.50	-5.34	.00
3MS Score	-.09	.11	-.08	-.79	.43
Model 5					
Age	.00	.02	-.01	-.13	.89
Years of Education	-.02	.03	-.09	-.92	.36
Number of Medications	-.19	.04	-.51	-5.32	.00
3MS Score	-.09	.11	-.09	-.84	.41
MHLC Total Score	-.34	.10	-.03	-.34	.74
Model 6					
Age	.00	.02	-.02	-.20	.85
Years of Education	-.02	.03	-.09	-.91	.36
Number of Medications	-.19	.04	-.50	-5.19	.00
3MS Score	-.10	.11	-.09	-.89	.38
MHLC Total Score	-.38	.10	-.04	-.38	.71
GSES Total Score	-.06	.09	-.06	-.66	.51

Table 12: Type #3 Regression analysis with the Adherence Questionnaire and the inclusion of demographic variables (continued).

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 7					
Age	.00	.02	-.02	-.21	.83
Years of Education	-.02	.03	-.09	-.86	.39
Number of Medications	-.19	.04	-.50	-5.05	.00
3MS Score	-.10	.11	-.10	-.90	.37
MHLC Total Score	-.04	.10	-.04	-.38	.71
GSES Total Score	-.06	.09	-.06	-.66	.51
BMQ Differential Score	.01	.10	.02	.15	.89

Table 13: Type #3 Regression analysis with the RAM Total Score.

Model Summary					Change Statistics	
Model	Variables Entered	R	R Square	Adjusted R Square	R Square Change	Significance of F Change
1	MHLC Total Score	.08	.01	-.00	.01	.45
2	GSES Total Score	.16	.02	.00	.02	.20
3	BMQ Differential Score	.29	.08	.05	.06	.02

Table 13: Type #3 Regression analysis with the RAM Total Score (Continued).

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 1					
MHLC Total Score	.08	.10	.08	.75	.45
Model 2					
MHLC Total Score	.09	.10	.09	.85	.40
GSES Total Score	.13	.10	.13	1.28	.20
Model 3					
MHLC Total Score	.08	.10	.08	.78	.44
GSES Total Score	.12	.10	.12	1.14	.26
BMQ Differential Score	.23	.10	.24	2.34	.02

Table 14: Type #3 Regression analysis with the RAM total score and the inclusion of demographic variables.

Model Summary					Change Statistics	
Model	Variables Entered	R	R Square	Adjusted R Square	R Square Change	Significance of F Change
1	Age	.11	.01	.00	.01	.29
2	Years of Education	.13	.02	-.00	.01	.48
3	Number of Medications	.27	.07	.04	.06	.03
4	3MS	.27	.07	.03	.00	.80
5	MHLC Total Score	.28	.08	.03	.01	.45
6	GSES Total Score	.31	.10	.03	.01	.24
7	BMQ Differential Score	.35	.12	.05	.03	.12

Table 14: Type #3 Regression analysis with the RAM total score and the inclusion of demographic variables (Continued).

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 1					
Age	.02	.02	.11	1.06	.29
Model 2					
Age	.01	.02	.09	.84	.40
Years of Education	-.02	.03	-.08	-.71	.48
Model 3					
Age	.02	.02	.11	1.06	.29
Years of Education	-.02	.03	-.06	-.54	.59
Number of Medications	.09	.04	-.24	2.28	.03
Model 4					
Age	.02	.02	.12	1.08	.28
Years of Education	-.02	.03	-.06	-.57	.57
Number of Medications	-.09	.04	.23	2.19	.03
3MS Score	-.03	.12	.03	.25	.80
Model 5					
Age	.17	.02	.11	1.02	.31
Years of Education	-.01	.03	-.04	-.34	.73
Number of Medications	.09	.04	.24	2.26	.03
3MS Score	.46	.12	.04	.38	.71
MHLC Total Score	.84	.11	.09	.76	.45

Table 14: Type #3 Regression analysis with the RAM total score and the inclusion of demographic variables (continued).

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 6					
Age	.02	.02	.13	1.13	.26
Years of Education	-.01	.03	-.04	-.36	.72
Number of Medications	.09	.04	.23	2.12	.04
3MS Score	.06	.12	.06	.49	.62
MHLC Total Score	.09	.11	.10	.83	.41
GSES Total Score	.12	.10	.12	1.17	.24
Model 7					
Age	.02	.02	.10	.92	.36
Years of Education	-.06	.03	-.00	-.02	.98
Number of Medications	.07	.04	.19	1.71	.09
3MS Score	.02	.12	.02	.17	.86
MHLC Total Score	.09	.11	.09	.79	.43
GSES Total Score	.11	.10	.11	1.06	.29
BMQ Differential Score	.17	.11	.18	1.57	.12

A Priori Analysis Type #4.

The previous analyses with the health belief measures addressed the a priori hypotheses regarding the self-efficacy and necessity-concerns differential. The only health belief hypothesis not yet addressed was the relationship of the locus of control elements to the adherence measures. Although the direction of the relationship was not clearly predicted by the literature, external locus of control was expected to predict adherence scores. With the Adherence Questionnaire total as the dependent variable in

the regression analysis, the internal locus of control, external powerful others locus of control, and the external chance locus of control subscales were entered into the analyses. Shown in Table 15, only the internal locus of control subscale significantly predicted the Adherence Questionnaire total ($\underline{B}$ = .281, $\underline{p}$ < .05). As seen in Table 16, with the addition of the demographic variables, the internal locus of control subscale no longer was significantly predictive, but the number of medications was significant ($\underline{B}$ = -.180, $\underline{p}$ < .001).

The next set of analyses was conducted with the RAM total as the dependent variable, and the subscales of the locus of control measure as the independent variables. Shown in Table 17, none of the locus of control subscales significantly predicted the RAM total. Seen in Table 18, when the demographic variables were included in the analysis, only the number of medications significantly predicted the RAM total ($\underline{B}$ = .092, $\underline{p}$ < .05).

To summarize these findings, for those analyses where the dependent variable was the Adherence Questionnaire total, the number of medications was a significant predictor in all analyses, such that fewer medications predicted better adherence. In addition to this variable, the executive function composite was the only other significant predictor of the adherence variables. In this case, poorer scores on the executive function measures predicted better adherence. Internal locus of control predicted better adherence, unless the number of medications was first controlled for in the regression equation. None of the other health belief variables significantly predicted the Adherence Questionnaire total.

Table 15: Type #4 Regression analysis with the Adherence Questionnaire.

Model Summary					Change Statistics	
Model	**Variables Entered**	**R**	**R Square**	**Adjusted R Square**	**R Square Change**	**Significance of F Change**
1	Internal LOC Score	.22	.05	.04	.05	.04
2	Powerful Others LOC Score	.26	.07	.05	.02	.13
3	Chance LOC Score	.30	.09	.06	.02	.20

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	**Standard Error**	**Beta**		
Model 1					
Internal LOC Score	.22	.10	.22	2.10	.04
Model 2					
Internal LOC Score	.27	.11	.26	2.46	.02
Powerful Others LOC Score	-.16	.10	-.16	-1.52	.13
Model 3					
Internal LOC Score	.28	.11	.28	2.60	.01
Powerful Others LOC Score	-.20	.11	-.20	-1.83	.07
Chance LOC Score	.13	.10	.14	1.30	.20

Table 16: Type #4 Regression analysis with the Adherence Questionnaire and the inclusion of demographic variables.

Model Summary					Change Statistics	
Model	Variables Entered	R	R Square	Adjusted R Square	R Square Change	Significance of F Change
1	Age	.07	.00	-.01	.00	.53
2	Years of Education	.10	.01	-.01	.01	.51
3	Number of Medications	.53	.28	.25	.27	.00
4	3MS	.53	.28	.25	.01	.39
5	Internal LOC Score	.54	.29	.25	.01	.24
6	Powerful Others LOC Score	.56	.32	.27	.02	.09
7	Chance LOC Score	.56	.32	.26	.00	.87

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 1					
Age	.01	.02	.07	.63	.53
Model 2					
Age	.00	.02	.05	.44	.66
Years of Education	-.02	.03	-.07	-.66	.51
Model 3					
Age	.00	.01	.00	.04	.97
Years of Education	-.03	.02	-.11	-1.13	.26
Number of Medications	-.20	.04	-.52	-5.71	.00

Table 16: Type #4 Regression analysis with the Adherence Questionnaire and the inclusion of demographic variables (continued).

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 4					
Age	.00	.02	-.02	-.19	.85
Years of Education	-.02	.03	-.09	-.90	.37
Number of Medications	-.19	.04	-.50	-5.41	.00
3MS Score	-.09	.10	-.09	-.86	.39
Model 5					
Age	.00	.02	-.03	-.31	.76
Years of Education	-.02	.03	-.08	-.82	.41
Number of Medications	-.19	.04	-.49	-5.20	.00
3MS Score	-.07	.11	-.07	-.69	.49
Internal LOC Score	.11	.10	.11	1.18	.24
Model 6					
Age	.00	.02	-.04	-.36	.72
Years of Education	-.03	.03	-.12	-1.18	.24
Number of Medications	-.18	.04	-.48	-5.10	.00
3MS Score	-.10	.11	-.09	-.89	.38
Internal LOC Score	-.16	.10	.16	1.60	.11
Powerful Others LOC Score	-.17	.10	-.17	-1.71	.09
Model 7					
Age	.00	.02	-.04	-.37	.71
Years of Education	-.03	.03	-.11	-1.12	.27
Number of Medications	-.18	.04	-.47	-4.95	.00
3MS Score	-.10	.11	-.09	-.88	.38
Internal LOC Score	.16	.10	.16	1.59	.12
Powerful Others LOC Score	-.17	.10	-.17	-1.69	.10
Chance LOC Score	.02	.10	.02	.17	.87

Table 17: Type #4 Regression analysis with the RAM Total Score.

Model Summary					Change Statistics	
Model	**Variables Entered**	**R**	**R Square**	**Adjusted R Square**	**R Square Change**	**Significance of F Change**
1	Internal LOC Score	.12	.01	.00	.01	.24
2	Powerful Others LOC Score	.13	.02	-.00	.00	.68
3	Chance LOC Score	.14	.02	-.01	.00	.63

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	**Standard Error**	**Beta**		
Model 1					
Internal LOC Score	.12	.10	.12	1.19	.24
Model 2					
Internal LOC Score	.11	.11	.11	1.01	.32
Powerful Others LOC Score	.04	.11	.04	.41	.68
Model 3					
Internal LOC Score	.10	.11	.10	.94	.35
Powerful Others LOC Score	.06	.11	.06	.53	.60
Chance LOC Score	-.05	.11	-.05	-.48	.63

Table 18: Type #4 Regression analysis with the RAM total score and the inclusion of demographic variables.

Model Summary					Change Statistics	
Model	Variables Entered	R	R Square	Adjusted R Square	R Square Change	Significance of F Change
1	Age	.11	.01	.00	.02	.29
2	Years of Education	.13	.02	-.00	.01	.48
3	Number of Medications	.27	.07	.04	.06	.02
4	3MS	.27	.07	.03	.00	.83
5	Internal LOC Score	.31	.10	.04	.02	.16
6	Powerful Others LOC Score	.31	.10	.03	.00	.91
7	Chance LOC Score	.31	.10	.02	.00	.80

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 1					
Age	.02	.02	.11	1.07	.29
Model 2					
Age	.01	.02	.09	.85	.40
Years of Education	-.02	.03	-.08	-.70	.48
Model 3					
Age	.02	.02	.11	1.06	.29
Years of Education	-.02	.03	-.06	-.57	.57
Number of Medications	.09	.04	.24	2.29	.02

Table 18: Type #4 Regression analysis with the RAM total score and the inclusion of demographic variables (continued).

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 4					
Age	.02	.02	.12	1.07	.29
Years of Education	-.02	.03	-.07	-.60	.55
Number of Medications	.09	.04	.23	2.19	.03
3MS Score	.02	.12	.02	.21	.83
Model 5					
Age	.02	.02	.10	.92	.36
Years of Education	-.01	.03	-.06	-.51	.61
Number of Medications	.09	.04	.25	2.38	.02
3MS Score	.05	.12	.05	.40	.69
Internal LOC Score	.15	.11	.15	1.42	.16
Model 6					
Age	.02	.02	.10	.92	.36
Years of Education	-.01	.03	-.05	-.47	.64
Number of Medications	.09	.04	.25	2.35	.02
3MS Score	.05	.12	.05	.41	.68
Internal LOC Score	.15	.11	.15	1.33	.19
Powerful Others LOC Score	.01	.11	.01	.11	.91
Model 7					
Age	.01	.02	.11	.94	.35
Years of Education	-.01	.03	-.06	-.51	.61
Number of Medications	.09	.04	.25	2.25	.03
3MS Score	.05	.12	.05	.40	.69
Internal LOC Score	.14	.11	.14	1.26	.21
Powerful Others LOC Score	.02	.11	.02	.17	.87
Chance LOC Score	-.03	.11	-.03	-.26	.80

For those analyses where the dependent variable was the RAM total, the number of medications was a significant predictor when the cognitive variables and the locus of control scales were examined. These results revealed that a greater number of medications were related to better adherence. In addition to the number of medications, the speed composite variable was significantly predictive of the RAM total, such that better speed was related to better adherence, and the executive function composite variable was also significantly predictive of the RAM total, such that poorer executive functioning was related to better adherence. Of the health belief measures, the greater belief in the necessity of medicine over concerns about it significantly predicted the RAM total, unless the number of medications was controlled for first in the equation.

Exploratory Analyses.

As discussed above, the correlation analyses revealed that the measures included as components in the hypothesized composite variables of executive functioning and memory were not all highly related to each other. To investigate the relationships between the contributing components, factor analyses were initiated on each a priori grouping of variables. As shown in Table 19, the results indicate that there were two different factors among the executive function data, such that one factor consisted of the BADS Action Errors measure alone, and the other factor consisted of all the other executive function measures. Similarly, among the memory measures, two different factors were apparent, one that appeared to include working memory measures (i.e., Digit Span Forward, Digit Span Backward, and Letter Number Sequencing), while the other included time delayed memory elements (i.e., MIST total score, and CVLT long delay free recall) (see Table 20). As such, the regression analyses with the two measures of

Table 19: Factor Analysis of Executive Function Composite Components

Contributing Score	Component	
	1	2
FAS Total Score	.59	.50
WAIS Similarities Total	.66	.46
BADS Cards Trial 2 Errors	.52	-.48
Trails B Total Time	.76	-.18
Stroop Interference	.64	-.11
BADS Action Errors	-.21	.66

Table 20: Factor Analysis of Memory Composite Components

Contributing Score	Component	
	1	2
Digit Span Forward	.69	-.42
Digit Span Backward	.72	-.50
Letter Number Sequencing	.79	.17
MIST Total Score	34	.68
CVLT Long Delay Free Recall	.53	.55

adherence were run with these new factors instead of the a priori proposed groupings of variables. Table 21 shows the independent variables (including composites) used in these factor-based regression analyses. The individual scores contributing to the factor composites can be found in Appendix J.

The results of these analyses are largely consistent with those found with the a priori proposed groupings of the measures. That is, as seen in Table 22, as grouped through factor analyses, the elements that significantly predicted variability on the

Table 21: Regression Analyses with Factor Analysis Groupings of Data

Dependent Variables	Independent Variables
(i) Adherence Questionnaire	Executive Function Factor BADS Action Error Score Memory Factor 1 Memory Factor 2 Speed Composite MHLC Total Score BMQ Differential Score GSES Total Score
(ii) RAM Total Score	Executive Function Factor BADS Action Error Score Memory Factor 1 Memory Factor 2 Speed Composite MHLC Total Score BMQ Differential Score GSES Total Score

Table 22: Regression analysis with the factor derived composites on the Adherence Questionnaire

Model Summary					Change Statistics	
Model	**Variables Entered**	**R**	**R Square**	**Adjusted R Square**	**R Square Change**	**Significance of F Change**
1	Number of Medications	.50	.25	.24	.25	.00
2	Executive Factor	.53	.28	.27	.03	.05
3	BADS Action Errors	.54	.29	.27	.01	.26
4	Memory Factor 1	.57	.32	.29	.03	.06
5	Memory Factor 2	.57	.32	.28	.00	.89
6	Speed Composite	.57	.33	.28	.01	.36
7	MHLC Total Score	.57	.33	.27	.00	.86
8	GSES Total Score	.58	.33	.26	.00	.72
9	BMQ Difference Score	.58	.33	.26	.00	.68

Table 22: Regression analysis with the factor derived composites on the Adherence Questionnaire (Continued)

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 1					
Number of Medications	-.19	.04	-.50	-5.35	.00
Model 2					
Number of Medications	-.19	.04	-.51	-5.53	.00
Executive Factor	-.34	.17	-.18	-2.00	.05
Model 3					
Number of Medications	-.19	.04	-.49	-5.32	.00
Executive Factor	-.36	.17	-.20	-2.11	.04
BADS Action Errors	-.12	.11	-.11	-1.13	.26
Model 4					
Number of Medications	-.19	.04	-.51	-5.52	.00
Executive Factor	-.49	.18	-.27	-2.71	.01
BADS Action Errors	-.12	.10	-.11	-1.18	.24
Memory Factor 1	.24	.13	.19	1.90	.06
Model 5					
Number of Medications	-.20	.04	-.51	-5.48	.00
Executive Factor	-.50	.19	-.27	-2.60	.01
BADS Action Errors	-.12	.10	-.11	-1.17	.25
Memory Factor 1	.24	.13	.19	1.87	.07
Memory Factor 2	.02	.13	.01	.14	.89

Table 22: Regression analysis with the factor derived composites on the Adherence Questionnaire (Continued)

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 6					
Number of Medications	-.19	.04	-.49	-5.26	.00
Executive Factor	-.56	.20	-.31	-2.75	.01
BADS Action Errors	-.10	.11	-.09	-.95	.35
Memory Factor 1	.24	.13	.18	1.86	.07
Memory Factor 2	.01	.13	.01	.05	.96
Speed Composite	.13	.14	.10	.92	.36
Model 7					
Number of Medications	-.19	.04	-.49	-5.23	.00
Executive Factor	-.56	.20	-.31	-2.74	.01
BADS Action Errors	-.10	.11	-.09	-.95	.34
Memory Factor 1	.24	.13	.18	1.81	.07
Memory Factor 2	.00	.14	.00	.00	1.00
Speed Composite	.13	.14	.10	.93	.36
MHLC Total Score	-.02	.10	-.02	-.17	.86
Model 8					
Number of Medications	-.19	.04	-.49	-5.13	.00
Executive Factor	-.56	.21	-.31	-2.72	.01
BADS Action Errors	-.10	.11	-.09	-.93	.36
Memory Factor 1	.23	.13	.18	1.75	.09
Memory Factor 2	-.00	.14	-.00	-.02	.99
Speed Composite	.14	.15	.10	.97	.334
MHLC Total Score	-.02	.10	-.02	-.20	.85
GSES Total Score	-.03	.10	-.03	-.36	.72

Table 22: Regression analysis with the factor derived composites on the Adherence Questionnaire (Continued)

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 9					
Number of Medications	-.18	.04	-.48	-4.73	.00
Executive Factor	-.57	.21	-.31	-2.74	.01
BADS Action Errors	-.11	.11	-.10	-1.00	.32
Memory Factor 1	.24	.13	.18	1.77	.08
Memory Factor 2	.00	.14	.01	.05	.96
Speed Composite	.14	.15	.10	.97	.34
MHLC Total Score	-.02	.10	-.02	-.16	.87
GSES Total Score	-.03	.10	-.03	-.33	.74
BMQ Difference Score	-.04	.10	-.04	-.42	.68

Adherence Questionnaire total were the number of medications ($B = -.185$, $p < .001$) and the executive function factor ($B = -.574$, $p < .01$). Thus, as the number of medications decreases, the level of adherence increases. As the scores on the executive function measures decrease, the level of adherence increases.

The results were different in the analyses with the RAM total as the dependent variable. Table 23 shows that in these analyses, the elements predicting the RAM total were the number of medications ($B = .097$, $p < .05$), the BADS Action Error score ($B = -.360$, $p < .01$), and the executive function factor ($B = -.424$, $p = .052$).. Thus, as the number of medications decrease, the adherence score on the RAM increased, and as the

Table 23: Regression analysis with the factor derived composites on the RAM Total Score.

Model Summary					Change Statistics	
Model	**Variables Entered**	**R**	**R Square**	**Adjusted R Square**	**R Square Change**	**Significance of F Change**
1	Number of Medications	.22	.05	.04	.05	.04
2	Executive Factor	.30	.09	.07	.04	.05
3	BADS Action Errors	.48	.23	.21	.14	.00
4	Memory Factor 1	.49	.24	.20	.01	.27
5	Memory Factor 2	.49	.24	.20	.00	.88
6	Speed Composite	.51	.26	.20	.02	.20
7	MHLC Total Score	.51	.26	.19	.00	.73
8	GSES Total Score	.51	.26	.19	.00	.58
9	BMQ Difference Score	.52	.27	.19	.01	.32

	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Significance of t**
	B	**Standard Error**	**Beta**		
Model 1					
Number of Medications	.08	.04	.22	2.05	.04
Model 2					
Number of Medications	.08	.04	.21	1.99	.05
Executive Factor	-.37	.19	-.21	-2.00	.05

Table 23: Regression analysis with the factor derived composites on the RAM Total Score (Continued).

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 3					
Number of Medications	.10	.04	.26	2.68	.01
Executive Factor	-.45	.17	-.25	-2.58	.01
BADS Action Errors	-.42	.11	-.38	-3.91	.00
Model 4					
Number of Medications	.10	.04	.27	2.76	.01
Executive Factor	-.37	.19	-.20	-1.96	.05
BADS Action Errors	-.42	.11	-.38	-3.89	.00
Memory Factor 1	-.15	.13	-.11	-1.10	.27
Model 5					
Number of Medications	.10	.04	.27	2.74	.01
Executive Factor	-.36	.20	-.20	-1.79	.08
BADS Action Errors	-.42	.11	-.38	-3.87	.00
Memory Factor 1	-.14	.13	-.11	-1.07	.29
Memory Factor 2	-.02	.13	-.02	-.16	.88
Model 6					
Number of Medications	.11	.04	.29	2.92	.00
Executive Factor	-.45	.21	-.25	-2.12	.04
BADS Action Errors	-.39	.11	-.35	-3.53	.00
Memory Factor 1	-.14	.13	-.11	-1.09	.28
Memory Factor 2	-.04	.13	-.03	-.27	.79
Speed Composite	.19	.15	.14	1.31	.20

Table 23: Regression analysis with the factor derived composites on the RAM Total Score (Continued).

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 7					
Number of Medications	.11	.04	.29	2.92	.01
Executive Factor	-.44	.21	-.25	-2.10	.04
BADS Action Errors	-.39	.11	-.35	-3.45	.00
Memory Factor 1	-.14	.13	-.11	-1.03	.31
Memory Factor 2	-.02	.14	-.02	-.16	.87
Speed Composite	.19	.15	.14	1.28	.21
MHLC Total Score	.04	.10	.04	.34	.73
Model 8					
Number of Medications	.11	.04	.28	2.82	.01
Executive Factor	-.45	.21	-.25	-2.10	.04
BADS Action Errors	-.39	.11	-.35	-3.46	.00
Memory Factor 1	-.13	.14	-.10	-.96	.34
Memory Factor 2	-.02	.14	-.01	-.13	.90
Speed Composite	.18	.15	.13	1.16	.25
MHLC Total Score	.04	.10	.04	.38	.71
GSES Total Score	.06	.10	.06	.56	.58

Table 23: Regression analysis with the factor derived composites on the RAM Total Score (Continued).

	Unstandardized Coefficients		Standardized Coefficients	t	Significance of t
	B	Standard Error	Beta		
Model 9					
Number of Medications	.10	.04	.25	2.38	02
Executive Factor	-.42	.21	-.23	-1.95	.06
BADS Action Errors	-.36	.12	-.32	-3.06	.00
Memory Factor 1	-.14	.14	-.11	-1.04	.30
Memory Factor 2	-.04	.14	-.03	-.29	.77
Speed Composite	.17	.15	.13	1.14	26
MHLC Total Score	.03	.10	.03	.30	.76
GSES Total Score	.05	.10	.05	.51	.61
BMQ Difference Score	.10	.10	.11	.99	.33

BADS Action Error score decreased the RAM score increased. It is important to note in interpreting these results that the BADS Action Error scores were set such that a higher score actually represented better performance (i.e., fewer errors). Thus, as the performance on the BADS Action test declined, the adherence score on the RAM improved. As in the a priori analyses, as the scores on the executive function composite worsened, adherence improved.

Intentionality Questionnaire

The Intentionality Questionnaire was specifically designed for the present study, following the work of Cooper, et al. (1982), to identify the relative importance of intentional and unintentional factors in nonadherent behaviour. The eight questions were intended to measure the frequency of intentional and unintentional nonadherence for only those occasions when medication had not been taken as it had been prescribed. However,

from comments made by participants during their completion of this measure, many participants interpreted the questions as measures of the frequency of occurrence of the behaviours for all medication taking experiences, both adherent and nonadherent. That is, they interpreted the questions as "How often do you have side effects" rather than the intended "How often do you not take your medications because of side effects?" While it is not clear how many of the participants completed the measure this way, cautious interpretation of the results is necessary.

Four of the questions were created to measure intentional nonadherence, which was deemed to involve events that could influence someone's decision whether or not to take medication (i.e., beliefs that more or less medication was needed than prescribed, that the medicine produced unpleasant side effects, or that the medicine was expensive). Four questions were intended to measure unintentional nonadherence, which was deemed to involve events that influenced whether or not someone took their medication as prescribed, but through unplanned means (i.e., physical difficulty taking the medicine, busyness, uncertainty about how to take the medicine, and forgetfulness). A factor analysis was run on the collected data to determine if the questions grouped together as designed (see Table 24).

Table 24: Factor Analysis of Intentionality Questionnaire items

Contributing Score	Component	
	1	2
Question 1	.66	.23
Question 2	.70	-.35
Question 3	.78	-.12
Question 4	.47	-.18
Question 5	.42	.70
Question 6	.66	.04
Question 7	.61	-.45
Question 8	.31	.74

The data revealed that the questions did group into two factors, but that the division was not cleanly into intentional/unintentional as originally conceived. That is, six of the questions grouped together as one factor (the four intentional nonadherence questions and two of the unintentional nonadherence questions: "The medicine is difficult to take (e.g., swallow)" and "You are not sure how to take the medicine as prescribed"), and two questions grouped together as a second factor (the remaining two unintentional nonadherence questions). In reviewing the nature of the questions that grouped together in the first factor, they all have the common element that they could be perceived of as aggravations or impediments. That is, in addition to the intentional items, the two questions grouped in the first factor that were originally designed to be measures of unintentional nonadherence could be elements influencing someone's decision whether or not to take medication, by making the experience of taking medications unpleasant. For example, a person may choose not to take their medications because it is hard to swallow.

Analyses were conducted with the data grouped as originally designed (i.e., into the four intentional versus the four unintentional questions) to identify any relationship between reported intentionality of nonadherence and actual reported adherence. The means were calculated for the intentional questions and the unintentional questions, and participants were categorized by which type of score was larger. For the original groupings of intentional and unintentional items, most participants had higher unintentional mean scores (N = 47) than intentional mean scores (N = 23) or no difference between the scores (N = 22). With the factor groupings, more participants showed no difference between the factor means (N = 43) than had either factor 1 or 2 being larger (factor 1 larger N = 28, factor 2 larger N = 21).

The Adherence Questionnaire total scores were then dichotomised to identify those participants scoring above and below the median. Those scoring above the median were considered "good adherers" and those scoring below the median were considered "poor adherers". Chi square analysis revealed that there was no significant relationship between adherence status as a "good adherer" or a "poor adherer" with the responses on the Intentionality Questionnaire (χ^2 (2, $\underline{N}$ = 92) = 1.27, $\underline{p}$ >.05). The RAM total produced similar results (χ^2 (2, $\underline{N}$ = 92) = .18, $\underline{p}$ >.05). Using the factor-groupings rather than the hypothesized groupings also produced similar results. In summary, the Intentionality Questionnaire does not appear to be clearly measuring whether one's nonadherence is intentional or unintentional, and does not appear to be related to one's status as a "good" or "poor" adherer on the self-report measures of adherence.

Discussion

This study generated a vast amount of information, and produced some results that were counter to the expected outcomes. The initial rationale for the study was to build upon the research previously done by Park, et al. (1999), to produce information about medication adherence as it may relate to cognitive variables and health belief variables, among older participants with a wide variety of health issues. To this end, multiple cognitive measures of executive functioning, memory (prospective and retrospective), and processing speed were administered to cognitively intact older adults. In addition, questionnaires concerning self-efficacy, locus of control, and the balance between benefits and concerns about medication were administered. Medication adherence was measured with self-report questionnaires.

Multiple regression analyses of the data followed two routes. The first set of analyses were intended to follow the hypotheses as originally proposed, directed by the theoretical findings of previous research. To this end, regression analyses were run on the two measures of adherence to identify the contributions of the cognitive factors of executive functioning, memory, and speed, and the health belief measures of general self-efficacy, locus of control, and the necessity-concerns differential. In addition to these theory-driven analyses, a second set of analyses was run driven by the data generated in the study. That is, measures that had been hypothesized as representing the same underlying construct were found not to group together as predicted in the actual data set. Factor analyses identified slightly different groupings of the executive functioning and memory measures, and regression analyses were run with these factors instead of the

proposed groupings, to identify any common characteristics among the grouped variables, with respect to the prediction of adherence.

The variable found to be most robust in its prediction of medication adherence was the number of medications taken by the participant. The results from all analyses with the Adherence Questionnaire as the dependent variable showed consistently that as the number of medications decreased, adherence increased. This finding has been found before in the literature (e.g., Graveley and Oseasohn, 1991). Clearly, the Adherence Questionnaire was sensitive to the number of medications used by the participants in this study, which may reflect the nature of the scoring of this measure. The other measure of adherence, the RAM total score, was less consistently related to the number of medications, and the relationship was in the opposite direction to that seen with the Adherence Questionnaire. That is, adherence increased, as measured by the RAM total score, as the number of medications increased. This finding suggests that the RAM total may be measuring different aspects of medication adherence than the Adherence Questionnaire. The poor correlation between the two measures also supports this suggestion. It is of interest that these two measures of adherence did correlate significantly with each other when the number of medications was partialled out of the correlation first. Such a finding suggests that both adherence measures share some quality in their measurement of medication adherence that is more complex than mere volume of medication regimen.

It is not entirely clear why the number of medications would have significant, yet opposite, relationships to the two adherence measures. The Adherence Questionnaire questions and scoring are clearly related to the number of medications; when the number

of medications increases, the likelihood of a participant obtaining a "positive screen" for nonadherence increases. The RAM total score is not based in any way on the number of medications, however, and is instead only reflective of the participant's subjective scrutiny of their own medication adherence. Perhaps it is the face validity of the RAM questions that makes it sensitive to the number of medications in the opposite direction to that of the Adherence Questionnaire. That is, perhaps individuals who take many medications are less willing (than individuals taking fewer medications) to openly admit to nonadherence, and so score higher on this measure. Or, perhaps the RAM is a measure of adherence that is simply less sensitive to the volume or complexity of the medication regimen, and instead is reflecting a different quality of adherence. A third possible explanation is related to the time span to be measured by each scale. The Adherence Questionnaire specifically asks only about the last week of medication use, whereas the RAM has an open-ended time frame. That is, perhaps individuals taking many medications are more likely to be nonadherent in the short term (i.e., as measured by the Adherence Questionnaire) but feel themselves more adherent over the long term (i.e., as measured by the RAM).

A Priori Analyses

Hypothesis 1.

The first hypothesis of this study addressed the global constructs of cognitive variables and health beliefs as related to medication adherence. A composite score was calculated to combine all the cognitive measures into one score, and the same was done for the health belief measures. The two self-report measures of adherence produced different results as the dependent variables in these analyses. Neither the cognitive

composite nor the health belief composite significantly predicted any variability in the Adherence Questionnaire, contrary to expectations. However, the RAM total score was significantly predicted by the health beliefs construct, but it was not predicted by the cognitive construct. Further analysis (i.e., in Analysis Type 3, to be discussed in more detail below) revealed that the RAM total score was predicted by the BMQ necessity-concerns differential, such that adherence increased when the belief in the necessity of medications was greater than the concern about it. These measures (the RAM and the BMQ) were both developed by Horne and Weinman (1999), where the RAM total was used to establish the validity of the BMQ. These measures are related to one another in the present study, but neither the BMQ nor the RAM were related to the other measure of adherence in the present study (i.e., the Adherence Questionnaire), therefore raising questions about what underlying constructs are actually being measured by these scales.

Hypothesis 2.

The second hypothesis in the present study investigated the association between different types of cognitive functions assessed in the study and the adherence measures. The only cognitive variable to significantly predict the Adherence Questionnaire was the executive function composite variable, while the memory and speed composites were not significantly predictive of this scale. While it had been expected that the executive function composite would predict adherence better than the memory or speed composite variables, the finding of the direction of the relationship to the adherence measure was quite unexpected. Consistently, the results indicated that as performance on the executive function measures declined, adherence as measured on the Adherence Questionnaire improved.

To date, only one other previous study has been found that shows this pattern of relations between executive functions and adherence. Verdoux, Liraud, Assens, Abalan, and van Os (2002) studied long term medication adherence in young (less than 60 years old) individuals diagnosed with a psychotic disorder. Participants and their caregivers were asked to report on medication-taking behaviours at six month intervals over two years. Nonadherence was characterized as the discontinuation of medication against medical advice for a period of at least two weeks. Individuals were categorized as good or poor adherers. Neuropsychological tests were administered, including the Wisconsin Card Sorting Test (WCST) as a measure of executive functioning.

Verdoux, et al. found that poor baseline performance on the WCST predicted better medication adherence. While self-report can be subject to reporting bias, Verdoux, et al. did not attribute their findings to errors in reporting because they used multiple informants of the adherence behaviour. Instead, they proposed that lower cognitive flexibility, as inferred from poorer performance on the WCST, would actually be beneficial in medication adherence. They suggested that as individuals with low cognitive flexibility develop a regular routine for taking their medications, they would be less likely to vary from this schedule than individuals with greater cognitive flexibility, who will be more prone to situational circumstances. The study by Verdoux, et al. raises some interesting issues that could apply to the present work. It may be that those individuals with lower cognitive flexibility, as measured on the tasks of executive functioning, were more rigid in their medication taking routines than those with higher cognitive flexibility, resulting in greater adherence.

Another possible explanation for the results of the present study relates to some speculations in the literature on prospective memory. As reviewed by Moscovitch (1982), the most relevant factor differentiating older and younger participants on an everyday memory task was the use of mnemonic devices. The individuals in the Moscovitch study who trusted their memories alone (i.e., without memory aids) were the ones who forgot to complete the prospective telephone task, whereas those who provided themselves with external reminders were able to remember to call. Moscovitch concluded from this research that awareness of one's likelihood to forget means that one is more likely to structure the environment to prevent forgetting. As related to the present findings, it may be that those individuals who were capable of managing the planning and self-monitoring required for good medication adherence (i.e., had good executive functioning) were those who did not implement external supports for taking their medications, and so were actually less adherent. On the other hand, those individuals who had poor planning abilities (i.e., poor executive functioning) may have put greater structure in place for adherence, for example, with external organizational aids. Unfortunately, the method of medication organization (e.g., a dosette or calendar) used by each participant was not recorded in this study. Anecdotally, some participants were very eager to explain their elaborate organizational systems, whereas other participants seemed to have no orderly method of keeping track of their medications. Systematic investigation into organizational strategies would be an interesting area for further research, as it has obvious relevance to intervention strategies. In other words, individuals may benefit from more education regarding the importance of external organizational strategies, even if (or perhaps especially if) they feel themselves highly

capable of mental organization. Along these lines, Park, et al. (1992) have already shown that the addition of medication organizers and charts improved medication adherence among the oldest-old.

An alternative interpretation of the results found in the current study is related to the nature of the adherence measure used. With the Adherence Questionnaire, nonadherence scores were contributed to, in part, by the participant's self-report of adherence errors made in the previous week. It may be that those participants with better executive functioning were better able (or were more likely to) report incidents of non-adherence. In other words, the finding that poorer executive functioning predicts better adherence may actually reflect that poorer executive functioning predicts poorer ability to self-monitor (that is, self-report on) medication use. This suggestion is supported by the finding that poorer executive functioning scores were also related to better adherence on the RAM, a measure less specific in its questions about nonadherence.

Turning attention to the results of the analyses with the RAM total as the dependent variable, it was found that in addition to significant prediction of the RAM total by the executive function composite, the speed composite also predicted the RAM but only when the number of medications were included in the regression equation. Improving speed scores and declining executive functioning scores predicted improved adherence on the RAM. The three proposed explanations for the negative association between the executive function composite variable discussed above similarly apply to the RAM total adherence measure. As for the relation between the RAM total and the speed composite with the inclusion of the number of medications, perhaps once the complexity of the medication regimen was accounted for by the number of medications, the

variability due to speed became significant. In other words, the RAM score may be reflective of those general cognitive processes explained by processing speed (Salthouse, 1996), but only once the variability due to the complexity of the medication regimen is removed. The RAM total score may be more sensitive to general cognitive processes than the Adherence Questionnaire because the RAM draws on broader concepts of medication taking behaviour than the very specific questions of the Adherence Questionnaire.

Hypotheses 3 and 4.

The last a priori hypotheses investigated the association between different types of health beliefs assessed in the study and the adherence measures. None of the locus of control total, self-efficacy total, or BMQ necessity-concerns differential predicted medication adherence as measured on the Adherence Questionnaire. However, the BMQ necessity-concerns differential significantly predicted adherence measured on the RAM total, unless the number of medications was controlled for first, such that the greater the belief in the necessity of medications over concerns about them, the better the medication adherence. As discussed above, both of these measures (BMQ and RAM) were developed by Horne and Weinman (1999), and so it is unclear what underlying construct these scales may actually measure. Perhaps both scales are related to broad beliefs about medication use.

Finally, the specific elements of locus of control were investigated to address all of the original hypotheses. The internal locus of control subscale significantly predicted medication adherence as measured by the Adherence Questionnaire, but not the RAM, such that greater internal locus of control was related to better adherence on the

Adherence Questionnaire. This finding was contrary to the expectation based on previous research that external locus of control would be most predictive of adherence, and instead suggests that individuals who believe that their own behaviour is the most important factor to their health are best able to maintain a medication routine. This effect disappeared, however, with the addition of the number of medications to the regression equation, indicating that this demographic variable was a better predictor of adherence than internal locus of control. A possible relationship between the variability accounted for by the number of medications and internal locus of control may be interesting to consider in more detail. That is, if a greater number of medications are related to decreased internal locus of control, it may reflect that it is more difficult for an individual to feel in control of his or her health when taking a large number of medications.

The finding that the health belief variables were such poor predictors of medication adherence was unexpected. While it is possible that the general underlying health belief constructs measured were not related to medication adherence, it seems more likely that the type of measures used for these constructs were not sensitive enough. For example, one possible explanation for the absence of any predictive effect of self-efficacy for medication adherence concerns the construct of self-efficacy itself. As originally proposed by Bandura (1977) self-efficacy was not supposed to be measured as a generalized construct, and instead, must be conceptualized as one's belief in one's ability to successfully complete a specific type of task, for example, academics. In other words, the generalized self-efficacy questionnaire may not have been specific enough to the task of medication adherence for any relationship to emerge. It may be that a significant predictive relationship would have been found if a modified version (i.e., not

specific to transplant recipients) of the self-efficacy scale developed by DeGeest et al. (1994) to investigate medication use among organ transplant recipients had been used instead of the general self-efficacy measure. Similarly, the shortened versions of the MHLC (Robinson-Whelen and Storandt, 1992) and the GSES (Bosscher and Smit, 1998) for use with an older population may have revealed a significant predictive relationship of these measures to medication adherence.

Exploratory Analyses.

As previously mentioned, the cognitive measures were combined into composite scores in two ways: one combination was driven by the original hypotheses about how the measures should be grouped, and the second combination was driven by the groupings of the data in factor analyses. The results of the regression analyses using these cognitive factor composites were largely consistent with the results of the analyses with the hypothesized groupings. That is, when the Adherence Questionnaire was the dependent variable, the number of medications and the executive function factor were the best predictors of adherence, such that fewer medications and poorer executive functioning were associated with better adherence. When the RAM total was the dependent measure, more medications were associated with better adherence, and among the cognitive variables poorer scores on the executive function factor and the BADS Action test were associated with better adherence.

A questionnaire was developed for use in this study to assess the relative degree of intentional versus unintentional nonadherence. There was no apparent relationship between the scores on this Intentionality Questionnaire and adherence status, where "good" adherence was defined as scores above the median adherence score and "poor"

adherence was defined as scores below the median adherence score. The lack of a significant relationship between the Intentionality Questionnaire and adherence status was found regardless of which adherence measure was used as the dependent variable, and regardless of whether the originally hypothesized grouping of the items into intentional and unintentional questions or the data-driven groupings of the questions were used in the analysis. It is difficult to conclude with certainty that the Intentionality Questionnaire was a valid measure of the quality of reported nonadherence, especially given that many of the participants appeared to misunderstand the questions on this measure. That is, many participants may have responded to the items with regard to medication taking behaviours in general, rather than specifically to nonadherent behaviours. If participants had answered the questions this way, the questionnaire would have been a measure of the frequency of unpleasant events affecting medication use. Unfortunately, these results cannot support or disconfirm the concept of a difference between unintentional and intentional nonadherence as first proposed by Cooper, et al. (1982). As such, no conclusions can be made regarding how adherence interventions may best incorporate this conceptual distinction.

Theoretical Implications

Although the diagram presented in the introduction (refer to Figure 2) was not intended to imply relationships between variables, it may be used as a framework to discuss how the actual results of the present study differed from the expected relationships. Modified from the model presented by Park and Jones (1997), the elements that were expected to be closely associated with adherence scores were health beliefs and cognitive functioning. Indirect influence on medication adherence was

expected from factors such as medication variables (e.g., number of medications), and individual differences (e.g., education, living status, and age). Instead, the actual results of the study showed that the number of medications is a direct and strong predictive element of medication adherence, as is the one cognitive variable of executive functioning. Individual differences, such as age, education, and living status appear to be indirectly related to adherence. Health beliefs, as measured in the present study, did not appear to be significantly related to medication adherence. However, the absence of a significant relationship between the health belief measures in this study and medication adherence on self-report does not preclude the possibility that some relationship, as measured by other means, does exist.

Medication adherence is an extremely complex behaviour, under the influence of many individual and interacting elements. It may be that the components that contribute to real-life medication adherence are dynamic, and subject to varying influences at varying times and under varying circumstances. Although this study included a wide variety of variables, it is impossible to include in one study all of the factors that could be related to medication adherence. For example, no measure of mood was administered in the present study, but Carney, Freedland, Eisen, Rich, and Jaffe (1995) found that depression had a negative influence on medication adherence among cardiac patients. However, DiMatteo, Giordani, Lepper, and Croghan (2002) have shown that the odds of a good clinical outcome improve if the patient is adherent rather than nonadherent to their medication regimen. Determining the critical factors to successful medication adherence clearly has important clinical relevance. How then, can future research best approach the investigation of medication adherence?

Future Research

Given the results of the present study, some implications for future research with individuals taking medications present themselves. First, research questions were raised by the specific finding that better medication adherence was related to poorer executive function scores. To review, three explanations appear relevant for the surprising finding that poorer executive functioning scores predict better adherence in the present study. The proposed explanations are: (1) poorer cognitive flexibility makes for more rigid medication routines and therefore fewer mistakes, (2) poor executive functioning leads to greater use of external aids, thereby improving medication adherence, and (3) poor self-monitoring means poorer self-reporting, not better adherence.

Future research may address these issues in a number of different ways. If greater cognitive rigidity leads to better adherence, it would be useful to focus on the degree of variability in medication taking routines, such that less variability should be associated both with better adherence overall and poorer executive functioning (i.e., greater cognitive rigidity). Since the electronic monitoring system (MEMS) can record variability in the time of day medications are taken, this method would allow investigation into adherence variability even if medications were taken every day. The issue that poor self-monitoring may lead to poor self-reporting may be addressed by measuring adherence with multiple informants or by using a more objective measures of adherence, such as the Medication Event Monitoring System (MEMS).

On the other hand, if the present findings are reflective instead of reliance on external organizational or memory aids, a systematic investigation of how individuals monitor their own regimens would be very informative. Gould, et al. (1997) surveyed

older adults at a trade show about their strategies for remembering everyday activities including medication use. These researchers were particularly interested in differentiating between strategies that engaged internal cues (i.e., mental activity) and external cues (i.e., physical changes in the environment). Gould, et al. found that older adults rely more on internal strategies to remember to take medications, and external strategies for other everyday memory demands. It would be interesting to investigate in greater detail the relationship between internal and external cues to medication adherence, not only in how these strategies affect memory performance, but also in how they are related to executive functioning.

The second set of research implications raised by the present study relate specifically to the measures used. It seems that the measures of health belief used were not related to medication adherence as measured by self-report. However, in addition to prior research evidence, it seems intuitive that an individual's beliefs about his or her illness must influence whether or not they adhere to their medication routine. As such, perhaps the constructs chosen for investigation in the current study were not the most important illness representation elements, or the measures of these constructs were not appropriately sensitive. Further investigation into this area is required before illness representation is dismissed as a contributing element to medication adherence, for example, by developing tools specific to self-efficacy and medication use, or through the use of health belief scales with adherence measured by the MEMS.

A further important measurement issue to be discussed is the scoring of the Adherence Questionnaire. In the original development of the scale, Svarstad, et al. (1999) had previous knowledge of the participants' medications, and were targeting the

adherence for use of one particular type of medication. Scoring on the Adherence Questionnaire reflected the specificity of this knowledge and these values were used in the validation of the scale with the MEMS. To make the Adherence Questionnaire more broadly applicable in the present study, slight modifications were made to the scoring of this scale. As no independent records were available regarding the mediations taken by participants, details of the prescription medications were recorded off the medication containers at the first test session. The participants' responses at the second test session were then compared to these initial records, and these produced positive or negative nonadherence screen scores. These scoring modifications to the Adherence Questionnaire may have affected the validity of this measure, but it was still considered the best available self-report scale of adherence. Research is needed into the psychometric properties of the scale with these modifications, including the effect of the changes on the validity of the scale when compared to an objective measure of adherence, such as the MEMS.

An additional area for future research is that of intentional and unintentional adherence. Given the potential importance of this concept to practical interventions, it is important to systematically investigate the relationship between actual failure to adhere to a medication regimen and the intention to do so. Health behaviour such as medication adherence needs to be considered in terms of behavioural intentions, for example, as modeled by the theory of reasoned action (Miller, Wikoff, and Hiatt, 1992). Although the measure developed for the present study, the Intentionality Questionnaire, did not definitively answer this question, future clarifications to the wording of the questions may produce valuable information in this area.

Another measurement issue in the present study relates to the length of the neuropsychological battery administered to participants. Given that memory and processing speed were not significantly predictive of medication adherence, it may be beneficial in future investigations to look in detail only at executive functioning measures. Such research could involve particular focus on each of the underlying elements of executive functioning, such as planning, self-monitoring, and cognitive flexibility or a multi-test standardized scale, such as the Delis-Kaplan Executive Function System (D-KEFS) (Delis, Kaplan and Kramer, 2001). The D-KEFS is a recently published measure of executive functioning made up of multiple subtests to assess different components of planning and problems solving, and standardized in an age range of 8 to 89, with the exception of the Proverbs test, designed for adolescents and adults aged 16 to 89 (Delis, et al. 2001). The benefit of this scale would be the possible use of both individual subtest scores and overall scale scores to predict adherence scores.

Other broader research implications were raised by the present study. It seems evident that more than one type of method of measuring medication adherence is necessary for a complete picture of the behaviour. That is, self-report measures must be used to obtain a subjective view of how the participants believe themselves to be adhering to their medication routines, but an additional objective measure of medication use (such as the MEMS) is also necessary, especially if there is some question of the ability of participants to monitor their own behaviour. Unfortunately, the use of electronic monitoring devices may restrict the simultaneous investigation of other variables. For example, the results of the present study raised the question of the importance of organizational and memory aids (e.g., dosettes) to adherence. The use of

these types of devices has very significant clinical implications, and deserves further investigation, however, the use of aids and medication adherence cannot be simultaneously evaluated with an electronic device as the measure of adherence. Perhaps a pill-box with electronic sensors needs to be designed to address questions of this nature. Regardless, investigations into the types of organizational systems without a focus on the efficacy to measured adherence would be useful in understanding qualitatively how individuals are trying to help themselves organize and remember. Such work would build upon the work of others, such as Gould, et al. (1997) and Park, et al. (1992).

Other ideas for modifications to the present methods would also simplify the conclusions that could be drawn from future research, but would necessarily limit the generalizability of the work. For example, if only one type of illness or medication were included in the investigation, rather than an open selection of illness and medication types, the conclusions may be more clearly interpreted, but less broadly applicable. That is, if a future study on medication adherence were to limit its scope to individuals taking one type of medication (e.g., hydrochlorothiazide) or with one type of illness (e.g., hypertension) then interpretations of results could address the issues specific to these situations, trying to narrow down the influential components, but may not be good explanations for adherence issues in general.

Another potentially rich area for further investigation is the use of non-prescribed substances in participant's medication regimen. Anecdotally, many of the participants in the present study were taking vitamins and natural health supplements on the advice of their physicians. These substances were not included in the present analyses of adherence, but the participants, in some cases, were as vigilant with these items as they

were with prescribed and controlled medications. Adherence to natural supplements may be even more subject to individual health beliefs than prescribed medications.

In conclusion, there are many roads still to be traveled in the area of medication adherence. Future work must not be driven only by the questions raised from previous research, but should also address the how interventions may be most practically implemented to maximize the beneficial result on medication adherence. Methodological issues, such as measurement of adherence for example, must be balanced with applicability and generalizability of the results generated. It may be that, in the case of medication adherence, the "big picture" is greater than the sum of its parts, but restrictions in measurement may necessarily restrict observation to one piece of the puzzle at a time.

References

Ajzen, I. & Madden, T.J. (1986). Prediction of goal-directed behavior: Attitudes, intentions, and perceived behavioral control. Journal of Experimental Social Psychology, 22, 453-474.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review, 84(2), 191-215.

Bandura, A. (1982). Self-efficacy mechanism in human agency. American Psychologist, 37(2), 122-147.

Bosscher, R.J., & Smit, J.H. (1998). Confirmatory factor analysis of the General Self-Efficacy Scale. Behaviour Research and Therapy, 36, 339-343.

Brus, H., van de Laar, M., Taal, E., Rasker, J., & Wiegman, O. (1999). Determinants of compliance with medication in patients with rheumatoid arthritis: the importance of self-efficacy expectations. Patient Education and Counseling, 36, 57-64.

Carney, R.M., Freedland, K.E., Eisen, S.A., Rich, M.W., & Jaffe, A.S. (1995). Major depression and medication adherence in elderly patients with coronary artery disease. Health Psychology, 14(1), 88-90.

Col, N., Fanale, J.E., & Kronholm, P. (1990). The role of medication noncompliance and adverse drug reactions in hospitalizations of the elderly. Archives of Internal Medicine, 150, 841-845.

Cooper, D., & Fraboni, M. (1988). Toward a more valid and reliable Health Locus of Control scale. Journal of Clinical Psychology, 44(4), 536-540.

Cooper, D., & Fraboni, M. (1990). Psychometric study of forms A and B of the Multidimensional Health Locus of Control scale. Psychological Reports, 66, 859-864.

Cooper, J.K., Love, D. W., & Raffoul, P.R. (1982). Intentional prescription nonadherence (noncompliance) by the elderly. Journal of the American Geriatrics Society, 30, 329-333.

Day, R.A., Moore, K.N., & Hodgins, M. (1998). The effects of instruction and practice on medication knowledge and compliance. Canadian Journal of Rehabilitation, 12(1), 15-24.

Delis, D.C., Kaplan, E., & Kramer, J.H. (2001). Delis-Kaplan Executive Function System (D-KEFS): Examiner's Manual. San Antonio, TX: Psychological Corporation.

References (Continued)

Delis, D.C., Kramer, J.H., Kaplan, E., & Ober, B.A. (1987). California Verbal Learning Test. San Antonio, TX: Psychological Corporation.

De Geest, S., Abraham, I., Gemoets, H., & Evers, G. (1994) Development of the long-term medication behaviour self-efficacy scale: qualitative study for item development. Journal of Advanced Nursing, 19, 233-238.

DiMatteo, M.R., Giordani, P.J., Lepper, H.S., & Croghan, T.W. (2002). Patient adherence and medical treatment outcomes: A meta-analysis. Medical Care, 40(9), 794-811.

Donovan, J.L. (1995). Patient decision making: The missing ingredient in compliance research. International Journal of Technology Assessment in Health Care, 11(3), 443-455.

Donovan, J.L., & Blake, D.R. (1992). Patient non-compliance: Deviance or reasoned decision-making? Social Science & Medicine, 34(5), 507-513.

Feurerstein, M., Labbé, E. E., & Kuczmierczyk, A.R. (1986). Health Psychology: A Psychobiological Perspective. New York: Plenum Press, pp. 248-277.

Folstein, M.L., Folstein, S.E., & McHugh, P.R. (1975). Mini-mental state: A practical method for grading the cognitive status of patients for the clinician. Journal of Psychiatric Research, 12, 189-198.

Glisky, E.L., & Glisky, M.L. (1999). Memory rehabilitation in the elderly. In D.T. Stuss, G. Winocur, & I.H. Robertson (Eds.), Cognitive Neurorehabilitation: A Comprehensive Approach. Cambridge: Cambridge University Press.

Gould, O.N., McDonald-Miszczak, L., & King, B. (1997). Metacognition and medication adherence: How do older adults remember? Experimental Aging Research, 23, 315-342.

Gravely, E.A., & Oseasohn, C.S. (1991). Multiple drug regimens: Medication compliance among veterans 65 years and older. Research in Nursing & Health, 14, 51-58.

Gurland, B.J., Cross, P., Chen, J., Wilder, D.E., Pine, Z.M., Lantigua, R.A., & Fulmer, T. (1994). A new performance test of adaptive cognitive functioning: The Medication Management (MM) test. International Journal of Geriatric Psychiatry, 9, 875-885.

References (Continued)

Health Canada Division of Aging and Seniors. Seniors in Canada – At a glance: Who are Canada's seniors?. Canada's Aging Population. http://www.hc-sc.gc.ca/seniors-aines/pubs/fed_paper/fedreport2_03_e.htm (last modified 20 August 2002).

Hovsepian, M. (2001). Modell's Drugs in Current Use and New Drugs 2001. New York: Springer Publishing.

Horne, R. & Weinman, J. (1998). Predicting treatment adherence: an overview of theoretical models. In L.B. Myers and K. Midence (Eds). Adherence to Treatment in Medical Conditions. Amsterdam: Harwood Academic Publishers, pp. 25-50.

Horne, R., & Weinman, J. (1999). Patients' beliefs about prescribed medicines and their role in adherence to treatment in chronic physical illness. Journal of Psychosomatic Research, 47(6), 555-567.

Horne, R., Weinman, J., & Hankins, M. (1999). The Beliefs about Medicines Questionnaire: the development and evaluation of a new method for assessing the cognitive representation of medication. Psychology and Health, 14, 1-24.

Hoyer, W.J, Rybash, J.M., & Roodin, P.A. (1999). Adult Development and Aging. Boston: McGraw-Hill (pp. 307-322).

Isaac, L.M., Tamblyn, R.M., & the McGill-Calgary Drug Research Team. (1993). Compliance and cognitive function: A methodological approach to measuring unintentional errors in medication compliance in the elderly. The Gerontologist, 33(6), 772-781.

Leirer, V.O., Morrow, D.G., Tanke, E.D., & Pariante, G.M. (1991). Elders' nonadherence: Its assessment and medication reminding by voice mail. The Gerontologist, 31(4), 514-520.

Lezak, M.D. (1995). Neuropsychological Assessment. New York: Oxford University Press.

Lorenc, L., & Branthwaite, A. (1993) Are older adults less compliant with prescribed medication than younger adults? British Journal of Clinical Psychology, 32, 485-492.

Maibach, E., & Murphy, D.A. (1995). Self-efficacy in health promotion research and practice: conceptualization and measurement. Health Education Research, 10(1), 37-50.

References (Continued)

Mann, L.S., Westlake, T., Wise, T.N., Beckman, A., Beckman, P., Brodeur, S., & Poretz, D. (1999). Executive functioning and compliance in HIV patients. Psychological Reports, 84, 319-322.

Marshall, G.N., Collins, B.E., & Crooks, V.C. (1990). A comparison of two multidimension health locus of control instruments. Journal of Personality Assessment, 54(1&2), 181-190.

McDaniel, M.A., & Einstein, G.O. (1992). Aging and prospective memory: Basic findings and practical applications. Advances in Learning and Behavioral Disabilities, 7, 87-105.

McDonald-Miszczak, L., Maki, S.A., & Gould, O.N. (2000). Self-reported medication adherence and health status in late adulthood: The role of beliefs. Experimental Aging Research, 26, 189-207.

McDowell, I., Kristjansson, B., Hill, G.B., & Hébert, R. (1997). Community screening for dementia: The Mini Mental State Exam (MMSE) and Modified Mini-Mental State Exam (3MS) compared. Journal of Clinical Epidemiology, 50(4), 377-383.

McGinnis, J.M. (1997). Tithonus revisited: Can preventive medicine change the aging process in our society? Annals of the Royal College of Physicians and Surgeons of Canada, 30(8), 467-470.

Miller, P., Wikoff, R., & Hiatt, A. (1992). Fishbein's Model of Reasoned Action and compliance behavior of hypertension patients. Nursing Research, 41(2), 104-109.

Morrell, R.W., Park, D.C., Kidder, D.P., & Martin, M. (1997). Adherence to antihypertensive medications across the life span. The Gerontologist, 37(5), 609-619.

Morrow, D.G., Leirer, V.O., Andrassy, J.M., Tanke, E.D., & Stine-Morrow, E.A.L. (1996). Medication instruction design: Younger and older adult schemas for taking medication. Human Factors, 38(4), 556-573.

Moscovitch, M. (1982). A neuropsychological approach to perception and memory in normal and pathological aging. In F.I.M. Craik & S. Trehub (Eds). Aging and Cognitive Processes. New York: Plenum Press, pp. 55-78.

Myers, L.B., & Myers, F. (1999). The relationship between control beliefs and self-reported adherence in adults with cystic fibrosis. Psychology, Health & Medicine, 4(4), 387-391.

References (Continued)

Park, D.C. (1999). Aging and the controlled and automatic processing of medical information and medical decisions. In D.C. Park, R.W. Morrell, & K. Shifren (Eds). Processing of Medical Information in Aging Patients: Cognitive and Human Factors Perspective. Mahwah, NJ: Lawrence Erlbaum Associates, pp. 3-19.

Park, D.C., Hertzog, C., Leventhal, H., Morrell, R.W., Leventhal, E., Birchmore, D., Martin, M, & Bennett, J. (1999). Medication adherence in rheumatoid arthritis patients: Older is wiser. Journal of the American Geriatric Society, 47, 172-183.

Park, D. & Jones, T. (1997). Medication adherence and aging. In A.D. Fisk & W.A. Rogers (Eds). Handbook of human factors and the older adult. San Diego, CA: Academic Press, pp. 257-287.

Park, D.C., & Kidder, D.P. (1996). Prospective memory and medication adherence. In M. Brandimonte, G.O. Einstein, & M.A. McDaniel (Eds). Prospective Memory: Theory and Applications. Mahwah, NJ: Lawrence Erlbaum Associates, pp. 369-390.

Park, D.C., Willis, S.L., Morrow, D., Diehl, M., & Gaines, C.L. (1994). Cognitive function and medication usage in older adults. The Journal of Applied Gerontology, 13(1), 39-57.

Park, D.C., Morrell, R.W., Frieske, D., & Kincaid, D. (1992). Medication adherence behaviors in older adults: Effects of external cognitive supports. Psychology and Aging, 7(2), 252-256.

Patrick, L., & Howell, K. (1998). Mental status and self-medication ability in the hospitalized elderly. Canadian Journal on Aging, 17(4), 425-439.

Poole, G., Matheson, D. H., & Cox, D.N. (2001). The Psychology of Health and Health Care: A Canadian Perspective. Toronto: Prentice Hall, pp. 18-29 and 187-195.

Raiz, L.R., Kilty, K.M., Henry, M.L., & Ferguson, R.M. (1999). Medication compliance following renal transplantation. Transplantation, 68(1), 51-55.

Raskin, s. & Buckheit, C. (2001). Novel measures of prospective memory. Paper presented at the meeting of the International Neuropsychological Society, Chicago, IL.

Regard, M. (1981a). Cognitive rigidity and flexibility: A neuropsychological study. Unpublished Ph.D. dissertation, University of Victoria.

Regard, M. (1981b). Stroop Test Victoria Version: Manual of Instructions and Norms. Victoria, BC: Test Material Sales Office, Psychology Clinic, University of Victoria.

References (Continued)

Reitan, R.M. (1986). Trail Making Test: Manual for Administration and Scoring. Tucson, AZ: Reitan Neuropsychology Laboratory.

Repchinsky, C. (Ed.) (2001). Compendium of Pharmaceuticals and Specialties, 36th Edition. Toronto: Canadian Pharmacists Association.

Robinson-Whelen, S., & Storandt, M. (1992). Factorial structure of two health belief measures among older adults. Psychology and Aging, 7(2), 209-213.

Rotter, J.B. (1954). Social learning and clinical psychology. Englewood Cliffs, NJ: Prentice-Hall. As cited in: Wallston, B.S., Wallston, K.A., Kaplan, G.D., & Maides, S.A. (1976). Development and validation of the Health Locus of Control (HLC) scale. Journal of Consulting and Clinical Psychology, 44(4), 580-585.

Royall, D.R., Mahurin, R.K., & Gray, K.F. (1992). Bedside assessment of executive cognitive impairment: The Executive Interview. American Geriatric Society, 40, 1221-1226.

Rutter, D.R., Quine, L., & Chesham, D.J. (1993). Social Psychological Approaches to Health. New York: Harvester Wheatsheaf, pp. 35-41.

Salthouse, T.A. (1996). The processing-speed theory of adult age differences in cognition. Psychological Review, 103(3), 403-428.

Sherer, M., Maddux, J., Mercandante, B., Prentice-Dunn, S., Jacobs, B., & Rogers, R. (1982). The self-efficacy scale: Construction and validation. Psychological Reports, 51, 663-671.

Spreen, O., & Strauss, E. (1998). A Compendium of Neuropsychological Tests: Administration, Norms, and Commentary, 2nd Edition. New York: Oxford University Press.

Statistics Canada for the Division of Aging and Seniors. Seniors taking medication. Canada's Seniors (No. 48). http://www.hc-sc.gc.ca/seniors-aines/pubs/factoids/en/no48.htm (10 July 2000).

Statistics Canada for the Division of Aging and Seniors. Seniors in Canada – At a Glance. Canada's Aging Population. http://www.hc-gc.ca/seniors-aines/pubs/fed_paper/fedreport2_03_e.htm (20 August 2002).

Svarstad, B.L., Chewning, B.A., Sleath, B.L., & Claesson, C. (1999). The brief medication questionnaire: A tool for screening patient adherence and barriers to adherence. Patient Education and Counseling, 37, 113-124.

References (Continued)

Tabachnick, B.G. & Fidell, L.S. (1989). Using Multivariate Statistics (2nd ed.). New York, NY: HarperCollins.

Tamblyn, R. & Perreault, R. Summary of encouraging the wise use of prescription medication by older adults. Publications of the National Forum on Health. http://wwwnfh.hc-sc.gc.ca/publicat/execsumm/tamblyn.htm (10 July 2000).

Taylor, S. E. (1999). Health Psychology. Boston: McGraw Hill, pp. 64-68.

Teng, E.T. & Chui, H.C. (1987). The Modified Mini-Mental State (3MS) examination. Journal of Clinical Psychiatry, 48(8), 314-318.

Tombaugh, T.N., McDowell, I., Kristjansson, B., & Hubley, A.M. (1996). Mini-Mental State Examination (MMSE) and the Modified MMSE (3MS): A psychometric comparison and normative data. Psychological Assessment, 8(1), 48-59.

Tranel, D., Anderson, S.W., & Benton, A. (1994). Development of the concept of `executive function' and its relationship to the frontal lobes. In F.Booler and J. Grafman (Eds.), Handbook of Neuropsychology, Vol. 9. Elsevier Science B.V., pp. 125-148.

Tuokko, H. & Hadjistavropoulos, T. (1998). An Assessment Guide to Geriatric Neuropsychology. Mahwah, NJ: Lawrence Erlbaum Associates.

Verdoux, H., Liraud, F., Assens, F., Abalan, F., & van Os, J. (2002). Social and clinical consequences of cognitive deficits in early psychosis: a two-year follow-up study of first-admitted patients. Schizophrenia Research, 1-2, 149-159.

Wall, R.E., Hinrichsen, G.A., & Pollack, S. (1989). Psychometric characteristics of the Multidimensional Health Locus of Control scales among psychiatric patients. Journal of Clinical Psychology, 45(1), 94-98.

Waller, K.V. & Bates, R.C. (1992). Health locus of control and self-efficacy beliefs in a healthy elderly sample. American Journal of Health Promotion, 6(4), 302-309.

Wallston, K.A., Stein, M.J., & Smith, C.A. (1994). Form C of the MHLC scales: A condition-specific measure of locus of control. Journal of Personality Assessment, 63(3), 534-553.

Wallston, K.A., Wallston, B.S., & DeVellis, R. (1978). Development of the Multidimensional Health Locus of Control (MHLC) Scales. Health Education Monographs, 6, 160-170.

References (Continued)

Wallston, B.S., Wallston, K.A., Kaplan, G.D., & Maides, S.A. (1976). Development and validation of the Health Locus of Control (HLC) scale. Journal of Consulting and Clinical Psychology, 44(4), 580-585.

Wechsler, D. (1997a). Administration and Scoring Manual Wechsler Adult Intelligence Scale - Third Edition. New York: Psychological Corporation.

Wechsler, D. (1997b). Technical Manual Wechsler Adult Intelligence Scale - Third Edition. New York: Psychological Corporation.

West, R.L. (1996). An application of prefrontal cortex function theory to cognitive aging. Psychological Bulletin, 120(2), 272-292.

Willis, S.L., Allen-Burge, R., Dolan, M.M., Bertrand, R.M., Yesavage, J., & Taylor, J.L. (1998). Everyday problem solving among individuals with Alzheimer's disease. The Gerontologist, 38(5), 569-577.

Wilson, B.A., Alderman, N., Burgess, P.W., Emslie, H., & Evans, J.J. (1996). Behavioural Assessment of the Dysexecutive Syndrome. Bury St. Edmunds: Thames Valley Test Company.

Woodruff, S.L., & Cashman, J.F. (1993). Task, domain, and general self-efficacy: A reexamination of the self-efficacy scale. Psychological Reports, 72, 423-432.

Zanetti, O., Vallotti, B., Frisoni, G.B., Geroldi, C., Bianchetti, A., Pasqualetti, P., & Trabucchi, M. (1999). Insight in dementia: When does it occur? Evidence for a nonlinear relationship between insight and cognitive status. Journal of Gerontology: Psychological Sciences, 54B(2), P100-P106.

Appendix A

General Self-Efficacy Scale (Sherer, et al., 1982)

Items are rated on a 14-point Likert-type scale ranging from "strongly disagree" scored as one to "strongly agree" scored as fourteen. Reversed items are converted for scoring. The higher the score, the higher the self-efficacy expectations.

When I make plans, I am certain I can make them work.

One of my problems is that I cannot get down to work when I should. (R)

If I can't do a job the first time, I keep trying until I can.

When I set important goals for myself, I rarely achieve them. (R)

I give up on things before completing them. (R)

I avoid facing difficulties. (R)

If something looks too complicated, I will not even bother to try it. (R)

When I have something unpleasant to do, I stick to it until I finish it.

When I decide to do something, I go right to work on it.

When trying to learn something new, I soon give up if I am not initially successful. (R)

When unexpected problems occur, I don't handle them well. (R)

I avoid trying to learn new things when they look too difficult for me. (R)

Failure just makes me try harder.

I feel insecure about my ability to do things. (R)

I am a self-reliant person.

I give up easily. (R)

I do not seem capable of dealing with most problems that come up in life. (R)

Appendix B

Multidimensional Health Locus of Control, Forms A and B (Wallston, et al. 1978)

All items are scored on a 6-point Likert-type scale, ranging from "strongly disagree" scored as one to "strongly agree" scored as six.

Internal Health Locus of Control (IHLC):

Form A:

If I get sick, it is my own behavior which determines how soon I get well again.

I am in control of my health.

When I get sick I am to blame.

The main thing which affects my health is what I myself do.

If I take care of myself, I can avoid illness.

Form B:

If I become sick, I have the power to make myself well again.

I am directly responsible for my health.

Whatever goes wrong with my health is my own fault.

My physical well-being depends on how well I take care of myself.

When I feel ill, I know it is because I have not been taking care of myself properly.

I can pretty much stay healthy by taking good care of myself.

Appendix B (Continued)

Powerful Others Health Locus of Control (PHLC):

Form A:

Having regular contact with my physician is the best way for me to avoid illness.

Whenever I don't feel well, I should consult a medically trained professional.

My family has a lot to do with my becoming sick or staying healthy.

Health professionals control my health.

When I recover from an illness, it's usually because other people (for example, doctors, nurses, family, friends) have been taking good care of me.

Regarding my health, I can only do what my doctor tells me to do.

Form B:

If I see an excellent doctor regularly, I am less likely to have health problems.

I can only maintain my health by consulting health professionals.

Other people play a big part in whether I stay healthy or become sick.

Health professionals keep me healthy.

The type of care I receive from other people is what is responsible for how well I recover from an illness.

Following doctor's orders to the letter is the best way for me to stay healthy.

Appendix B (Continued)

Chance Health Locus of Control (CHLC):

Form A:

No matter what I do, if I am going to get sick, I will get sick.

Most things that affect my health happen to me by accident.

Luck plays a big part in determining how soon I will recover from an illness.

My good health is largely a matter of good fortune.

No matter what I do, I'm likely to get sick.

If it's meant to be, I will stay healthy.

Form B:

Often I feel that no matter what I do, if I am going to get sick, I will get sick.

It seems that my health is greatly influenced by accidental happenings.

When I am sick, I just have to let nature run its course.

When I stay healthy, I'm just plain lucky.

Even when I take care of myself, it's easy to get sick.

When I become ill, it's a matter of fate.

Appendix C

Beliefs about Medicines Questionnaire (BMQ) (Horne et al., 1999)

All items are scored on a 5-point Likert-type scale, ranging from "strongly disagree" scored as one to "strongly agree" scored as five.

BMQ Specific:

Your views about medicines prescribed for you:

My health, at present, depends on my medicines.

Having to take medicines worries me.

My life would be impossible without my medicines.

Without my medicines I would be very ill.

I sometimes worry about long-term effects of my medicines.

My medicines are a mystery to me.

My health in the future will depend on my medicines.

My medicines disrupt my life.

I sometimes worry about becoming too dependent on my medicines.

My medicines protect me from becoming worse.

Appendix C (Continued)

BMQ General:

Your views about medicines in general:

Doctors use too many medicines.

People who take medicines should stop their treatment for a while every now and again.

Most medicines are addictive.

Natural remedies are safer than medicines.

Medicines do more harm than good.

All medicines are poisons.

Doctors place too much trust on medicines.

If doctors had more time with patients they would prescribe fewer medicines.

Many older people take multiple medications to maintain their health. But it can be difficult to take medications exactly the way your doctor prescribed them. Sometimes you may forget to take them, or you may decide they work better for you if you take them differently than the doctor suggested. I am interested in what factors are important to the way you take your medications.

I am conducting a study through the Department of Psychology at the University of Victoria. I am looking for volunteers who are over 65 years of age to participate in a study about medication management.

I will be asking you to answer questions about your health and will be giving you a series of problem solving tasks.

Participants must be able to read and speak English, and must be taking at least one prescription medication on a regular basis. You should be the primary person in charge of managing your medications.

If you are interested in this study of medication management, please call for more information.

Thank you for your interest!

Rhonda Feldman
University of Victoria

Office Telephone:

472-4466

Appendix D (Continued)

As appeared in Saanich News, May 30, 2001:

Psych grad to study seniors

A UVic psychology graduate student is looking for seniors to help her conduct a study on factors affecting medication use.

Rhonda Feldman intends to study the link between cognitive abilities like memory, problem solving and planning and the use of medication. "Everyone knows how important memory is in taking medication, but not much research has been done on how attitudes about health and the abilities to plan and solve problems affect how people manage their medications," she notes.

Feldman need [sic] about 20 volunteers over 65 who are managing their own prescriptions and can read and write English. She is willing to make house calls to complete her research. She expects her first visit to take about an hour and her second, a week later, would last about an hour and a half. Volunteers will be interviewed and asked to participate in various activities to test memory and problem solving abilities. To participate call Feldman at 472-44656.

Appendix E

Adherence Questionnaire (BMQ, Svarstad, Chewning, Sleath, and Claesson 1999).

A) OVERALL MEDICATION PROFILE:

1. Please list below all of the medications you took in the PAST WEEK. For each medication you list, please answer each of the questions in the box below.

IN THE PAST WEEK:

Medication Name and Strength	How many days did you take it?	How many times per day did you take it?	How many doses (e.g., pills) did you take each time?	How many times did you miss taking a dose?	For what reason were you taking it?	How well does the medicine work for you 1 = well 2 = okay 3 = not well
						1 2 3
						1 2 3
						1 2 3
						1 2 3
						1 2 3
						1 2 3
						1 2 3

2. Below is a list of problems that people sometimes have with their medicines. Please check how hard it is for you to do each of the following:

	Very Hard	Somewhat Hard	Not Hard At all	COMMENTS (Which medicine)
Open or close the medication bottle	____	____	____	_____
Read the print on the bottle	____	____	____	_____
Remember to take all the pills	____	____	____	_____
Get your refills in time	____	____	____	_____
Take So Many Pills at the same time	____	____	____	_____

3. Do any of your medications bother you in any way? YES____ NO____

a. IF YES, please name the medication and check below how much it bothers you.

	How Much Did It Bother You?				
Name Of Medication	A Lot	Some	A Little	Never	In what way did it bother you?
_____	____	____	_____	_____	_____
_____	____	____	_____	_____	_____
_____	____	____	_____	_____	_____

4. Was it harder to remember to take your medication during some parts of the week? YES____ NO____

a. IF YES, please check which was hardest. Weekdays ____ Weekends ____

Appendix E (Continued)

Scoring of the Adherence Questionnaire:

Regimen Screen (Questions 1a-1e)

Did R fail to list the prescribed drug in the initial (spontaneous) report?	1=yes 0=no
Did R stop or interrupt therapy due to a late refill or other reason?	1=yes 0=no
Did R report any missed days or doses?	1=yes 0=no
Did R reduce or cut down the prescribed amount per dose?	1=yes 0=no
Did R take any extra doses or more medication than prescribed?	1=yes 0=no
Did R report "don't know" in response to any questions?	1=yes 0=no
Did R refuse to answer any questions?	1=yes 0=no

NOTE: Score of ≥ 1 indicates positive screen for potential nonadherence.

Belief Screen (Questions 1g and 2-2a)

Did R report "not well" or "don't know" in response to Q 1g?	1=yes 0=no
Did R name the prescribed drug as a drug that bothers him/her?	1=yes 0=no

NOTE: Score of ≥ 1 indicates positive screen for belief barriers.

Recall Screen (Questions 1c and 3c)

Did R receive a multiple dose regimen (2 or more times/day)?	1=yes 0=no
Did R report "very hard" or "somewhat hard" in response to Q 3c?	1=yes 0=no

NOTE: Score of ≥ 1 indicates positive screen for recall barriers.

R = respondent

Appendix F

Reported Adherence to Medication scale (RAM) Horne, et al. (1999)

(1) I sometimes forget to take my medicines.

1	2	3	4	5
Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

(2) I sometimes alter the dose of my medication to suit my own needs.

1	2	3	4	5
Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree

(3) Some people forget to take their medicines. How often does this happen to you?

1	2	3	4	5
Very Often	Often	Sometimes	Rarely	Never

(4) Some people I have talked to say that they miss out a dose of their medication or adjust it to suit their own needs. How often do you do this?

1	2	3	4	5
Very Often	Often	Sometimes	Rarely	Never

Appendix G

Intentionality Questionnaire

Many people take their medicines differently than instructed to by their doctor. They may forget to take their medicines at the right time, or they may miss a dose completely. People can also choose for many reasons to take their medicines in a different manner than prescribed.

When you **do not** take your medication as it was prescribed, how often is it because:

You feel you do not always need to take your medicine.

1	2	3	4	5
Very Often	Often	Sometimes	Rarely	Never

The medicine produces unpleasant side effects.

1	2	3	4	5
Very Often	Often	Sometimes	Rarely	Never

The medicine is difficult to take (e.g., swallow).

1	2	3	4	5
Very Often	Often	Sometimes	Rarely	Never

You feel you need more medicine than was prescribed.

1	2	3	4	5
Very Often	Often	Sometimes	Rarely	Never

You are busy and do not have time to take your medicine.

1	2	3	4	5
Very Often	Often	Sometimes	Rarely	Never

Appendix G (Continued)

You are not sure how to take the medicine as prescribed.

1	2	3	4	5
Very Often	Often	Sometimes	Rarely	Never

The medicine is expensive.

1	2	3	4	5
Very Often	Often	Sometimes	Rarely	Never

It slips your mind to take your medicine.

1	2	3	4	5
Very Often	Often	Sometimes	Rarely	Never

Appendix H

All scores included in regression analyses

- Multidimensional Health Locus of Control Scale (MHLC) total score
- Beliefs About Medicines Questionnaire (BMQ) Difference score (Specific Necessity minus Specific Concerns)
- General Self-Efficacy Scale total score
- Intentional Nonadherence subscale total score and Unintentional Nonadherence subscale total score

- Verbal fluency (FAS) total score
- WAIS Similarities total score
- WAIS Digit Symbol total score
- WAIS Digit Span Forward total score
- WAIS Digit Span Backward total score
- WAIS Letter Number Sequencing total score
- BADS Cards Trial 2 total number of errors (score direction reversed)
- BADS Action Error total score (score direction reversed)
- Trails A time in seconds (score direction reversed)
- Trails B time in seconds (score direction reversed)
- Stroop Dots time in seconds (score direction reversed)
- Stroop Interference calculated score (Stroop Colour Word time / Dot time) (score direction reversed)
- MIST (prospective memory test) total score
- CVLT Long Delay Free Recall score

- Adherence Questionnaire total score (score direction reversed)
- RAM total score

Appendix I

Contributing scores to a priori composites

Cognitive Functioning Composite: (average of the following z-scores)

- Verbal fluency (FAS) total score
- WAIS Similarities total score
- BADS Cards Trial 2 total number of errors (score direction reversed)
- Trails B time in seconds (score direction reversed)
- Stroop Interference calculated score (Stroop Colour Word time / Dot time) (score direction reversed)
- BADS Action Error total score (score direction reversed)
- WAIS Digit Symbol total score
- Trails A time in seconds (score direction reversed)
- Stroop Dots time in seconds (score direction reversed)
- WAIS Digit Span Forward total score
- WAIS Digit Span Backward total score
- WAIS Letter Number Sequencing total score
- MIST (prospective memory test) total score
- CVLT Long Delay Free Recall score

Health Belief Composite: (average of the following z-scores)

- Multidimensional Health Locus of Control Scale (MHLC) total score
- Beliefs About Medicines Questionnaire (BMQ) Difference score (Specific Necessity minus Specific Concerns)
- General Self-Efficacy Scale total score

Appendix I (Continued)

Executive Function Composite: (average of the following z-scores)

- Verbal fluency (FAS) total score
- WAIS Similarities total score
- BADS Cards Trial 2 total number of errors (score direction reversed)
- Trails B time in seconds (score direction reversed)
- Stroop Interference calculated score (Stroop Colour Word time / Dot time) (score direction reversed)
- BADS Action Error total score (score direction reversed)

Processing Speed Composite: (average of the following z-scores)

- WAIS Digit Symbol total score
- Trails A time in seconds (score direction reversed)
- Stroop Dots time in seconds (score direction reversed)

Memory Composite: (average of the following z-scores)

- WAIS Digit Span Forward total score
- WAIS Digit Span Backward total score
- WAIS Letter Number Sequencing total score
- MIST (prospective memory test) total score
- CVLT Long Delay Free Recall score

Appendix J

Contributing scores for factor composites

Executive Function Factor (average of the following standardized scores):

- Verbal fluency (FAS) total score
- WAIS Similarities total score
- BADS Cards Trial 2 total number of errors (score direction reversed)
- Trails B time in seconds (score direction reversed)
- Stroop Interference calculated score (Stroop Colour Word time / Dot time) (score direction reversed)

Memory Factor 1 (average of the following standardized scores):

- WAIS Digit Span Forward total score
- WAIS Digit Span Backward total score
- WAIS Letter Number Sequencing total score

Memory Factor 2 (average of the following standardized scores):

- MIST (prospective memory test) total score
- CVLT Long Delay Free Recall score

Appendix K

Descriptive statistics for all measures included in the regression analyses

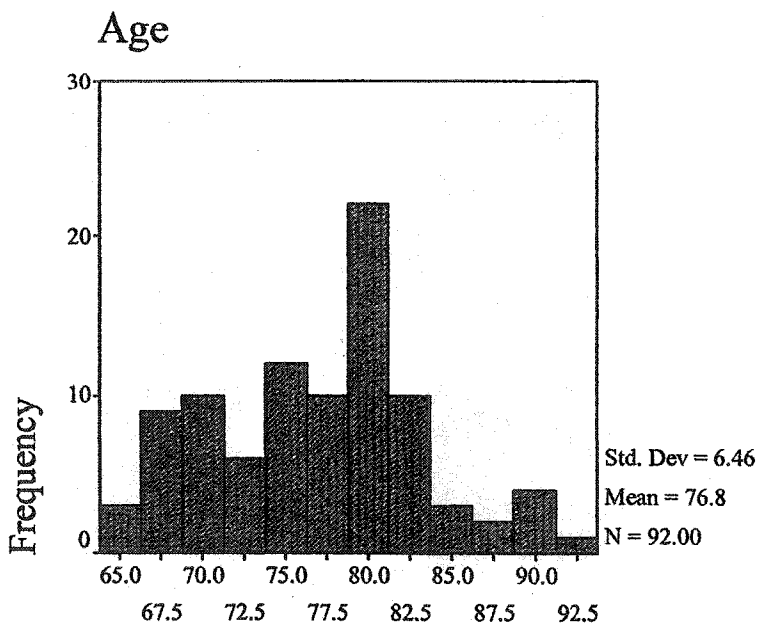
	N		Mean	Std. Deviation	Range	Minimum	Maximum
	Valid	Missing					
Age	92	0	76.82	6.46	27.00	65.00	92.00
Years Of Education	92	0	14.79	3.84	18.00	8.00	26.00
Number Of Medications	92	0	4.75	2.59	12.00	1.00	13.00
3MS	92	0	93.93	4.15	19.00	81.00	100.00
Executive Function Composite	92	0	.05	.49	2.52	-1.45	1.07
Speed Composite	92	0	.05	.72	3.52	-1.84	1.68
Memory Composite	89	3	.02	.61	2.90	-1.49	1.41
Health Beliefs Composite	91	1	.01	.63	3.32	-1.51	1.80
MHLC Internal Locus	92	0	52.96	8.36	40.00	30.00	70.00
MHLC Powerful Person	92	0	41.37	9.93	46.00	19.00	65.00
MHLC Chance Locus	92	0	32.20	8.59	37.00	12.00	49.00
MHLC Total Score	92	0	126.46	18.36	92.00	77.00	169.00
BMQ Differential	92	0	7.28	5.25	25.00	-6.00	19.00
GSES Total	91	1	173.66	30.73	123.00	112.00	235.00
Intentional Nonadherence	92	0	17.11	2.64	10.00	10.00	20.00
Unintentional Nonadhernce	92	0	17.97	1.79	7.00	13.00	20.00
Digit Span Forward	91	1	10.13	2.15	10.00	6.00	16.00
Digit Span Backward	90	2	6.90	2.10	9.00	4.00	13.00
FAS Total	92	0	39.50	10.66	52.00	14.00	66.00
WAIS Similarities	92	0	23.64	4.41	22.00	10.00	32.00

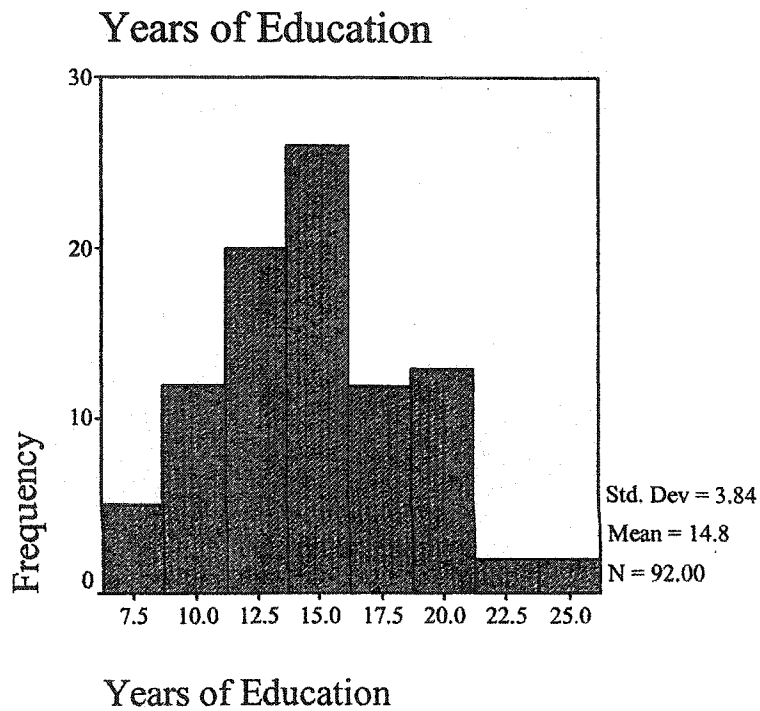
Appendix K (Continued)

	N		Mean	Std. Deviation	Range	Minimum	Maximum
	Valid	Missing					
WAIS Digit Symbol	92	0	54.77	11.40	60.00	35.00	95.00
CVLT Long Delay Free Recall	92	0	9.34	2.81	13.00	2.00	15.00
Trails A Time	92	0	39.37	11.60	64.00	22.00	86.00
Trails B Time	92	0	107.99	38.49	180.00	41.00	221.00
Stroop Dots Time	92	0	15.05	4.11	23.00	8.00	31.00
Stroop Interference C/D	92	0	2.50	.75	3.57	1.29	4.86
BADS Action Errors	92	0	.88	.74	3.00	.00	3.00
Adherence Questionnaire Total	92	0	2.76	1.72	7.00	.00	7.00
RAM Total	92	0	17.08	2.40	10.00	10.00	20.00

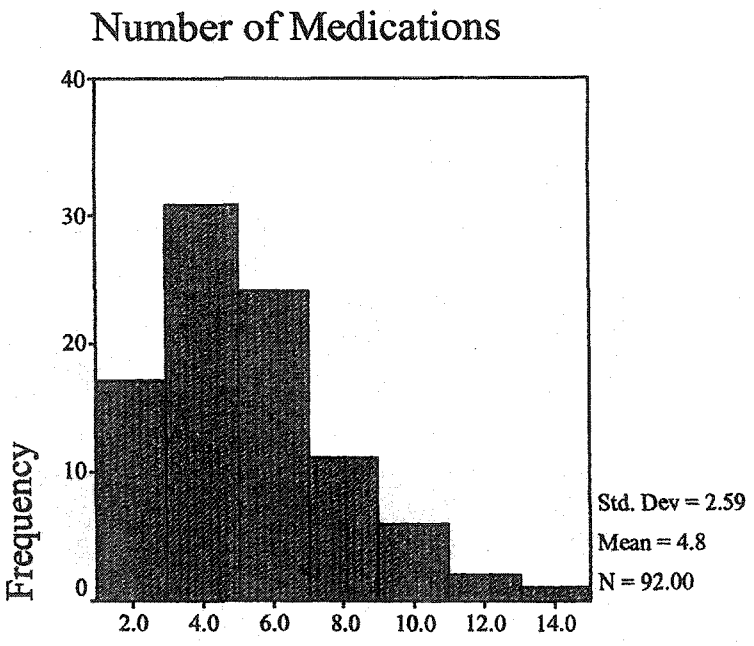
Appendix L

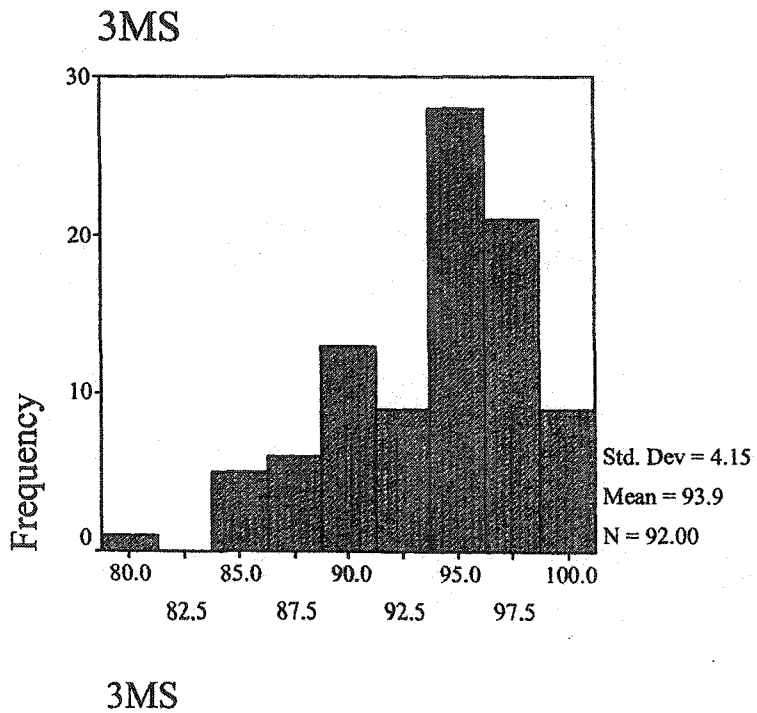
Frequency distribution histograms for all measures included in data analyses





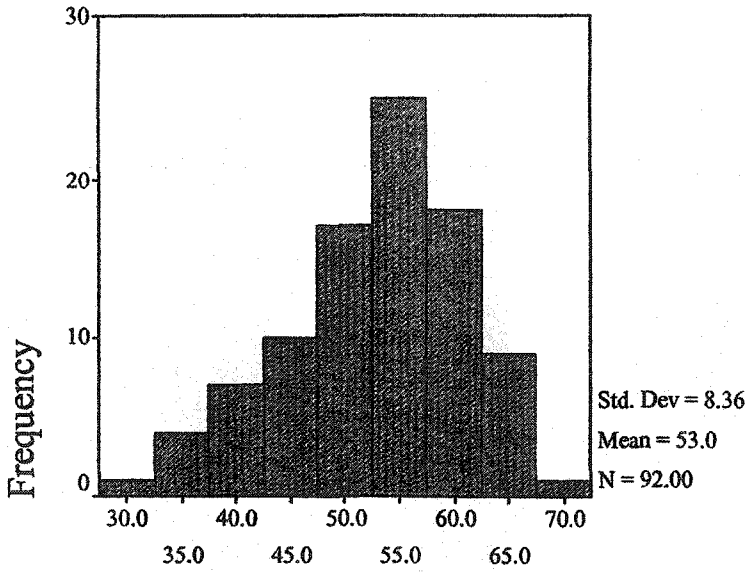
Appendix L (Continued)



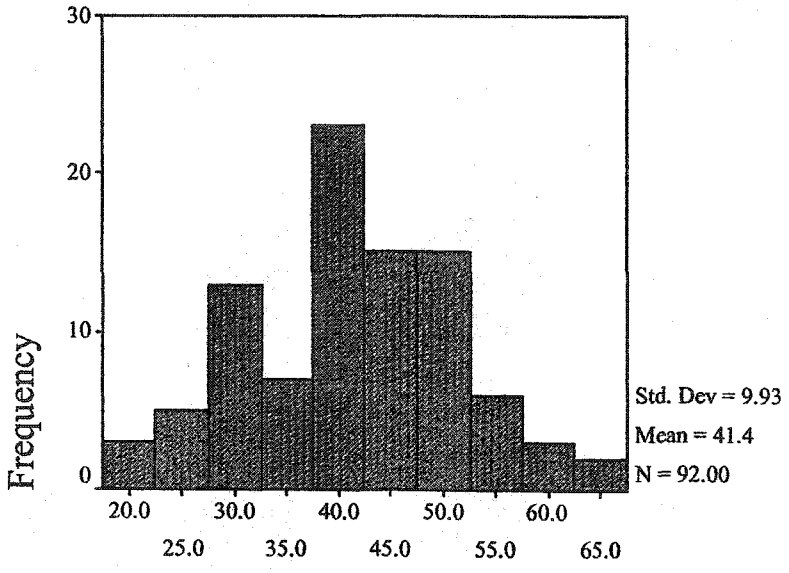


Appendix L (Continued)

MHLC Internal Locus of Control

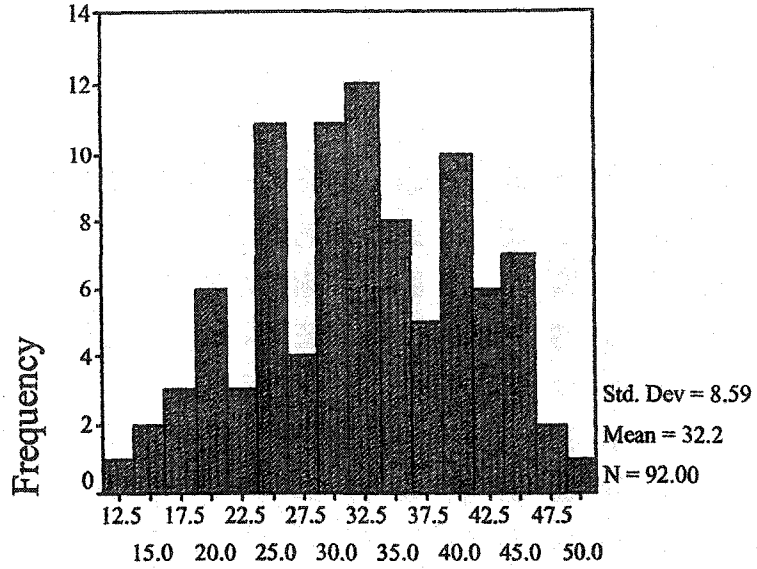


MHLC Powerful Person Locus of Control



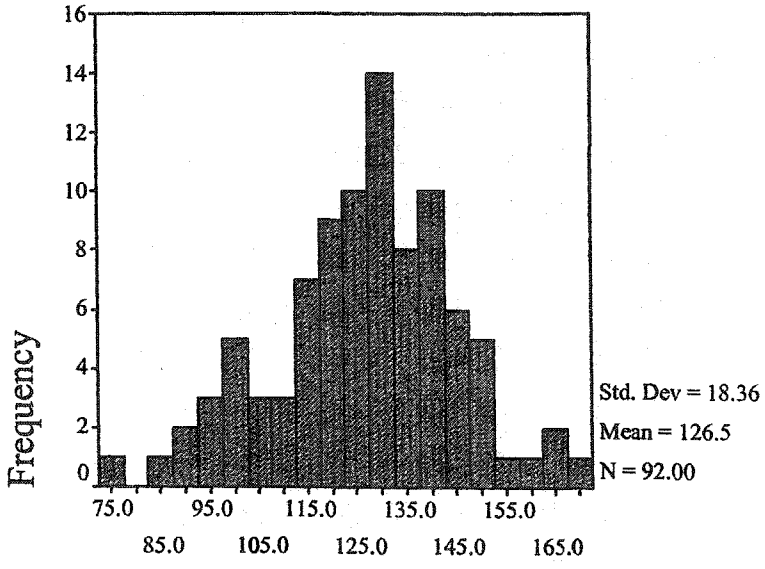
Appendix L (Continued)

MHLC Chance Locus of Control



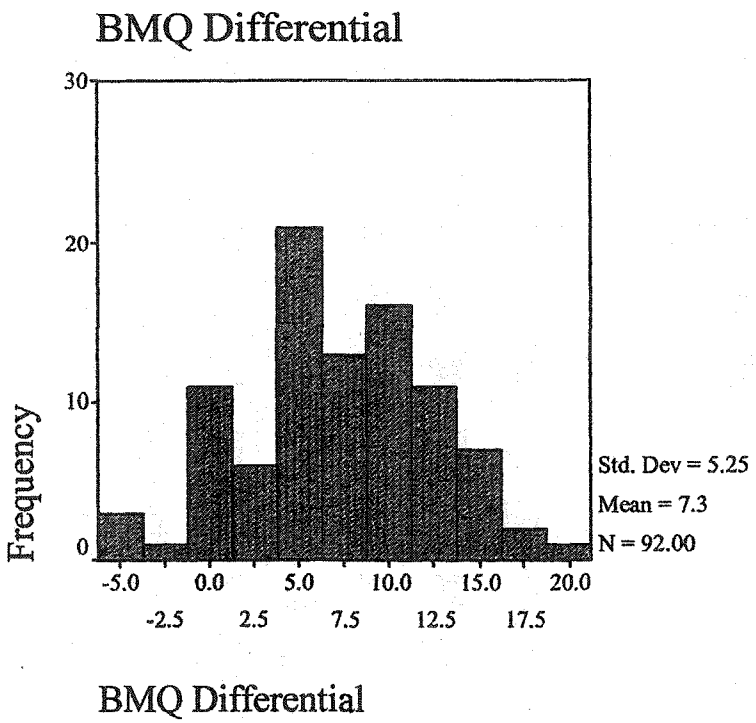
MHLC Chance Locus

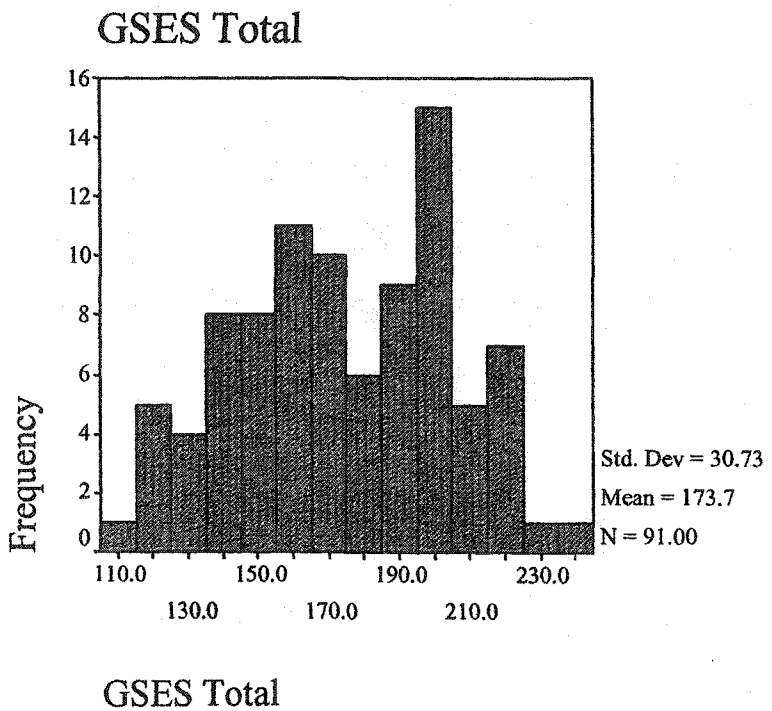
MHLC Total Score



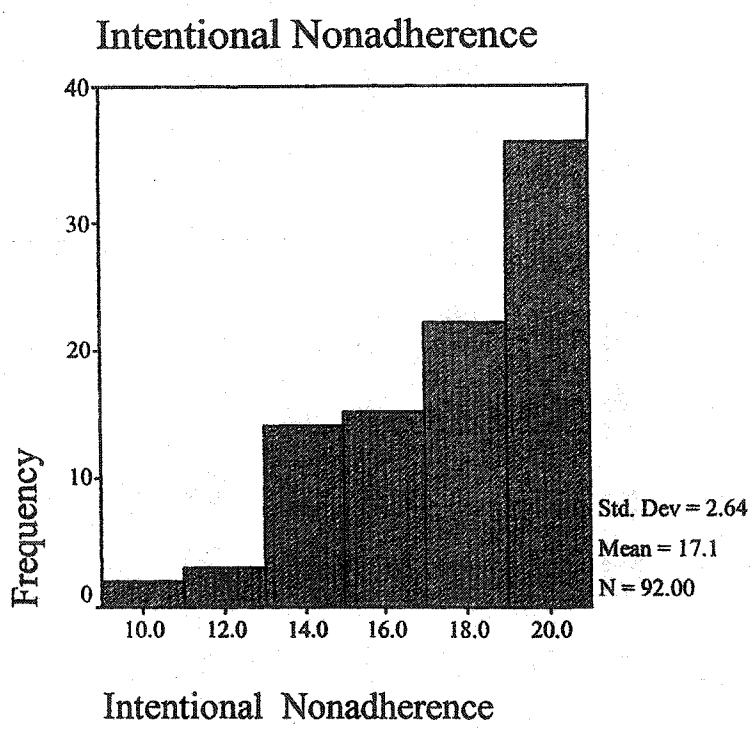
MHLC Total Score

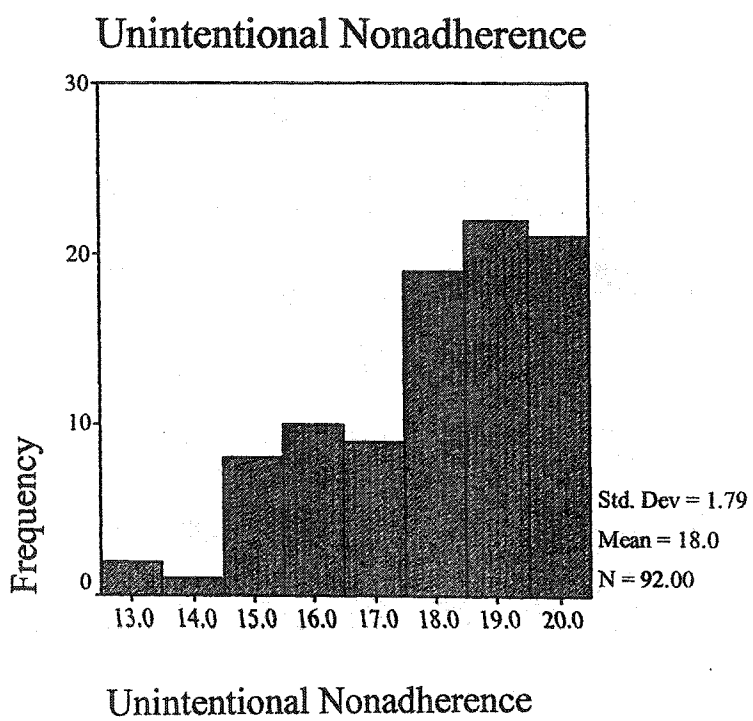
Appendix L (Continued)



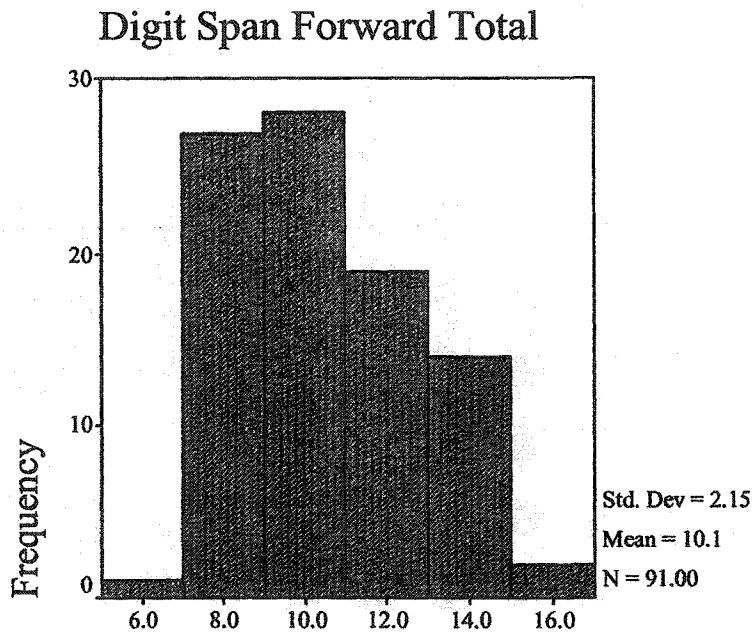


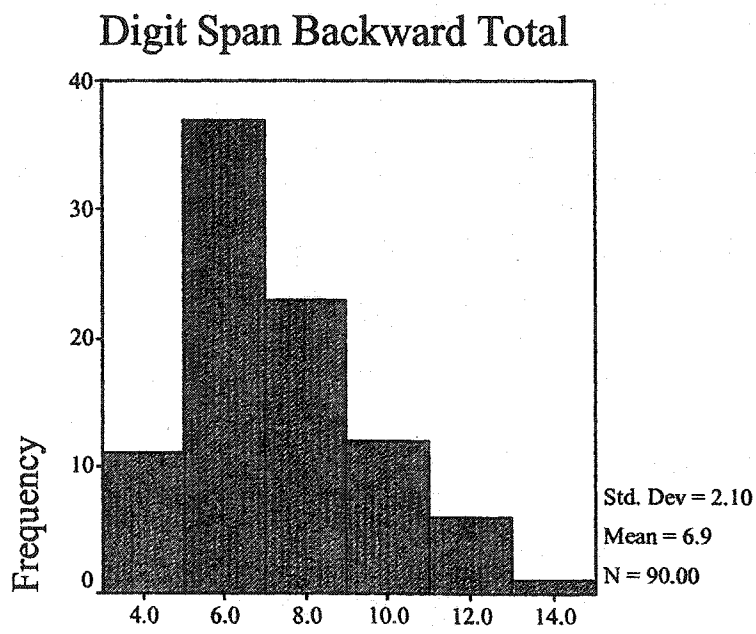
Appendix L (Continued)



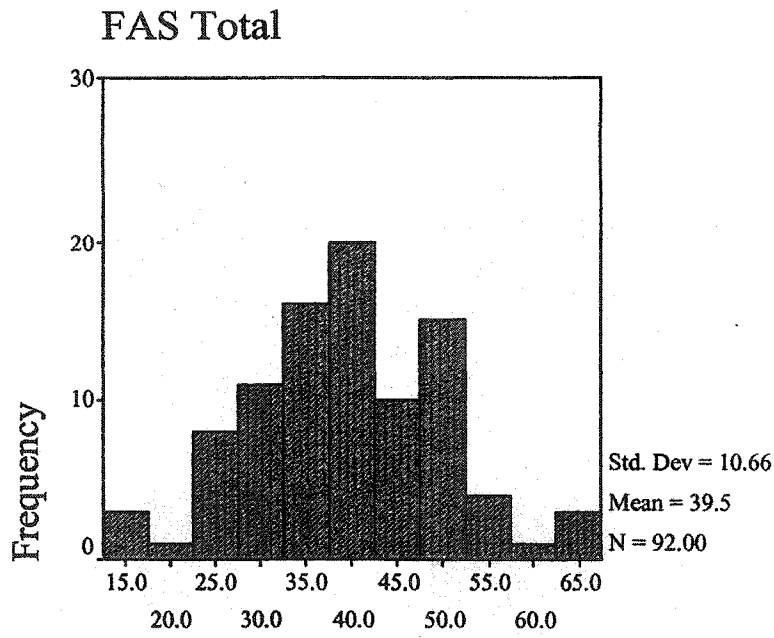


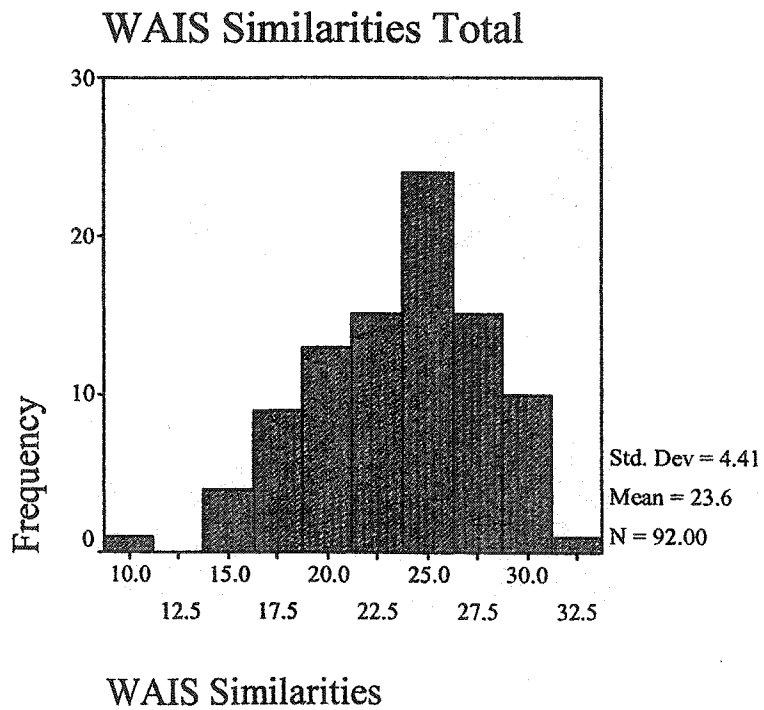
Appendix L (Continued)



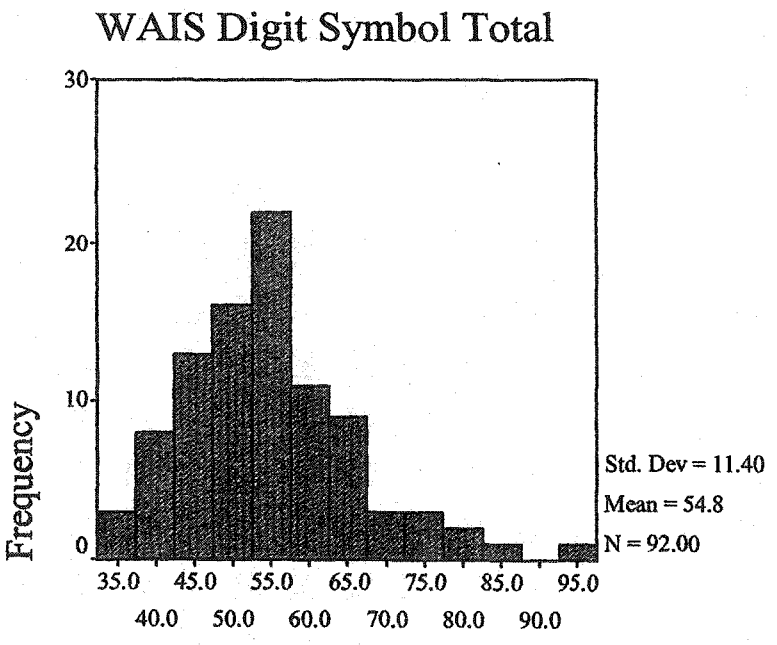


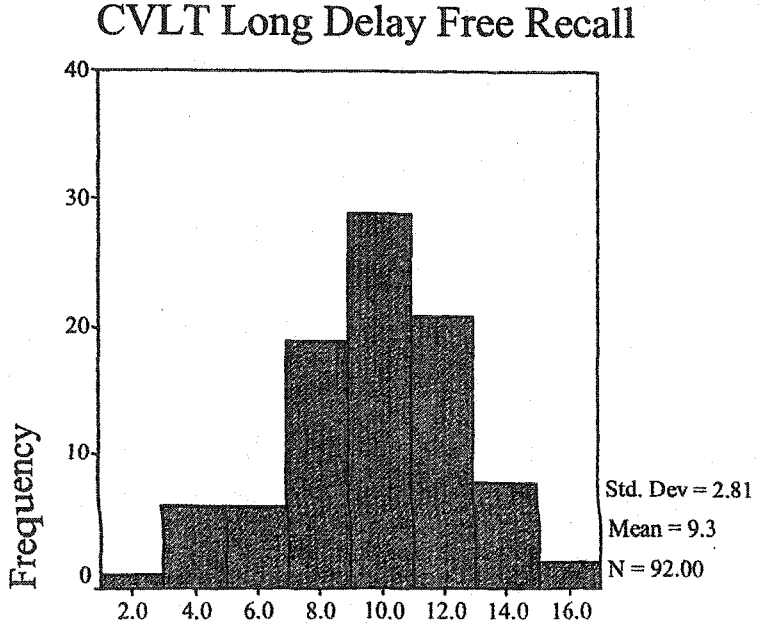
Appendix L (Continued)



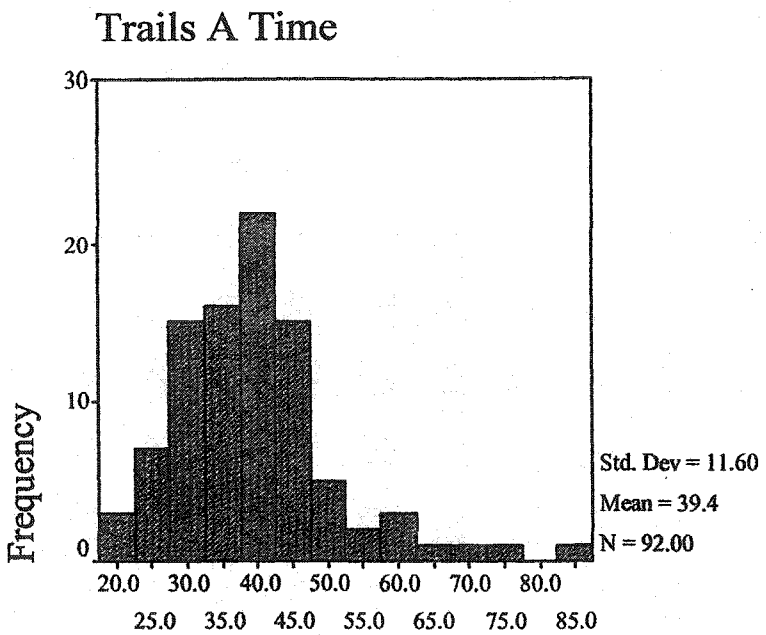


Appendix L (Continued)

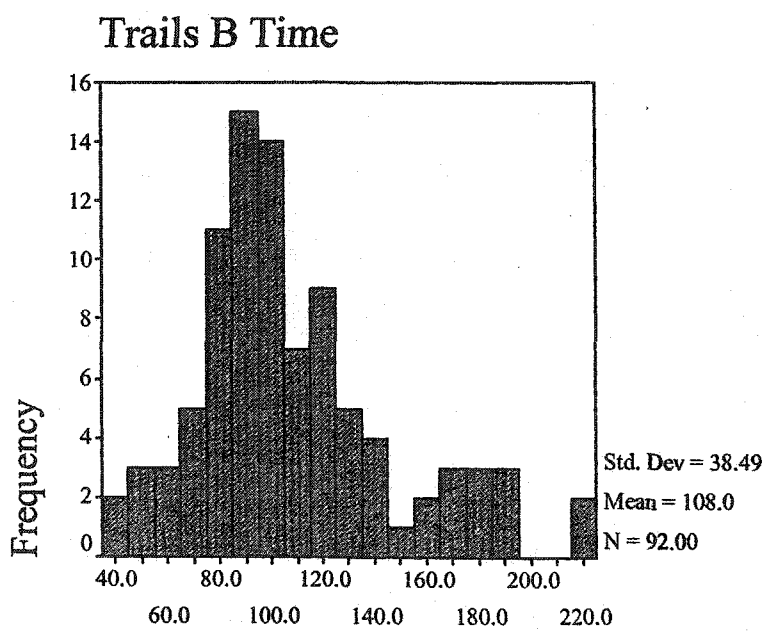




Appendix L (Continued)

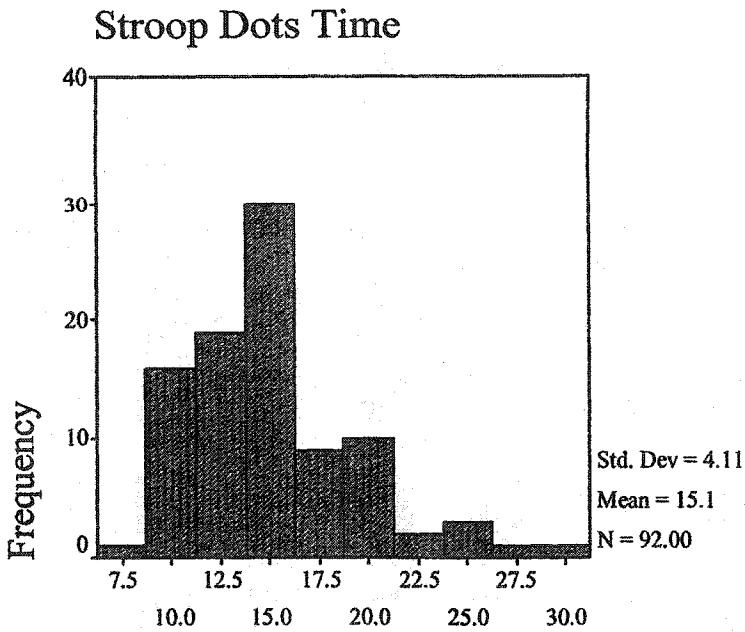


Trails A Time

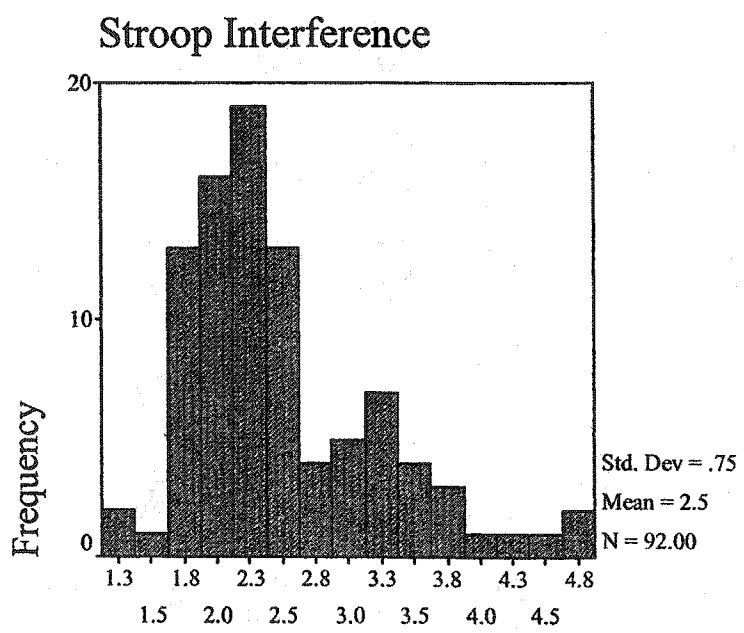


Trails B Time

Appendix L (Continued)

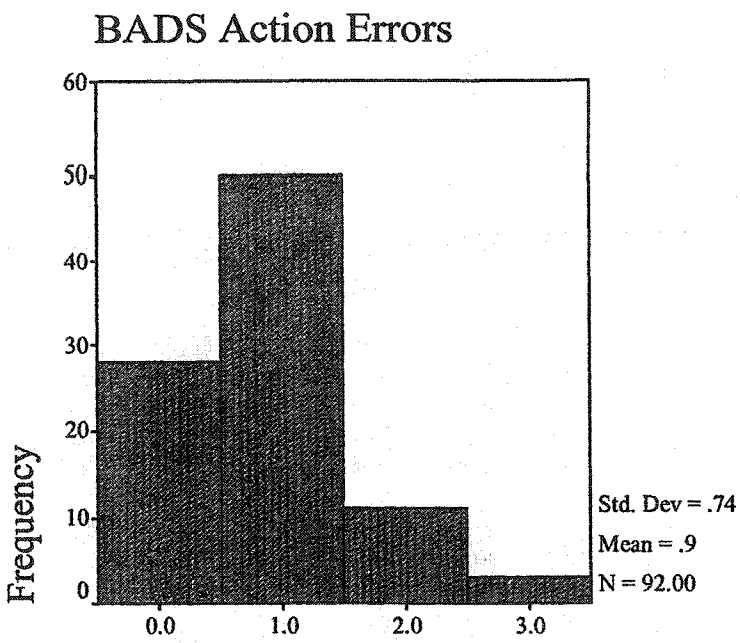


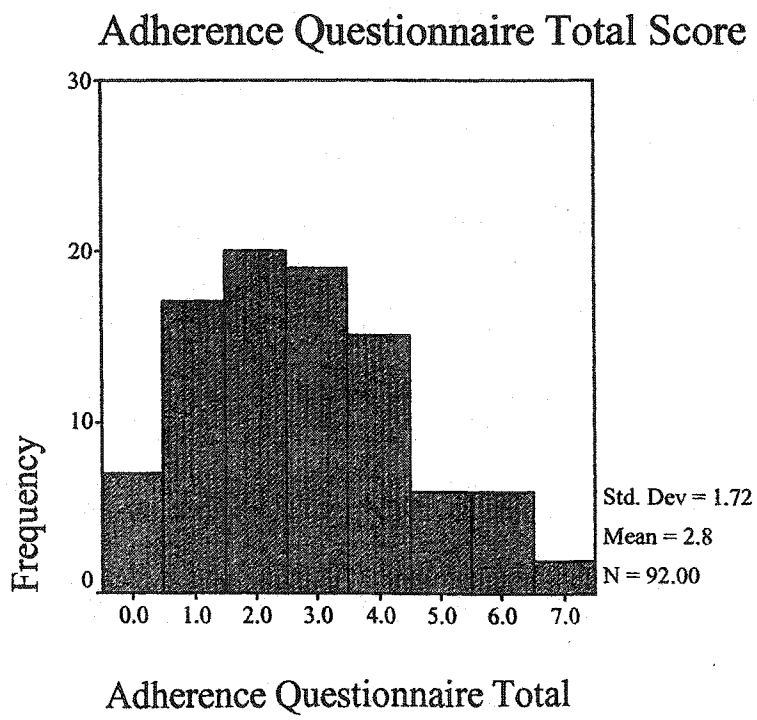
Stroop Dots Time



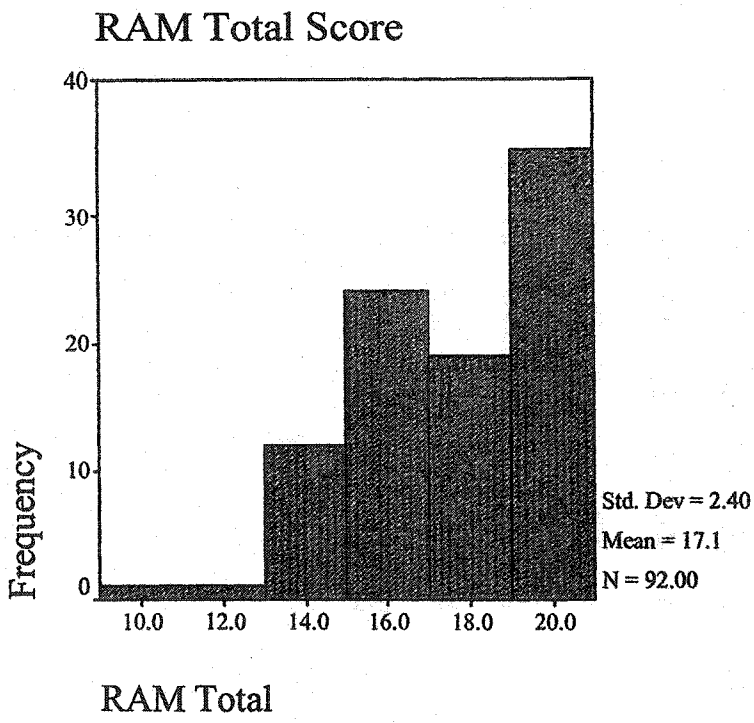
Stroop Interference C/D

Appendix L (Continued)





Appendix L (Continued)



Appendix M

Correlations of the number of medications and cognitive variables

	Number of Medications	3MS	Executive Function Composite	Speed Composite	Memory Composite
Number of Medications	1.00 N = 92	.19 N = 92	.04 N = 92	-.16 N = 92	.08 N = 89
3MS	.19 N = 92	1.00 N = 92	.43** N = 92	.45** N = 92	.47** N = 89
Executive Function Composite	.04 N = 92	.43** N = 92	1.00 N = 92	.35** N = 92	.46** N = 89
Speed Composite	-.16 N = 92	.45** N = 92	.35** N = 92	1.00 N = 92	.23* N = 89
Memory Composite	.08 N = 89	.47** N = 89	.46** N = 89	.23* N = 89	1.00 N = 89

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Appendix N

Correlation tables of measures contributing to composites

Correlations of Individual Measures Contributing to the Memory Composite

	Digit Span Forward	Digit Span Backward	Letter-Number Sequencing	CVLT Long Delay Free Recall	MIST Total Score
Digit Span Forward	1.00	.52**	.32**	.11	.08
Digit Span Backward	.52**	1.00	.42**	.11	-.02
Letter-Number Sequencing	.32**	.42**	1.00	.39**	.24*
CVLT Long Delay Free Recall	.11	.11	.39**	1.00	.22*
MIST Total Score	.08	-.02	.24*	.22*	1.00

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
N = 89

Correlations of Individual Measures Contributing to the Executive Function Composite

	FAS Total	Similarities	BADS Cards Trial 2 Errors	Trails B Time	Stroop Interference	BADS Action Errors
FAS Total	1.00	.39**	.07	.30**	.19	.02
Similarities	.39**	1.00	.09	.31**	.31**	.02
BADS Cards Trial 2 Errors	.07	.09	1.00	.40**	.21*	-.10
Trails B Time	.30**	.31**	.40**	1.00	.31**	-.14
Stroop Interference	.19	.31**	.21*	.31**	1.00	-.15
BADS Action Errors	.02	.02	-.10	-.14	-.15	1.00

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
N = 92

Appendix N (Continued)

Correlations of Individual Measures Contributing to the Processing Speed Composite

	Digit Symbol	Trails A Time	Stroop Dots Time
Digit Symbol	1.00	.43**	.54**
Trails A Time	.43**	1.00	.30**
Stroop Dots Time	.54**	.30**	1.00

**. Correlation is significant at the 0.01 level (2-tailed).
N = 92

Correlations of the Cognitive Function Composites

	Speed Composite	Memory Composite	Executive Function Composite
Speed Composite	1.00	.23* N = 89	.35** N = 92
Memory Composite	.23* N = 89	1.00	.46** N = 89
Executive Function Composite	.35** N = 92	.46** N = 89	1.00

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Correlations of the Health Belief Variables

	MHLC Total Score	GSES Total Score	BMQ Differential
MHLC Total Score	1.00	-.08 N = 91	.04 N = 92
GSES Total Score	-.08 N = 91	1.00	.07 N = 91
BMQ Differential	.04 N = 92	.07 N = 91	1.00

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).